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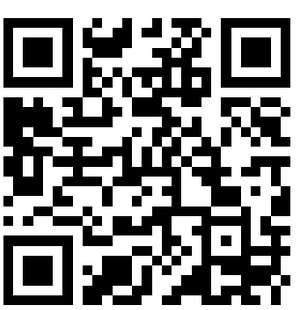

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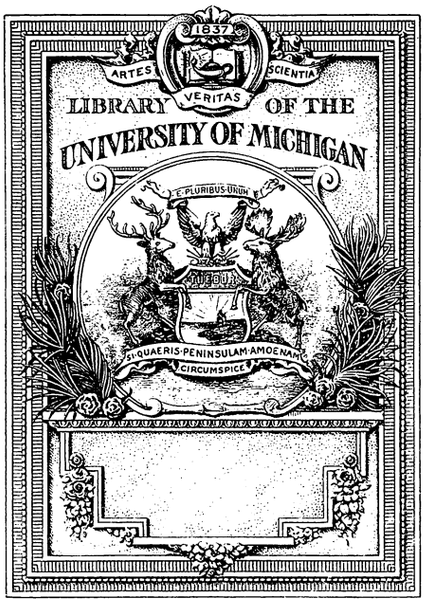

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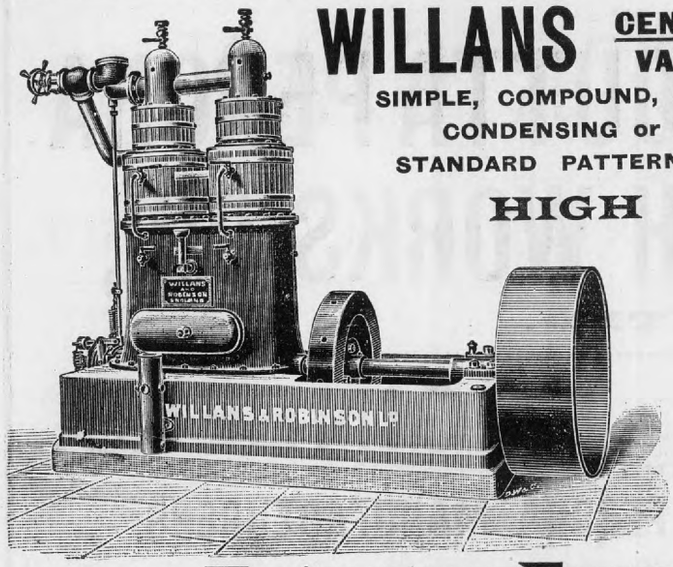

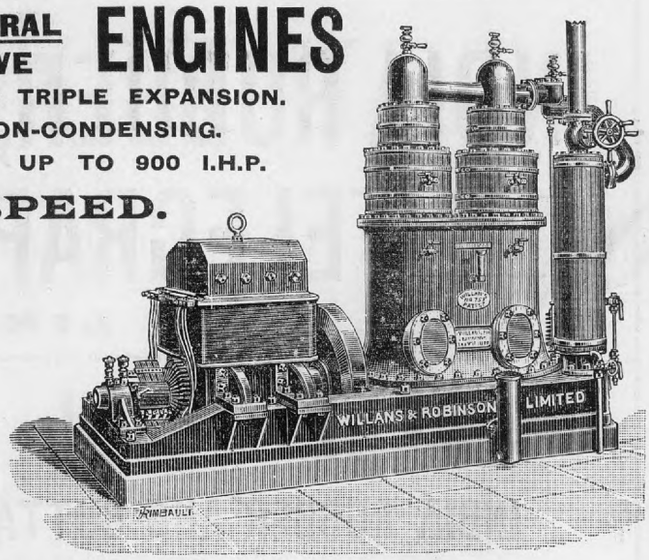

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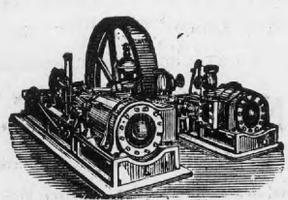

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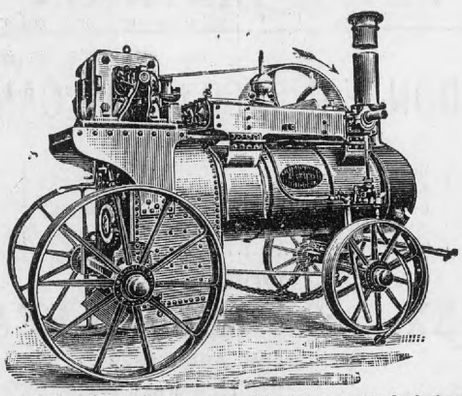

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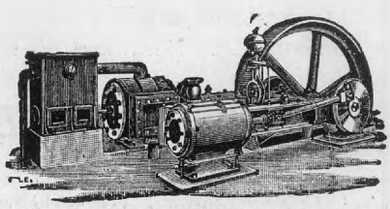

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 755.—Vol. XXX. FRIDAY, NOVEMBER 4, 1892. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6.

NOTES.

The system of inviting tenders to a specification to give an appearance of impartiality, when the destination of a contract as been already settled, is, as Lord Russell complains in our Correspondence columns, a crying evil. Certain offenders are already sufficiently known to the trade, but inexperienced firms are likely to be caught by this and other tricks, which it is almost impossible to prevent. There are, however, cases in which the invitation of one or two other contractors is justifiable. A consulting engineer, for example, may be asked to draw a specification, and to give a rough idea of the probable cost, for the purpose, perhaps, of defining the extent of the work. It is altogether indefensible that before sending out the real specification he should get one or two preliminary tenders to aid him in giving a rough estimate to his client, who expects him to have this requisite knowledge. But the client may be disposed to give the order to some firm with whom he has already done business. He asks that two or three copies of the specification should be sent to leading firms, that their estimates may be used as checks. If the specification is full and clearly drawn not much harm is done, but a distinction might be made between a mere estimate and a regular tender. In the case which we have suggested it would be most unjust to invite an inspection of sites or any proceeding that would incur special expenses; and on the same grounds the preparation of elaborate plans, calculations and designs should not be demanded.

The other suggestion of Lord Russell's is reasonable. One guinea should be enough to keep off the inquisitive, but a further refinement of what sometimes amounts to a petty extortion is the sub-division of the specification into half-a-dozen or more guineas' worth. The question of the return of the guinea on receipt of a *bonâ fide* tender is outside the present subject.

The investigations which M. Ricco has made upon the relation between the passage of sunspots across the sun's disc and the magnetic disturbances which generally accompany them are rather annoying. We have an ether, we hope only one, and its duty is to transmit light and electrical oscillations, which are indeed the same thing; whether electrical disturbances travel at a different speed in a wire or a vacuum tube being another matter. The difference between various determinations of the velocity of light and of the propagation of electrical disturbances is now within the limits of experimental error; but M. Ricco, in his contribution to the Académie des Sciences, which will be found on page 8 of our present issue, suggests that something—not sunspots and not earth-currents—is propagated at the most irregular and unheard of speed of 913 kilometres per second, or 335 times slower than light. This result is arrived at by reckoning the difference in time between the passage of the principal spot across the central meridian and that of the greatest deviation of the magnetometer from the mean declination. It might most reasonably have been supposed that the intensity of any terrestrial phenomena would have been proportional to the projected area of the sunspots, or if not extending over so long a period, to the area of the nucleus. M. Ricco does not take into account the duration of the magnetic disturbance, and his communication gives no clue to any comparison between the two phenomena as a whole. Under these circumstances the apparent retardation must be accepted with caution, and in the meantime no new variety of ether or extraordinary behaviour of the present one need be postulated.

Professor Tilden calls attention in *The Times* to the abuse of scientific titles, and by this he includes both the diversity of the "letters which are supposed to indicate membership of some learned body" and the highly improper uses which are often made of them. He divides these bodies into two classes, "corporations which have been instituted and intrusted with powers for the purpose of applying a test of professional knowledge and skill, and of granting diplomas or certificates of efficiency," and "voluntary associations of men interested in the pursuit of some common subject of study, and desirous of promoting its advancement . . . more especially by the diffusion of information by means of meetings and the publications of journals or otherwise." The abuses to which he alludes are the reference to the titles of the second class "by witnesses in courts of law or candidates for public appointments as evidence of professional trustworthiness," and in testimonials or reports by public analysts.

While giving a dozen examples of each class, the letters M.I.E.E. and A.M.I.E.E. do not appear in either, and we will not venture to do what Prof. Tilden has either omitted or shirked. We are glad to hear a report that the Council of the Institution of Electrical Engineers are now exercising some care in electing its members, but a considerable time must elapse before the difference in the two orders means much more than a

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difference in the subscription. Prof. TILDEN does not allude to that strange tag C.E., which any ironmonger or builder may write after his name if he likes, and it is possible that if any serious qualifications had been asked from candidates for election by the Institution of Electrical Engineers in former years, a tribe of E.E.'s or perhaps mere E.'s might have sprung up.

THE St. Pancras Vestry's central lighting station is the Mecca to which all electrically-minded Lighting Committees turn. The efficiency of conversion of that long line of Kapp-Willans sets is no doubt remarkably high, but its efficacy in convincing is equally so. No Committee's report is now complete without a preamble to the effect that, after having inspected the "installation" recently laid down by the Vestry of St. Pancras, "your Committee is of opinion that electric lighting is no longer in its infancy, but may be looked upon as having arrived at such a stage of development as to render possible its general utilisation." Within the last few days only, municipal pilgrims from places as far apart as Newport (Mon.) and Hampstead Heath have journeyed all the way to Stanhope-street to see the armatures rotate, and to revolve in their own minds the meaning of it all. Why not levy a poll-tax upon the visitors and relieve the rates?

LIVING at the Antipodes might reasonably be expected to result in Antipodeans looking at many matters from a point of view antipodal to our own. From all we hear, however, this is by no means generally the case, and, as regards the attitude of Australasian local authorities towards electric lighting enterprise, it certainly is not so. In another column we give a brief abstract of the debate which arose in the Legislative Council of New South Wales upon the second reading of an electric lighting Bill, promoted by the Australian Gaslight Company. The arguments, for and against, might just as well have been applied to Sydenham as to Sydney, for all that there was fresh or novel in them. Out in socialistic Australia the municipalities ought surely to be more vertebrate than has generally been the case in the Old Country; out there, at any rate, they should be in advance of the needs of the community, not lagging lazily behind them, and refusing to let private enterprise make up for municipal deficiencies.

New Books.—The title of Mr. Fahie's book, which will be ready shortly, has been altered to "House Lighting by Electricity."

Bridgend.—The Local Board, at a special meeting held on Friday evening, decided to obtain an Electric Lighting Provisional Order.

Liverpool Overhead Railway.—This railway is rapidly approaching completion. On Monday last the first train was placed on the metals.

International Telephonic Communication.—Steps are being taken to establish telephonic communication between Sweden and Denmark *viâ* the Sound.

Bradford.—In regard to the £30,000 voted last week by the Town Council for the extension of the Electric Lighting Works, it should be stated that it is only proposed to spend £9,000 immediately.

The Indian Telegraph Department.—The Secretary of State has sanctioned the proposal made by the Government of India regarding promotion in the Telegraph Department.

Christiania.—The machinery for the electric central station, now in course of construction, has arrived from Scotland. The work of laying down the cables is now nearly completed, and good progress is being made with the station.

A Proposed Electric Tramway in Wales.—The Directors of the Barry Railway are said to be contemplating the construction of an electric tramway from a point near the railway bridge at the East Barry end of the dock to Barry Island.

Accident.—According to a Reuter's telegram a workman at the Nervion shipbuilding yards at Bilbao was carrying some sheet iron on his shoulders, when his load came in contact with a "live" electric light wire, and the man was killed instantaneously.

Electric Lighting at Bowdon and Altrincham.—At recent meetings of these Local Boards, provisional agreements have been come to with the Manchester Swan-Edison Company for the lighting of the whole district of Bowdon and Altrincham.

Phosphorescent Zinc Sulphide.—Professor C. Henry has recently drawn the attention of the members of the Académie des Sciences to the phosphorescent character of zinc sulphide obtained from the sulphate, and suggests its use as a standard for photometric work.

The Johnstone Conduit.—The City of London Electric Light Company are going to lay down some "Johnstone" conduits (which are owned by the International Electric Subway Company), for telephone cables. The work will shortly be commenced in John Carpenter-street, Blackfriars.

The Western Union Telegraph Company.—The *Electrical Review* of New York states that it is in possession of information which leads it to believe that the negotiations for the absorption of the Postal Telegraph Cable Company by the Western Union Telegraph Company are nearly completed.

Leeds.—The Board of Trade have given their formal approval of the system adopted by the Yorkshire House-to-House Electricity Company. The Company are said to be meeting with good demand for the light. Every effort is being made to be ready for commencing the supply of current by December 1st.

The Accident to the Scotch Express.—The Marquis of Tweeddale was amongst the passengers by this train who escaped unhurt, and he was received with cheers and warmly congratulated, on making his appearance at the meeting of the Eastern Extension, Australasia and China Telegraph Company, of which he is a Director, at Winchester House, on Wednesday afternoon.

Leicester.—At the last meeting of the Town Council, Alderman Lennard said that the Gas Committee had expected to have been in a position to bring the electric lighting question forward. Tenders from 13 firms had been received, but they had found on going into them that they were all technical in character and required much examination and careful dealing with.

Hull.—The Town Council having applied to the Local Government Board for power to borrow £25,000 for laying down a system of electric light, Major-General H. D. Crozier, R.E., held an inquiry into the matter last week. The proceedings were only formal, there being no opposition. The details of the scheme were laid before the Inspector, who afterwards visited the lighting station.

Brighton.—At the meeting of the Town Council on Monday it was decided to largely extend the area of supply of the Municipal central station. The Lighting Committee stated that 10,248 8 c.p. lamps were now connected to the mains, and that last week the station made a net profit of £70. The loss on the first three months' (October—December, 1891) working was £280, and that on the first six months of the present year was about £650.

A Telegraph Strike.—The strike of telegraphists on the Atchison Company's system was due, it is said, to a young tele-

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graph operator, who, in a playful mood, thought he would alarm the managers by sending a despatch in the name of the chief of the Telegraphists' Union ordering the men to come out. They came, and, what is more, 500 of them were so hurt on finding they had been hoaxed that they resolved to continue the strike as a protest against things in general.

Personal.—Sir James N. Douglass is, in consequence of ill-health, about to retire from the post of Engineer-in-Chief to the Trinity House. The Elder Brethren have appointed Mr. Thomas Matthews as their Engineer.——Mr. Howard Tasker, who has been chief electrician to the Chelsea Electricity Supply Company for some years, has recently severed his connection with that Company. On the occasion of his departure he was presented with a suitable *souvenir* by the *employés*.

Glasgow Physical Society.—Among the Papers down for reading before this Society during the Session 1892-3 are the following:—December 16th, "The Thermo-electric Power of Platinum and Mercury," by Angus M'Lean, B.Sc.; January 27th, "Portative Electric Energy," by J. T. Niblett; February 10th, "Further Notes from the Board of Trade Laboratory," by J. Rennie; April 14th, "Capacity and Insulation Tests," by A. W. Meikle, M.A.; April 28th, "Electrical Engineering Laboratories," by J. D. Cormack, B.Sc.

Physical Society.—At the meeting of this Society last week, the discussion on Mr. Williams's Paper "On the Relation of Physical Quantities to Directions in Space," was opened by Prof. Perry, who read a communication from Prof. Fitzgerald. Mr. Madden, Prof. Rücker, Prof. Henrici, and Dr. Sumpner followed, and the discussion was adjourned. We hold over our report until we can give the complete discussion. Papers on "Molecular Physics" were taken at this meeting, and the discussion of these was also adjourned.

Cable Interruptions and Restorations:—

	Interrupted.	Restored.
Hong Kong Foochow	Oct. 22, 1892	Nov. 1, 1892.

Telegrams for Shanghai, Amoy, Foochow and Japan can now be sent "*viâ* Eastern."

Cables actually interrupted.	Date of interruption.
Bissao-Bolama (communication with)	September 8, 1892.
Cayenne-Vizeu.....	September 24, 1892.
Jamaica-Colon	October 13, 1892.
Para-Maranham	October 15, 1892.
Hong Kong-Amoy	October 22, 1892.

The Brush Storage Battery Patents.—On the 4th ult. the United States Circuit Court of Appeal gave judgment in the suit of Brush Electric Company *v.* Electrical Accumulator Company, sustaining on a somewhat narrower basis the original judgment of Judge Coxe, given in the Circuit Court on July 23, 1891, upholding Brush's claims covering the pasted plate. As an American contemporary rightly remarks, "This litigation has been the principal business engaged in by the manufacturers of storage batteries for a number of years, and it has naturally resu'ted in very little progress in the improvement of the cells."

Montreal.—The Montreal Street Railway Company, to whom, as was stated in our issue of September 16, p. 528, the exclusive privilege of working the tramway system of that city by electricity has been conceded for 30 years, have since August 1st been energetically pushing forward the work, and successfully inaugurated electric traction on Sept. 21st by the opening of a line of four miles of single track, extending from the centre of the city to the exhibition grounds. In addition, one of the old lines, consisting of four miles of double track, was equipped and in operation some ten days later. For present use the Company has 20 motor cars of American manufacture and 15 of Canadian make. Between 80 and 100 cars will ultimately be wanted.

Board of Trade Electrical Standards Committee.—At a meeting of this Committee, held on Thursday the 27th ult., the report made to the British Association by the Electrical Standards Committee of the Association in August last was discussed, and the supplementary report which the Committee propose to make to the Board of Trade was considered. The following members were present:—Sir Courtenay Boyle, Major Cardew, Mr. W. H. Preece, Lord Kelvin, Lord Rayleigh, Prof. Carey Foster, Mr. R. T. Glazebrook, Dr. John Hopkinson, Prof. W. E. Ayrton. The supplementary report is now being drafted, and a final decision will shortly be arrived at.

The Lighting of the Corporation Central Markets.—This afternoon the Lady Mayoress will inaugurate the electric light which is being supplied at the Central Markets by Messrs. Julius Sax. Some 300 16 c.p. lights are already fixed, together with 50 50 c.p. lights in the central avenue supplied by Messrs. Sax to the Corporation free of cost. A temporary plant has been laid down close to Farringdon-street Station consisting of a 50 H.P. Davey Paxman locomotive boiler and horizontal engine driving an Elwell-Parker dynamo supplying 200 amperes at 100 volts. We are informed that orders have been received for 8,000 lights varying from 16 to 50 c.p., and it is intended to lay down 6 200 H.P. direct-coupled steam dynamos.

The Phonopore.—Mr. Langdon-Davies informs us that his Phonopore patents have become the property of the Phonopore Syndicate, which has recently been converted into the Phonopore Company, and that his contract (which was for technical services only) has now terminated, his personal connection with the Company having ceased on September 30th last. Mr. C. E. Spagnoletti, as we have previously announced, is now Managing Director of the Phonopore Company. Communications on the subject of the Phonopore should be addressed either to Mr. Spagnoletti, or to the Secretary, the Phonopore Company, Faraday House, Charing Cross-road. Mr. Davies now proposes to occupy himself with the development of his Rapid Submarine Telegraph and new Telephone Apparatus, &c. All correspondents should address: Mr. Davies, 45, Redcliffe-square, S.W.

The Electric Light and Insects.—Mr. D. S. Stewart records in a recent number of the *Entomologist* that at the Eddystone lighthouse exhibited in the Botanic Gardens at Old Trafford (the same lighthouse as was shown at the Naval Exhibition), he saw one evening in August great numbers of moths. Before ascending, he says, one could see them from below, flashing in and out of the rays in hundreds; and when the top was reached the place was found to be full of them—"some, apparently dazzled by the light, frantically flying in all directions, buzzing and banging in your face, up your sleeves, down your neck, everywhere. In every sheltered niche and cranny four or five were to be seen together, and especially was this so on the staircase, which was strewn with their partially cremated remains, the result of their all too successful attempts at self-immolation."

Hertzian Oscillations.—In his treatise, "On the Propagation of Electric Force," Prof. Hertz mentions some experiments tending to prove that the production of resonance and the period of oscillation in resonators are not influenced by the specific resistance or the magnetic properties of the secondary conductor. But if the phenomena be observed electrometrically, the individual properties of the metals soon show themselves. This method has been employed by V. Bjerknes, who gives an account of his results in *Wiedemann's Annalen*. Experiments made with copper, brass, German silver, platinum, nickel, and iron show that metals have different powers of absorbing the energy of electric waves. The rate of absorption increases with the resistance and with magnetisibility of the metal. Iron and nickel were able to follow the oscillations to a certain extent, which means that their magnetisation was actually reversed one hundred million times per second.

The McEvoy Night Sight for Heavy Guns.—This form of night sight has now been adopted nearly all the world over. The foresight consists of a socket which fits on to the ordinary day sight, and which carries a small electric lamp inside it. The light given by the lamp illuminates a small glass cone which forms the tip of the fore sight. The rear sight is constructed on the same principle, but the electric lamp illuminates a wire placed above it; this wire forming the cross of the "H" invariably used by the navy for the rear sight. In order to distinguish the rear sight from the fore sight, a red light is used with the former; this colour can be produced either by colouring the small electric lamp, or by painting the cross wire with red enamel. The current for illuminating the lamps is usually provided by a three-cell Leclanché battery,

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but the employment of a small dynamo for the illumination of the night sights, as well as for firing the guns, is under consideration.

The Use of the Search Light in Military Operations.—On Saturday evening last the 4th Middlesex R.V. carried out some interesting night operations near Ealing, with a view of testing the general utility of the search light, The light, which was manœuvred by Capt. Ronald Scott, was mounted on an ordinary waggon containing a battery of accumulators from which the necessary current was derived. Owing to non-completion of the specially designed carriage now in course of construction having broad tires to prevent the wheels from sinking into soft ground, and the extremely sodden state of the soil, it was not feasible to take up the position originally intended. The object of the attack was Horsenden Bridge. The attacking column was discovered half-a-mile from the bridge. In the course of the evening advertisements were thrown on the clouds by means of a projector. We understand from the *Daily Telegraph* that Mr. Scott claims to be the inventor of this mode of advertising.

Coast Communication.—In consequence of the difficulty of connecting Rathlin Island, off the north coast of Ireland, by telegraphic cable with the mainland, the committee of Lloyd's have been making trial of carrier pigeons. So far this experiment has proved very successful. During the naval manœuvres 33 pigeons were placed at the disposal of Captain Henderson, of Her Majesty's ship "Arethusa." Of the 33 birds only eight were trained, and these had been trained only to fly from Rathlin Island to the mainland, a distance of nine miles. The remainder were young birds and untrained. Captain Henderson reports that 17 birds were flown with messages when the ship was cruising near the Mull of Cantyre and Rathlin, the eight trained birds and nine others. The eight homed safely at Ballycastle, also three of the untrained birds. Captain Henderson judges from these results that well-trained birds may be trusted to convey messages from squadrons and ships for distances extending several hundred miles from the land, and may be the means of saving much wear and tear of ships and consumption of coal.

Manchester.—The bulk of the engine and boiler plant for the Municipal Central Station is being built by Messrs. J. Galloway and Sons, who are putting down six large boilers to work at 125lb. pressure, and four compound engines, each of 400 H.P.; whilst Messrs. Hornsby are supplying six smaller engines of 100 H.P. A couple of Green's economisers, containing an aggregate of about 600 pipes, are also being put down, and the boilers will be fitted with Vickers's mechanical stokers. The whole of the steam and feed pipes, which will be of wrought iron, are being supplied by Messrs. Galloway, and are to be put down in duplicate throughout. The dynamos are being partly constructed by Messrs. Mather and Platt, and partly by the Electric Construction Corporation, whilst the mains are being put down by the Okonite Company. The Corporation are also laying down a system for the supply of hydraulic power. The hydraulic power will be distributed through pipes, ranging from 3in. up to 7in. diameter. The pressure will be at 1,200lb. to the square inch. The power used will be charged for through meters, and a special feature of these, says *The Engineer*, will be that the measurement will be taken off at the exhaust instead of the supply.

The Voltage of the Arc.—In a recent number of the *Electrical World* Mr. J. R. Cravath writes as follows:—"In a former article (see *The Electrician*, Vol. XXVIII., p. 568) I gave the results of some experiments on the hissing of the electric arc. I did not then attempt to explain the fall of voltage in the hissing arc. I gave reasons for supposing that the hissing was due to the sudden heating of comparatively cool carbon to the boiling point. It has occurred to me since that this same cause might be made to account for the fall of voltage in the transition from the normal to the hissing arc. May it not be that the constant change in position of the positive evaporating surface and the constant heating of cool carbon to high temperature has in some way a 'dampening' effect, and so prevents the consumption of energy, and causes a drop in the voltage at the point where hissing begins? At least the crater is the centre of energy. Messrs. Cross and Shepard, in a Paper before the American Academy in 1886, showed that the cooling of the positive carbon resulted in a great fall of potential and great hissing and unsteadiness. This would seem to point in the same way. This is only advanced as a suggestion based on the facts as they seem at present, and future research may prove it wrong. The writer has himself had no opportunity to investigate the matter properly."

Electric Lighting in New South Wales.—Upon moving the second reading of the Australian Gaslight Company Electric Lighting and Supply Bill recently in the Legislative Council of New South Wales, the mover said that this was an instance in which private enterprise was anxious to do something which would take up a section of the surplus labour. In this Bill it was not proposed to absolutely part with the rights of the Municipalities. The Bill only contemplated giving the Company the power to take up the work if the different Municipalities interested agreed to permit it. There was nothing of a monopoly in the measure. There was nothing to prevent any other Company or a Municipality supplying electricity if they so desired. The maximum amount to be charged was 1s. per unit. (Gas in Sydney is 5s. 3d. per thousand.) The opponents of the measure said it was not only inadvisable but positively dangerous. The Company would under it have the right to run overhead wires conveying a current up to 3,000 volts pressure, while it had been proved that a current of 400 volts was deadly. Supposing this Bill were passed, the Company would "peck the eyes" out of the city, and would extend its wires to the most thickly-populated parts of it, while the more sparsely-peopled portions would be left unserved. Moreover, most electricians admitted that they were only now beginning to find out how ignorant they were, and it was expected that great advances would almost immediately be made in electric lighting. The proper body to supply electricity was the Local Authority. It would be in the interests of the people of Sydney that the Bill should be rejected, and the matter left over for a year or two, to see what the Council would do. The motion for second reading was defeated by 77 votes to 7.

Physiological Experiments with Magnets.—At the recent (second) annual meeting of the American Electro-Therapeutical Association in New York, Dr. F. Peterson and Mr. A. E. Kennelly described experiments made by them with magnets of great power at the Edison laboratory. The pole-faces of the magnet were 1·2cm. apart, and between these poles objects were placed for observation. The intensity of the field was about 5,000 lines per sq. cm. Experiments were made on blood, which was found to be unaffected in any way. Experiments upon frogs failed to give any result. Then the effect of a continuous current was noted, and circulation was found to cease. Benedikt's statement that magnetism will produce paralysis was then tested. A set of idle field magnets converging into a cylinder two feet in diameter and seven inches deep was employed. In this cylinder a dog was placed for five hours without the slightest visible effect. Experiments were next tried upon the brain. The armature and one journal were removed from a dynamo converting about 70 H.P. at full load, and in the space between the pole-pieces the subject placed his head. The intensity of the magnetic field produced was about 2,500 C.-G.-S. lines per square cm. A switch was arranged to open and close the exciting circuit. Sphygmographic tracings, taken continuously, showed no change in regularity. The respirations were not changed in the least, and there were no sensations that could be attributed to magnetic influence. Experiments in connection with reversed magnetism also failed to show any effect upon the subject. From these experiments the authors conclude that the human organism is unaffected by the most powerful magnets known to modern science; that neither direct nor reversed magnetism exerts any perceptible influence upon the iron in the blood, upon the circulation, upon ciliary or protoplasmic movement, upon sensory or motor nerves, or upon the brain. It may be remembered that Mr. Kapp and others have placed their heads in the space which is, as a rule, more usefully occupied by the armature of a dynamo, without experiencing any sensation whatever. In these cases, the magnetic flux was no doubt shunted to a great extent by the horns of the pole-pieces.

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THE LAW OF VARIATION OF CURRENTS FLOWING IN INDUCTIVE CIRCUITS.

In a lengthy Paper presented last June to the American Institute of Electrical Engineers, Messrs. Bedell and Crehore discuss the general solution for the current flowing in a circuit containing resistance, self-induction, and capacity, in consequence of any impressed electromotive force. The Paper contains no fewer than 204 equations with the accompanying proofs, and occupies 70 pages of print; but the feature which is of most interest and importance arises from the fact that a number of curves have been drawn to illustrate the equations and to show how the currents, &c., vary in certain numerical cases. These curves are more convincing and are easier apprehended than the mathematics, and a reproduction of them will prove instructive.

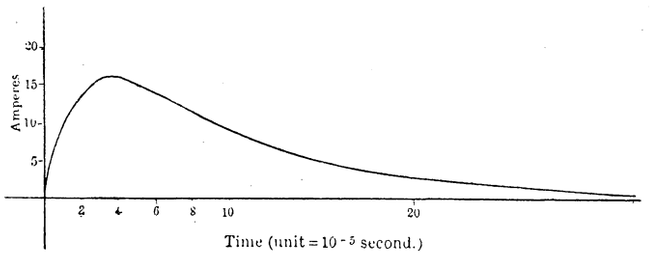

FIG. 1.—Curve showing current during non-oscillatory discharge of condenser with capacity C=1 micro-farad, through a circuit with resistance R=100 ohms, and self-induction L='0016 henrys, when originally charged to a potential of 2,000 volts.

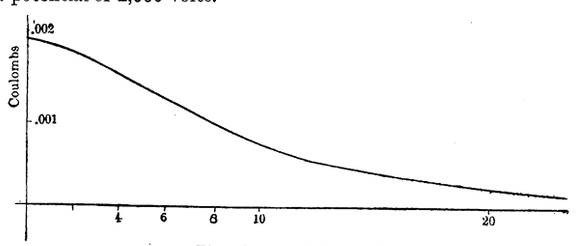

FIG. 2.—Curve showing non-oscillatory discharge of a condenser with capacity C=1 micro-farad, through a circuit with resistance R=100 ohms, and self-induction L='00016 henrys, when originally charged to a potential of 2,000 volts.

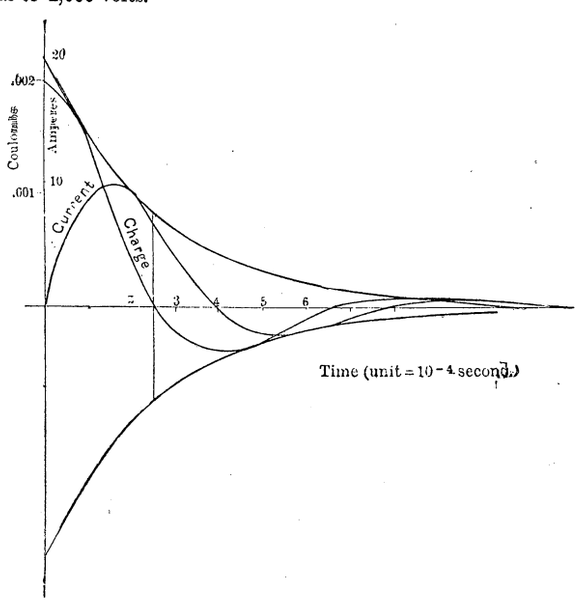

FIG. 3.—Oscillatory discharge of a condenser with capacity C=1 micro-farad, through a circuit with resistance R=100 ohms, and self-induction L='0125 henrys, when originally charged to a potential of 2,000 volts.

As is well known, the discharge of a condenser is continuous or oscillatory according as the capacity exceeds or falls short of a certain limiting value dependent on the self-induction and resistance of the circuit. Figs. 1 and 2 represent respectively the current flowing in the circuit, and the charge existing in the condenser at various times during the discharge of a condenser in a circuit for which the discharge is non-oscillatory, and the two curves in Fig. 3 represent the same quantities when the discharge becomes oscillatory. In the limiting case when the discharge is just non-oscillatory, Fig. 4 represents what happens. If the condenser, instead of being discharged, is

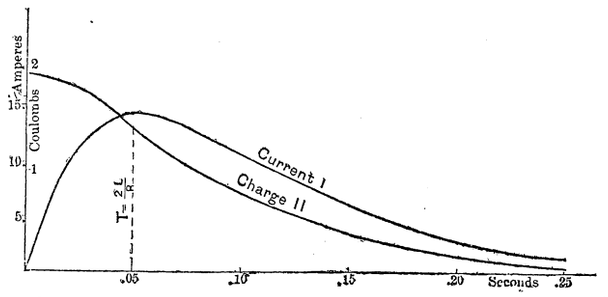

FIG. 4.—Just non-oscillatory discharge of a condenser with capacity C=1,000 micro-farads, through a circuit with resistance R=100 ohms, and self-induction L=2·5 henrys.

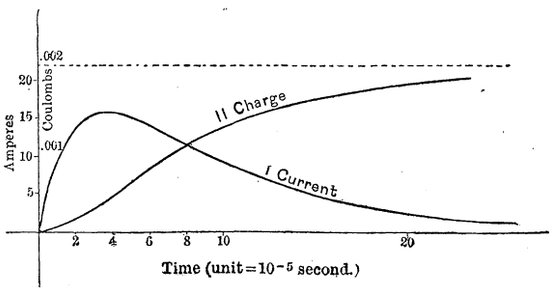

FIG. 5.—Non-oscillatory charge of a condenser with capacity C=1 micro-farad, through a circuit with resistance R=100 ohms, and self-induction L='0125 henrys when subjected to a potential of 2,000 volts.

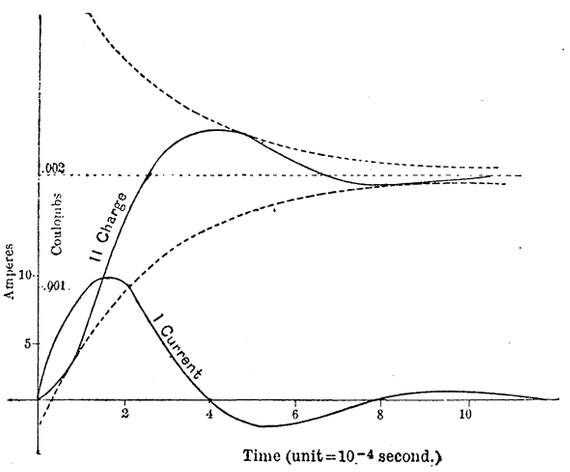

FIG. 6.—Oscillatory charge of a condenser with capacity C=1 micro-farad, through a circuit with resistance R=100 ohms, and self-induction L='0125 henrys, when subjected to a potential of 2,000 volts.

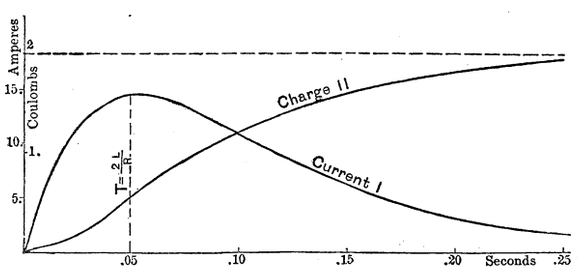

FIG. 7.—Just non-oscillatory charge of a condenser with capacity C=1,000 micro-farads, through a circuit with resistance R=100 ohms, and self-induction L=2·5 henrys.

charged by making contact with the external circuit, the curves are similar in character and are represented, for the three corresponding cases, in Figs. 5, 6, and 7 respectively.

When an alternating electromotive force of E volts acts in a circuit of resistance R ohms, having a self-induction of L.

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henrys, the circuit being completed through a condenser of capacity C farads, the current in amperes which results is

$$\frac{E}{\sqrt{R^2+\left(L\omega-\frac{1}{C\omega}\right)^2}}$$

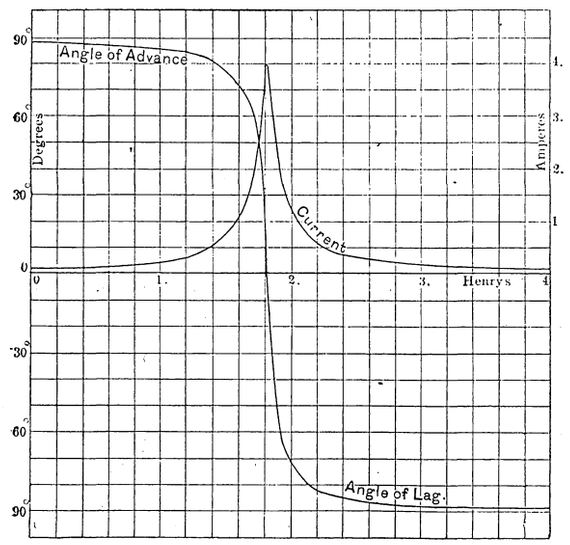

FIG. 8.—Value of current, and angle of advance or lag for different amounts of self-induction in a circuit in which R=50, C=55, E=200, ω=1,000.

constant, and the other varied there will be a particular value of this third quantity for which the current will attain a maximum value and at which the current will coincide in phase with the electromotive force E. The curves shown in Figs. 8, 9, and 10 illustrate these facts very clearly. In Fig. 8 the self-induction L is supposed to vary, in Fig. 9 C

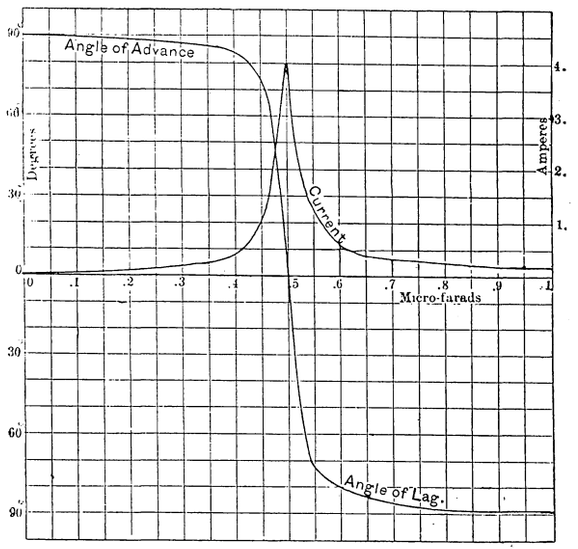

FIG. 9.—Value of current, and angle of advance or lag for different capacities in a circuit in which R=50, L=2, E=200, ω=1,000.

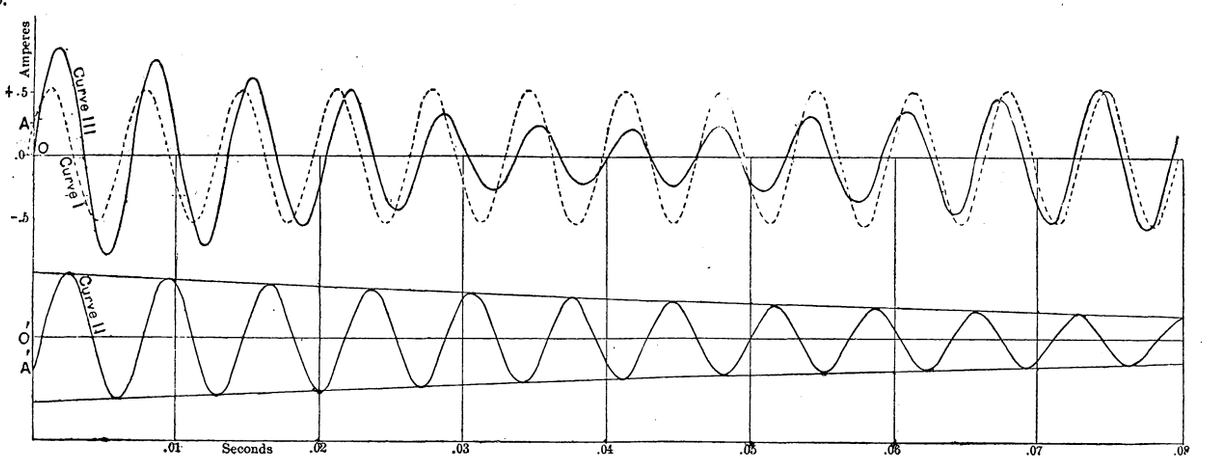

FIG. 11.— Curve III. shows the current which flows after the introduction of a harmonic electromotive force into a circuit with R, L, and C. It is the sum of the two component curves, 1, a sine-curve, and 2, a sine-curve with an amplitude decreasing according to a logarithmic decrement.

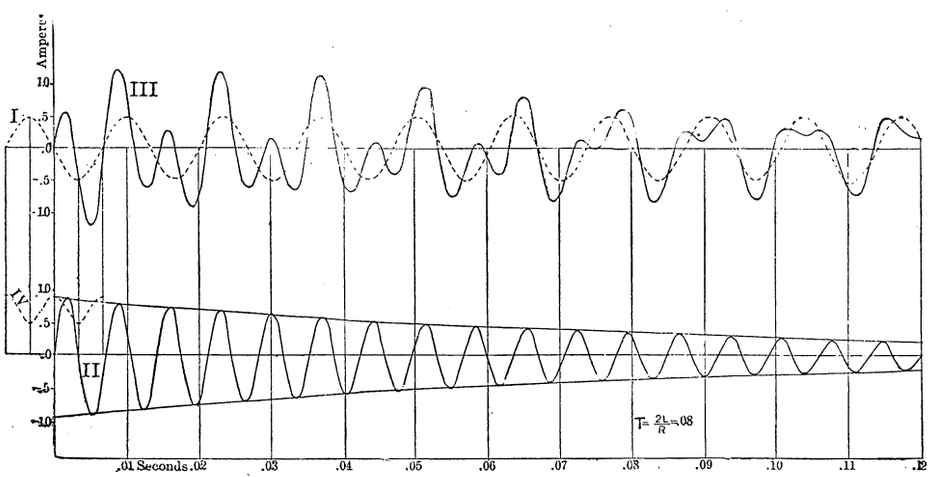

FIG. 12.—Curve III. shows the current which flows after the introduction of harmonic electromotive force into a circuit with R, L, and C. It is the sum of the two component curves, 1, a sine-curve, and 2, a sine-curve with an amplitude decreasing according to a logarithmic decrement.

where $\omega = 2\pi n$ and n is the frequency in periods per second. The phase of the current is in advance, or lags behind, the electromotive force E according as $1/C\omega$ is greater or less than $L\omega$. Accordingly if two of the quantities L, C, ω be kept

is altered, and in Fig. 10 it is the frequency which is supposed to change.

The curves in Figs. 8, 9, and 10 illustrate what is known as the periodic state, that is the state of things which obtains

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some time after the application of the periodic electromotive force E, and when the variations of the current strictly follow those of E. For the first few moments after applying E the currents do not assume their final form, and the current at any moment may be described as being the sum of two currents, one being the periodic current and the other an extra current which rapidly dies away. These component currents are

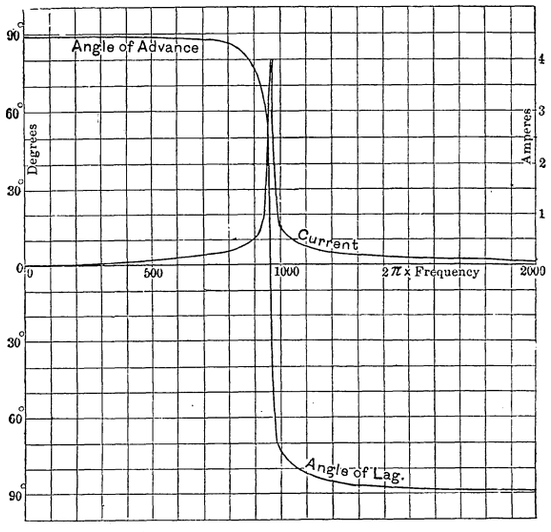

FIG. 10.—Value of current and angle of advance or lag for different frequencies in a circuit in which R=50, L=2, C=·55, E=200.

represented in Figs. 11 and 12 by curves I. and II. the resultant current is shown in the same figures by curve III., and the manner in which it is modified till it gradually assumes the periodic form shown in curve I. is clearly shown in the particular cases considered.

THE HOPKINSON THREE-WIRE PATENT.

The following is an abstract of Specification No. 3,576* of 1882, which was filed in its final form by Dr. John Hopkinson in the Patent Office on January 27, 1883. The title *after* amendment on June 22, 1891, is "Improvements in Distributing Electricity, and in Apparatus to be Employed for that Purpose." The title *before* amendment was as follows:—"Improvements in Distributing and Measuring Electricity and in Apparatus to be Employed for those Purposes":—

My improvements principally relate to maintaining the electromotive force in a system of conductors for an electric supply at a fixed potential, but they also relate to reducing the cost of such conductors consistently with efficiency and safety. When electricity is delivered by means of a pair of conductors to a distance from the station where the electricity is generated, there is a fall of potential due to the resistance of such conductors greater as the current is greater, and if it be desired to maintain the potential constant at the delivery end, it is necessary to increase the potential at the supply end, as the current increases, in a suitable manner. To ascertain the potential at the far end of the conductor, I make use of a galvanometer differentially wound with two coils, the one coil having a high resistance as for measuring potential and the other coil, of very low resistance, conveys the current to the main conductor, and acts in opposition to the high resistance coil. The differential coils may be wound on an electro magnet which acts as a relay to ring an electric bell, or to set in motion or reverse a small dynamo machine to adjust resistance or control the speed of the steam engine for the purpose of keeping the potential on service main conductors constant. An approximation to the same end may be attained by winding on the electro-magnets of the dynamo machines in addition to the usual coils, whether in shunt or conveying a current from a separate exciter, a few coils conveying the current to the main conductor, the effect of such coils being suitably adjusted. For the purpose of economising the cost of main conductors I place two dynamo machines in series, and I place two systems of lamps or other appliances consuming electricity of approximately equal capacity also in series. A main conductor is taken from each extreme pole of the two dynamos, and a smaller conductor from between the two dynamos to points between the two systems of lamps, this intermediate conductor serving to bring back to the central station any electricity required for one system of lamps in excess of that required for the other system of lamps. The iron casing used to protect the two main conductors may be used as intermediate conductors. More than two dynamos may be placed in series, and more than one intermediate smaller conductor may be used on the same principle as is above described.

Eleven lines relating to improvements in meters and switches are struck out. Up to this point the final specification is identical with the provisional:—

And in order that my said invention may be fully understood I shall now proceed more particularly to describe the same, and for that purpose shall refer to the several figures on the annexed sheets of drawings. Many devices have been proposed and used for keeping the difference of potential between the terminals of dynamo machines constant or for indicating when such potential deviates from its standard amount. When the electricity is to be used at a distance from the dynamo, and conductors of a sensible resistance are used, it is proper to maintain constant the difference of potential at the end of such conductors where the electricity is used, and not at the dynamo itself. If e be the difference of potential of the poles of the dynamo r, the resistance of the conductors from the dynamo to the place where the electricity is to be used, and c the current, it is necessary to maintain not e constant but $e—r\ c$, which is equal to the difference of potential of the two conductors at their other end.

Here follows a description of a differentially-wound galvanometer:—

This may be arranged either to indicate directly to the eye when the value of $e—r\ c$ is incorrect, or it may be used to operate as a relay and by making an electrical contact may cause a bell to ring or it may operate to introduce resistance or take resistance from one of the dynamo circuits, or it may be used to control the speed of the engine by any suitable method which has been proposed or used for maintaining the difference of potential constant between the poles of a dynamo machine. Fig. 2 shows how the differential instrument may be arranged to act as a relay. The application of this instrument to an extended system of electrical supply with a network of distributing mains is important. For each machine I provide a pair of feeders of a size appropriate to the current they are to carry, but independent of the distance they have to go. Each pair of feeders goes to

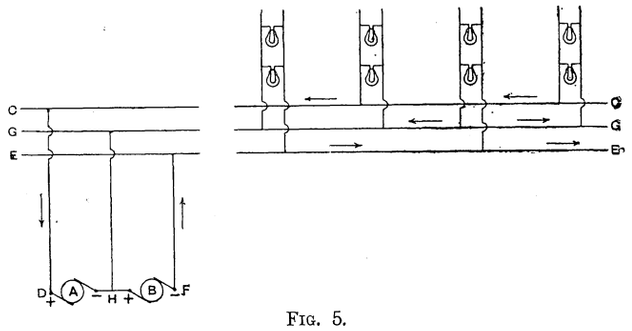

FIG. 5.

and is connected to some part or other of the system of distributing mains, and by the use of my invention I am able to keep the difference of potential constant at or near the point where the feeders join the distributing mains. By using a sufficient number of feeders I am able to keep the potential throughout the distributing mains very nearly constant; however, the distribution of the consumption may vary without requiring conductors of excessive size.

Here follows a description of a method of winding the magnets of a dynamo with shunt and main coils:—

I make no distinct and separate claim for the doubly-wound magnets above described, but have explained them here because they may be usefully employed, with a slight modification, in combination with the conductors as arranged under the next described head of my invention, and also in combination with the first described head of my invention.

In order to combine the advantages of comparatively high potential in the feeding conductors with lower potential in the houses in which the electricity is used, I make use of a system of three conductors in combination with two dynamo machines coupled in series. This system is shown diagrammatically in Fig. 5, where A B represents the two dynamos, C D and E F represent the extreme conductors which I will call the positive and negative conductors, and G H represents the intermediate conductor. The positive pole of the dynamo machine A is connected to the conductor C D, and its negative pole to the conductor G H. On the other hand, the positive pole of the dynamo machine B is connected to the conductor G H, and its negative pole to the conductor E F. The houses to be supplied are divided into two approximately equal parts, preferably the houses being taken alternately. The houses of one part are supplied between the conductor C D and the conductor G H, and those of the other part between the conductor G H and the conductor E F. The intermediate conductor G H may be of much smaller dimensions than either of the other two, as it has only to carry the difference of current consumed by the two divisions of consumers, that is those connected with the conductor C D and those connected with the conductor E F. It need not be insulated, and indeed it may be replaced by the iron or other metallic covering often used to protect the copper conductors. In cases where the two divisions of consumers may be safely assumed to have a very approximately equal consumption at all times, the intermediate conductor G H may be replaced in part by the earth and the negative pole of

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the dynamo machine A, and the positive pole of the dynamo machine B be connected together and to the earth.

This system may be extended by using more than two dynamos in series and dividing the consumers into as many groups, there will then be two large conductors connected to the extreme pole of the dynamos, and a number of smaller intermediate conductors, one less than the number of machines, each connected to the junction of two machines of the series.

To apply the indicating or regulating apparatus of the hereinbefore first described head of my invention to the system of conductors hereinbefore last described, it is necessary to wind a third coil to convey the current going or returning by the intermediate conductor G H; it is, in fact, necessary to maintain $e - r_1 c_1 - r_2 c_2$ constant, when e is the difference of potential between the pole of the dynamo machine; r_1 is the resistance of the conductor C D, r_2 is the resistance of the conductor G H, and c_1 c_2 are the currents in these conductors.

In like manner, to apply the approximate method above described to the system of these conductors two main circuit coils are required on the dynamo machine, but the method of adjustment is the same as in the simple case.

Some 44 lines relating to improvements in meters and switches are here struck out.

The foregoing description of instruments relates more particularly to continuous currents, but it is obvious that the arrangements are also applicable to alternate currents, but in that case the iron in the electro-magnetic apparatus must be so divided that local induced currents are prevented.

Having now described and particularly ascertained the nature of my said invention, and the manner in which the same is or may be used or carried into effect, I would observe in conclusion that what I consider to be novel and original, and therefore claim as the invention secured to me by the hereinbefore in part recited Letters Patent is:

First, the employment of a differentially wound indicating or regulating apparatus so connected to the conducting wires from a generator of electricity to a distant place as to indicate when the difference of potential between the two conductors leading to such distant place deviates from an assigned value at that distant place or to regulate the electricity, producing machinery in such wise as to maintain a constant difference of potential at a distance from the place of supply or generation of the current substantially as hereinbefore described with reference to Figs. 1 and 2 of the accompanying drawings.

Second. *In a system of electrical distribution or supply, the employment of three (or more) conductors in combination with two (or more) dynamo machines in series substantially as hereinbefore described with reference to Fig. 5 of the accompanying drawings, whether the middle conductor be continuous or be replaced by an earth return, as set forth.*

The third claim, relating to the method of removing a dynamo from the external circuit, or of changing a circuit from one dynamo to another by means of an automatic switch; and the fourth claim, relating to improvements in the meter described in Patent No. 49, of 1882, are struck out in the amended specification.

SUNSPOTS AND MAGNETIC DISTURBANCES IN 1892.*

BY M. RICCO.

Since the time of the apparition of the extraordinary sunspot of April, 1882, I have noticed that the passage of the large spots across the sun's disc have been often accompanied by magnetic disturbances. The same phenomenon repeated itself at the time of the passage of the extraordinary spot of February, 1892. Having received from the Washington Naval Observatory a copy of the photographic magnetograph curves showing the disturbances of 1892, by which we can determine the time of maximum, I compared this with the time of the transit of the principal sunspot at the minimum distance from the centre of the disc, that is to say, at the central meridian. It is not an easy or certain matter to determine the instant of maximum disturbance, since it results from the extraordinary and irregular oscillations of the declination (D) the horizontal component (F.H.) and the vertical component (F.V.) of the magnetism of the earth which do not always coincide. On that account I have limited myself to giving merely the hour at which the greatest deviation from the mean declination took place, near which also occurs the greatest variation of the two other components. I have reduced the time of the 75th meridian from Greenwich, adopted in the diagrams, to Catania time and I have compared the diagrams with the calculated time of the passage of the principal spot across the central meridian on the occasion of each disturbance. The following table gives a compendium of the numerical data obtained from the diagrams of the disturbances and from the calculations of the positions of the sunspots. The *excursions* are the amplitudes of the oscillations near the time of the maxima; and they are expressed in the case D in minutes of arc, and in the case of F.H. and F.V. in ten-thousandths of the C.G.S. unit. The diameter of the spots is expressed in terrestrial diameters:—

In 11 cases of magnetic disturbances seven took place after the passage of important spots across the least distance from the centre of the solar disc. Generally speaking, all the extraordinary, the strong, and very strong disturbances (except one) followed the passage of those spots which were, respectively, extraordinary, very big, and big; medium or feeble disturbances took place without the passage of sunspots.

All the disturbances were retarded in respect to the passage of the spots across the line of least distance from the centre of the solar disc. These retardations (except the second one) were comprised between the limits of 38 hours and 51 hours; the average being 45·3 hours, and as the synodic rotation of the spots is about 27 days = 648 hours, this retardation was only about one-fourteenth, and the deviations from the mean only a little more than one-hundreth of the time of rotation.

The figure annexed to the memoir shows this agreement of the six cases, and clearly proves that these positions of the spots on almost the same solar meridian, namely, that which is at a distance of 25deg. heliographic longitudes from the centre, at the moment of the maxima of the disturbances cannot be merely the result of chance.

This retardation of action upon the earth's magnetism of 45 hours 5 minutes indicates a speed of propagation from the sun to the earth of about 913 kilometres, that is to say, 335 times less than the speed of light.

We know, moreover, from the investigations of M. Wolf, of Zurich, that there is a perfect agreement between the period of the variations of the magnetic declination with that of the sunspots, and M. Garibaldi, of Genoa, has shown that this agreement is verified even in details. We know that Secchi and Tacchini have assumed for some time a connection between magnetic disturbances, the aurora borealis, sunspots, and solar protuberances. Finally, we know that in these spots there is vast movement and contact of vapours at different temperatures, which may well generate electricity, and the thickening of certain rays, particularly those of iron, which has been observed with the spectroscope, indicates a greater density, or, at any rate, a special condition of the vapour of this metal in the spots, which may also be the cause of the electric or magnetic action or induction which they exert on the earth when the spots cut, almost perpendicularly, the lines of force running between our planet and the sun.

For the present it is impossible to explain the disagreement of the retardation of the disturbance of January 29th. I intend to continue these investigations by going back to previous years.

Passage across the central Meridian.	Large Sunspots.	Diameter.	Heliographic Latitude.	Time of Maximum.	Magnetic Disturbances.	Excursions.			Retardation of the Disturbances.	
						D.	F.H.	F.V.	In Time.	In Arc.
4th January, 2 p.m.	Very big.	4	+20°	6th January, 4 a.m.	Very great.	42	·0013	·0035	38 hours.	21°
28th January, 3 p.m.	Big.	3	−10°	29th January, noon.	Great.	28	,,	·0013	21 ,,	12°
2nd—4th Feb., —	None.	—	—	2nd—4th Feb., —	Weak.	—	—	—	— —	—
12th February, 4 a.m.	Extraordinary.	11	−30°	14th February, 1 a.m.	Extraordinary.	90	∞	∞	45 hours.	25°
1st—5th March, —	None.	—	—	1st—5th Mar., —	Medium.	—	—	—	— —	—
7th March, 2 a.m.	None.	—	—	7th March, 2 a.m.	Great.	48	·0014	—	— —	—
10th March, 2p.m.	Extraordinary.	6	−29°	12th March, 11 a.m.	Very great.	53	·0020	—	45 hours.	25°
23rd April, 8 p.m.	Big.	2½	+11°	25th April, 11 p.m.	Great.	41	·0013	·0010	51 ,,	28°
24th April, 4 p.m.	Big.	3	+16°	26th April, 1 p.m.	Great.	46	·0025	·0018	45 ,,	25°
1st—2nd May —	None.	—	—	1st—2nd May, —	Medium.	—	—	—	— —	—
16th May, 5 p.m.	Extraordinary.	5	−16°	18th May, 6 p.m.	Extraordinary.	42	·0018	·0034	49 hours.	27°

* From the *Comptes Rendus*, Vol. CXV., No. 17.

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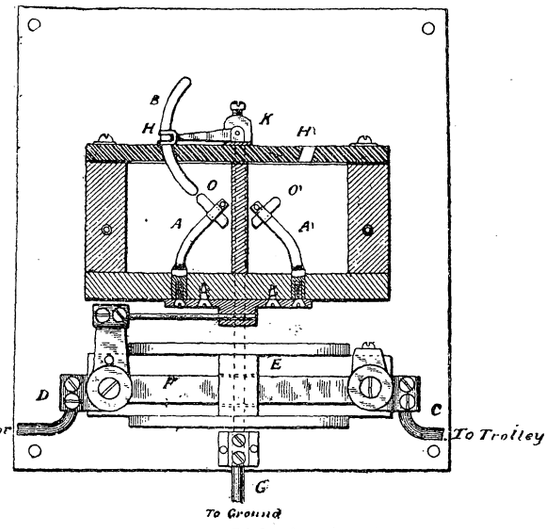
WESTINGHOUSE STREET-CAR LIGHTNING ARRESTER.*

The Westinghouse car lightning arrester, shown in the accompanying illustration, consists of two air chambers, A and A^1, having vents shown at H and H^1, through which the curved carbon, B, hinged at K, can freely pass, swinging from O to O^1. The carbon point O should be set so that it is separated from B when in its normal position, as shown in the figure, by one-sixteenth of an inch. The distance from O^1 to B should likewise be one-sixteenth of an inch when the curved carbon is in the other chamber. B is connected to G^1 and O and O^1 to D. F is a lead fuse, and E an insulating block provided with a slot through which the lead fuse is passed. The points C and D should be connected in series with the motor, and G should be connected to the ground, as shown in the figure. The action of the arrester is as follows :—

When a discharge takes place it passes through the lead fuse F to one of the carbons O or O^1, depending upon the position of B ; then across the air space to the curved carbon B, and from there to the ground, as shown in the figure. The dynamo current then following causes an arc to be established between the carbon B and O or O^1. The heat generated by this arc expands the air in the chamber, increasing the air pressure, and causes the carbon B to be instantly blown from one chamber to the other. This ruptures the arc and adjusts the arrester for the next discharge.

In the reported tests upon this arrester, 500-volt and 1,000-volt generators have been repeatedly short-circuited through it. In every case the circuit has been instantly broken without injury to



Westinghouse Car Lightning Arrester.

the dynamo, and the arrester has as quickly set itself in readiness for future use. In one of the tests made to demonstrate its promptness and reliability, carbons O and O^1 were so adjusted as to touch the carbon B in either of its two normal positions. A 1,000-volt generator was then short-circuited through the arrester, which resulted in the circuit being several times automatically opened and closed in one second without injury to either dynamo or arrester.

* From the *Electrical World*.

THE CONSTRUCTION OF TELEPHONIC APPARATUS.†

The French authorities have recently issued a circular to telephone makers, in which are laid down the conditions that will have to be fulfilled by their apparatus from January 1, 1893. The French Government, as is well known, have been operating the telephone system of the country ever since September 1, 1889. Instead of following the usual custom of telephone companies, who include in their annual rental the provision, fixing, and maintenance of their customers' apparatus, the French authorities decided to make the subscribers provide their own instruments. However, since the instruments purchased by the subscribers are kept in order by the authorities, no instruments are allowed unless well made, and capable of assuring good speaking. This way of going to work leaves the road open to the introduction of telephonic apparatus embodying all the improvements of inventors and manufacturers, and it is to be preferred to the system adopted by telephone companies, such as the English, for example, who when they have adopted a cheap type adhere to it and force it on their subscribers. But having made this rule the authorities found themselves involved in considerable difficulties in connection with the maintenance of the subscribers' telephonic apparatus, owing chiefly to the diversity of the parts. It is in consequence of this that they will impose the following rules on manufacturers, on and after January 1, 1893 :—

(1) All screws entering into the construction of telephonic apparatus must be to the standard gauge of the central depôt.

(2) Butt contacts are absolutely forbidden and are to be replaced by friction contacts.

(3) Spirals coming out from the cheeks of induction coil bobbins are to be done away with, and connection must be made with the coils by means of metallic blocks sunk in the cheeks.

(4) Only steel strips with platinised contacts to be made use of in connection with the telephonic springs.

(5) The spring of the movable hook should work in a normal manner when weights of from 200 to 600 grammes are attached to the hook.

(6) Wooden screws are to be replaced by metal screws or by bolts. The heads of the bolts are to be provided with lugs, and the nuts are to be grooved, so as to permit of their being screwed up by a screwdriver.

(7) All connections are to be made with insulated copper wire, covered with cotton or silk braiding, and ending in brass eyes. The braiding is to be red in the case of the primary circuit, blue for the secondary circuit, yellow for the bell circuit, and all three colours for wires common to all three circuits.

(8) The terminals are to be arranged and lettered, as shown in the accompanying figure.

(9) Only boxwood, thoroughly dry and sound, is to be used for the cheeks of the induction coils.

(11) Flexible cords are to be attached to the receivers by means of external terminals.

(12) The membranes of the receivers are to be varnished.

The following remarks are merely intended to be suggestive :—

(1) Split the heads of bolts to permit of screwing up by a screwdriver.

(2) Place the commutator hook on the left, which allows the speaker making use of the telephone to have his right hand free.

(3) Do not use for the receiver coils bobbins that split, but, on the contrary, use metal cheeks soldered to the cores, taking care to insulate this mass of metal from the wire.

All these rules explain themselves. The second, for instance, is explained by the fact that, contacts oxidising very easily with induced currents, it is advisable to use friction contacts which are automatically cleaned by each motion of the commutator hook. Subscribers will gain as well as the authorities by the application of these rules, since they are intended to prevent a host of little disturbances, the most evident result of which was to prejudice the subscribers whose service was momentarily interrupted, against the authorities.

† From *La Lumière Électrique*.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 4th.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Presidential Address by Dr. John Hopkinson, F.R.S.

MONDAY, November 7th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Paper to be read : "The use of Steel Needles in driving a Tunnel at King's Cross," by W. H. Holttum.

TUESDAY, November 8th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Address by Mr. Harrison Hayter, President, and presentation of Telford Medals and Premiums, and Miller Scholarship and Prizes awarded at the close of last Session.

THURSDAY, November 10th.

INSTITUTION OF CIVIL ENGINEERS.

9:50 a.m. Students' Visit to Tottenham and Forest Gate Railway.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. The following Paper will be discussed : "The Problems of Commercial Electrolysis," by James Swinburne.

FRIDAY, November 11th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. Continued discussion of the Papers by Mr. Williams and Mr. Sutherland : "Dimensions of Physical Quantities" and "Molecular Forces."

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Two short Papers to be read on subjects connected with the testing and calibration of electrical instruments.

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MUNICIPALISATION.

According to the old-fashioned notion, the duties of a municipality lay in the general well-being of the community to which it belonged, that is, it was to confine its attention to such works as the maintenance and cleansing of streets. The municipality was a consumer of gas and water, these being expended for the good of the ratepayers, but in no sense supplied to them. But now Local Authorities are beginning, and with great success, to undertake the business of purveying these and other commodities, and having once started as traders it is not easy to see where they will stop, for there is a wave of feeling in favour of municipalising many of those great industries which affect the convenience of dwellers in towns. It is urged that there is no reason why individual enterprise should be suppressed in favour of corporate action, for the whole world is open to the individual, while municipalities can engage in only a few businesses, and these are determined chiefly by considerations of price and uniform quality. It is not easy to define the direction in which the energies of these corporate bodies are at present tending. In Leeds and elsewhere the gas works have been managed with great economy, and the small profit has been applied to the reduction of the rates. We will not dwell here upon the contention that this is equivalent to selective taxation, for we wish to avoid the financial issues of the problem. The Corporation of Liverpool has carried out waterworks of immense importance, and the supply of electricity in the favoured parish of St. Pancras is

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the envy of many a Londoner. Bradford, too, as far as the supply goes, has no reason to regret that the Corporation has made use of its Provisional Order, though it is difficult to see how future extensions can be made without materially altering the method of distribution. Of Brighton we cannot say much at present, except that the many criticisms of the municipal supply seem to be inspired by a rival company. However, with Derby, Portsmouth, Bristol, Cambridge, Dublin, Glasgow, and other schemes in progress and in contemplation, a fair comparison will soon be possible, and the weak points will be discernible while the strong points will, no doubt, be self-evident. "There is one matter," wrote Sir FREDERICK BRAMWELL to *The Times* in July, 1882, "in which, perhaps, a governing body may be allowed to be interested, and that is in the supply of water. There are two circumstances which render this different from any other kind of supply or trading—one is, that it is so unlikely as to be practically impossible that the commodity will ever be superseded, and the other is that on sanitary grounds it is necessary to charge persons for water on the basis of a rate, and not according to the quantity used." The first of these two reasons has been amply justified during the ten years which have elapsed since the date of this letter. Gas is not being superseded, but its uses are circumscribed and altered by the rivalry of electrical supply; and where gas works have been owned by the Corporation, and still more noticeably where members of the municipal body have been individually interested in gas works, powerful opposition has been offered to the introduction of electricity. Who shall say whether electric supply, as we know it to-day, will survive for fifty years? The second reason clearly fails to apply to electric energy except as regards street lighting. No objection can be raised to the proposed lighting of the Victoria Embankment and Westminster and Waterloo Bridges with electric light by the County Council. No private company cares about street lighting, and the convenient subways will allow it to be effected at a much cheaper rate than any of the supply companies could afford to accept.

It may be argued with much reason that when a municipal body enters into trade without competition, there is no inducement to keep down the price. Experience, so far, is opposed to this, for at St. Pancras 6d. is charged for ordinary supply and 3d. for current used during the hours of daylight, Bradford charges 5d., and the 7d. of the Brighton Corporation as against the 10d. of the private company is no doubt one of the causes of the jealousy to which we have referred. These three Corporations are doing very fairly well. The Bradford station began to pay in its second year. In the first three months' working at Brighton there was a loss of only £300, the usual sums having been set aside for sinking fund and interest. At present we are given to understand that a net profit of £70 per week is being earned. It must be remembered that stringent regulations for the payment of the sinking fund and interest are made under the Local Government Act, and a municipality cannot carry over sums in the convenient way so common with private companies. On the other hand there is a strong temptation to juggle with the various accounts of Local Authorities, especially in matters such as office and clerical expenses which are spread over several departments. But a strong point in favour of a municipal service is to be found in the low rate at which general management can be efficiently provided by a Corporation.

A more serious objection to a municipal supply than that of price is the absence of any incentive to improvement or encouragement of invention when a municipality carries on a business of this kind; and whether any undertaking should pass into the hands of a Corporation, Local Board, or Imperial Government may be judged by the opportunities which are offered in any particular case for option, discretion, choice, variety, and improvement. Water, it is generally admitted, should be of one quality, and that the best; this is only fair to those who drink it. Unfortunately no such simple standard can be applied in the case of gas, and when the quality must be continually watched, it seems better that a Local Authority should do the watching while a private company does the making, especially when a hundred-pound photometer and all its concomitant apparatus seems to be necessary for the examination. Leaving the vexed question of alternating *versus* continuous currents on one side, there are only three requirements in electric supply—continuity, uniform pressure, and cheapness. Any consumer of ordinary intelligence can judge of these for himself, and on these grounds, and these alone, may electric supply be accepted as a suitable business for municipal management. There is nothing to prevent private enterprise from competing with a Local Authority in electric supply by bringing in a private Bill. But such competition is discouraged by the Board of Trade, and on account of financial considerations such a course is very unlikely. An argument in favour of the municipalisation of such undertakings as those to which we have already alluded is the facility for raising capital at a low rate. Again, municipalisation is naturally very popular among contractors, since they get paid in cash and are not compelled to load their safes with ordinary shares. We should be sorry to see this carried to an extreme. Electric supply has been the outcome of individual enterprise. Great energy on the part of both financiers and engineers was needed, courage and skill were required, perseverance and hard work were essential. The labour was ordinary labour, engine building, dynamo making, trench-digging, cable making, and a dozen other well known operations were performed, and the labour was paid for at the ordinary rates. But capital, not labour, took the risk, supplied the scientific knowledge, and conceived the schemes; and is, therefore, as much entitled to reward as labour itself. Private enterprise has started the industry, and private individuals should benefit by the results. The encouragement of mere construction is hardly the same thing, and the best that can be said of the resolution of a Local Authority to undertake its own electric supply is that it is good for the electrical contractor.

The municipalisation of tramways and railways is a very different matter; it is of course altogether outside the categories suggested by Sir FREDERICK BRAMWELL, and fails to come under the test which we have suggested. Nothing but competition can ensure efficiency here, and we need only point to the disgraceful local railway service in Kent and some suburbs of London to prove this statement. Where trifling details conduce largely to convenience, where complications of through trains, season tickets, and a score of other matters of discretion exists, private enterprise, spurred by keen competition, will undoubtedly give the best results. It is on the other hand true that disaster has been averted from the Ship Canal by the Corporation of Manchester, and, as we are reminded by a very interesting article in the current number of the *Quarterly Review*, when there was a prospect of the abandonment of the Metropolitan Railway, the Corporation of the City of London, rather than see the scheme fall through, came forward with an offer of £200,000, and thus secured the prosecution of an enterprise which it had prescience enough to see would ultimately be to the advantage of the community.

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Putting on one side the question whether, as a matter of principle, a municipal body has any business to embark in railway construction or tramway proprietorship, it is more than doubtful whether they should do so when the profuse promises of a modern prospectus fail to attract funds, and especially when, thanks to labour agitation and other influences, investors are looking everywhere rather than to industrial undertakings for the employment of their capital. If individual capitalists shrink from an undertaking, is it fair to risk the money of the ratepayers? The wave of feeling in favour of the municipalisation of everything does not alter the responsibility of the public body. The only man who is likely to escape immediate injury is the working man; capital may be squandered, but it goes into, or, at all events, *through* his pockets; the contractor may be ruined, but up till the very last Saturday he will pay wages, and the cunning man is he who seeks not to stem any particular tide of popular caprice, which may for the moment carry him off his legs, but contrive that it shall bear him, if not to the haven he intended, at all events to another as good.

REVIEWS.

The Science and Practice of Lighting. By W. H. Y. Webber. (London: Walter King.)

This book is mainly a reprint of a series of articles which recently appeared in the *Journal of Gas Lighting*, and is chiefly intended to give its readers an elementary explanation of the principles involved in the different systems of artificial lighting. With one or two exceptions there is no claim to originality in the treatment of the subject, but considerable credit is due to the author for collecting a large amount of useful information which has hitherto remained scattered in the pages of various periodicals. The first chapter is entitled "The Theory of the Radiation of Light and the Effect of Illumination." The fundamental terms are explained, and extracts are made, from the optical works of Lardner, Ganot, Parkinson, Heath and others, which expound these terms very clearly. A slip is made on page 6 in referring to Kepler's law, that the illumination caused by a light source varies inversely as the square of the distance from the light; for it is stated that "this proposition presupposes that the light source is perfectly regular—*i.e.*, radiates equally in all directions." This supposition is quite unnecessary, as the inverse square law holds whatever the character of the light, and only fails when the medium in which the light travels is an absorbent one. The style of the book on the whole is remarkably simple, only the slightest knowledge of mathematics being needed. While, however, in the first chapter, the term cosine is freely used, the explanation of this term is not given till almost the end of the book, when the simple trigonometrical terms are explained at great length. Under these circumstances an extract from Prof. Tait's book, occupying a whole page in the first chapter and involving not only cosines, but potential functions and double integrals, is peculiarly out of place. While the book is from one point of view commendably free from mathematics, the author gives up, as hopeless, several problems of no great difficulty, viz., the effect of a source of light with an appreciable area, instead of a mathematical point; the absorption and refraction of the atmosphere, the latter being indeed no great matter; and the effect of successive reflection. After quoting at considerable length from a no less antiquated authority than Dr. Lardner, the author exclaims "The difficulty of calculating the amount of this complicated reflection from reflection repeated *ad infinitum*, is evident."

The second chapter entitled "French Rules for Lighting" summarises the work of various French writers on illumination, such as Mascart, Montserrat, Brisac, Loppé, and Wybauw. Nearly all this information is to be found in the excellent treatise of Palaz on Industrial Photometry, but it has not previously appeared in English in book form, although some of it has been published in the pages of *The Electrician*, together with a problem by Mr. Loppé which, so far as the author knows, "has never before appeared in English." The third chapter deals with modern progress in scientific lighting and forms an interesting history of the successive improvements effected in gas lamps during the last 15 years owing chiefly to the growing competition with electric lighting. This chapter is mainly an abstract of contemporary articles in the *Journal of Gas Lighting*, and the author, who throughout the book shows a strong bias in favour of lighting by means of gas, holding up electrical engineers and their doings to derision, endeavours to show the advantages of greater subdivision of the light sources than is practicable with the electric light.

A critical chapter on modern practice follows, and this is perhaps the most important one in the book for electrical readers, as it is directly concerned with the relative merits of street lighting by gas and electricity. If a street is to be illuminated either by a few powerful electric lights or by many less powerful gas lights it is necessary in order to produce the same uniformity in the distribution of lighting that the electric lights should be placed on much higher posts than the gas lamps. Thus if the candle-power of the former, assumed to be equal in all directions, is 100 times that of the latter the one set of posts should be ten times as high as the second. With gas lamps of 16 c.p., and electric lights of 800 (mean) c.p., the ratio of the heights of the lamp posts should be 7 to 1. The usual practice is more nearly 2 to 1, so that the electric lighting would be more "spotty" than the gas lighting. The amount of uniformity which is desirable in street lighting is to a large extent a matter of opinion. It certainly varies enormously in different streets lit in the usual way by gas, and any attempt to obtain a numerical estimate of the quality of any kind of illumination from its variation from uniformity must needs be of very debateable value. Mr. Webber, however, makes the attempt; and advances the proposition that "the practical measure of the efficiency of the lighting is given by the difference between the brightest and the dimmest parts of the illuminated area." In order to understand this proposition, it is necessary to add that by the word *difference* Mr. Webber means *ratio*, and that the greater the index of efficiency the worse is the illumination. "With regard," says the author, "to the index of practical efficiency, which is the name here given to the difference between the best and the worst effects, it should clearly be kept as low as possible. It is hardly practicable to get it below 12 or 15, with cross or linear outdoor lighting respectively; and the best electric arc lighting in London runs it up to nearly 50, which should never be exceeded." Several practical examples of gas and electric lighting are then considered, and the calculation of the index of efficiency in these cases leads Mr. Webber to the conclusion that the former system is undoubtedly superior. One unfortunate electric system is discussed in which the brightness immediately under the lights is 300 times as great as that of the darkest places, and this is described as a degree of "spottiness" which a blind man could appreciate.

Mr. Webber's criterion of efficiency is not one which can be accepted without modification. Moreover, in applying it in cases where the illumination is calculated from the candle-power of the lights it must be remembered that in practice the dim light at the minimum between the lamps is generally increased by reflections or other circumstances extraneous to the lamps considered, and that in the case of arc lights the candle-power is not, as assumed in Mr. Webber's calculations, the same in all directions, but is naturally distributed so as to produce a more uniform illumination. That these effects have an important influence is shown by a calculation of the author's with reference to the electric lighting of Queen Victoria-street. He finds the ratio of the brightest to the dullest portions of this area to be 46·9, while it happens that actual measurements for this case show that the ratio is not more than 10, and about the same number represents the state of the lighting of Whitehall, which may be taken as an example of good gas lighting. The "index of efficiency" instead of being four times as great for arcs as for gas, as Mr. Webber makes out, is very nearly the same.

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The book may be recommended to those who have already sufficient acquaintance with the subject to prevent their falling into such errors as those to which we have alluded, and who are not inclined to take up the contemptuous attitude towards electric light which is encouraged in its pages.

Induction Coils. By G. E. BONNEY. (London: Whittaker and Co.)

This handy little book is not in any sense a work on electromagnetic theory, but is—as it claims to be—a practical manual for amateurs, to guide them in the construction and use of induction coils and their accessories. Written in a clear and attractive style, the book may be understood by the veriest tyro in electrical matters; while it possesses the further merit of offering simple but good reasons for every direction which is given and for every property which is described. The early chapters deal with the phenomena of induction—which are explained by reference to a few well-chosen experiments—and with the practical details in the construction of coils for general and for special use. A short account is next given of some large and celebrated induction coils, and of their achievements; but mention might well have been made of the valuable assistance in chemical and physical research which these coils have given. Mr. Bonney has wisely devoted a portion of his work to an account of the construction of that accessory, without which the coil would be useless and on which the success of the experiments so much depends—the primary battery. Several forms are described, and their suitability to various classes of work is carefully pointed out. The work is copiously illustrated, and there is a good index. This volume will, no doubt, be welcomed by the amateur experimenter who desires to make his own induction coils.

Handbuch der Electrotechnik. By DR. E. KITTLER. Vol. I., Second Edition. (Stuttgart: Ferdinand Enke, 1892.)

The present volume is the first of a series of three, in which the author apparently aims at including all branches of technical electricity, and purposes to treat each one of them in a very detailed manner. The extent of his ambition may be gathered from the fact that he devotes 500 pages, in other words half, of the volume before us to the theory and construction of direct current dynamos. The book is written in the style which, unfortunately, seems to commend itself to most engineers; although it contains an enormous number of formulæ of all kinds, no attempt is made to prove a large number of them or to indicate the steps by which they are obtained. We may, however, remark that Dr. Kittler does give references to the original papers, thus enabling a student, after a vast amount of ransacking of public libraries and bookshelves, to satisfy himself as to the real meaning of the symbols and equations found in the work. Of course it may be said that the volume is a handbook and not a text-book, but we are nevertheless of opinion that the portions referring to matters of theory would be improved by treating of fewer points, but in a more complete manner. The descriptions and figures of machines and instruments are very numerous, and are quite equal to anything of the kind which we have previously seen; the woodcuts especially are well executed, and exhibit clearly all the parts of the machine they are intended to represent. The volumes are to be separately indexed, each containing an index of names and contents, so that each volume is complete in itself. This is an advantage often overlooked in similar handbooks. The contents of the first volume include the general treatment of magnetism and induction, electrical measurements, the measurement of mechanical work (this section being from the pen of Herr Schröter, of Munich), and the principles, theory and construction of direct current dynamos.

The Electric Lighting of the Embankment.—On the recommendation of the Highways Committee of the London County Council, it was referred to the Parliamentary Committee to take the necessary measures to obtain the sanction of Parliament in the next Session to the carrying out of the electric light installation on the Victoria Embankment and parks and gardens, and the Westminster and Waterloo bridges.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 609, Vol. XXIX.)

20. The Cable Ship "Faraday."—This vessel, which has laid six cables across the Atlantic, and carried out some important repairs in deep water, is of a very distinct type. She may be called one of the masterpieces of the late Sir William Siemens, who, in the year 1873, considered the practice unsatisfactory of adapting existing ships for cable expeditions, and thought that the requirements in such a vessel demanded a special design throughout. That his design of the "Faraday" fulfilled these requirements in a very marked degree time has amply proved. In the middle of 1873 the keel of this vessel was laid at the Walker Yards, Newcastle-on-Tyne, by the builders, Messrs. Mitchell and Co., and she was launched the following February. By the courtesy of Messrs. Siemens Brothers and Co. the writer is able to present some illustrations and particulars of interest. In the first place, she is remarkable for the exact similarity of bow and stern (Fig. 73), hand and steam steering gear being fitted at both ends, and enabling her to answer the helm equally well when going astern. Further, being a twin-screw boat, she can be turned in her own length, and manœuvred with great ease and promptitude. A wide central deck space from bows to stern has been provided by placing her funnels abreast instead of fore and aft, and by this means the cable has a clear run along the centre of the deck from the tanks to the sheaves.

Her dimensions are :—360ft. long, 52ft. beam, by 36ft. deep. Her registered tonnage is 5,000, and coal bunker capacity 1,700 tons. She has carried as much as 1,962 knots of mixed cable on one trip, the weight of this cable being 4,500 tons, and her large coal capacity enabled her on one occasion to stay at sea for a period of three months without recoaling. There are three cable tanks, all of 30ft. depth, and having a total capacity of 2,000 miles of cable. The after and midship tanks are each of 45ft. diameter, and capable of taking in 800 knots of cable each, while the fore tank is 37ft. in diameter, and can hold 400 knots of cable.

For repairing work this vessel is fitted with powerful picking-up gear—Fig. 75—capable of lifting 30 tons at a speed of one knot per hour. It is fixed on the middle of the upper deck forward of the bridge, is roofed over, and provided with raised platform, to which all levers and valves are brought within easy reach. This view shows the path of the cable on deck from bows to tank, passing on its way the dynamometer, drum and hauling-off sheave. The buoys on this vessel are provided with four chains hanging over the top half of the buoy at equal distances apart. These are fast at top and bottom ends, and pass through two rings set in the buoy. Two cross ropes pass through the same rings, and encircle the buoy horizontally. The rings are also used for making buoys fast to deck by chains, as seen in illustration. The buoy is picked up by the top cross rope, and the chains on buoy are convenient for hanging on to or attaching the bridle chain.

The dynamometer is similar in action to those already described, but has the external appearance shown (Fig. 76). The framework forming the crosshead guides for the sheave is built of iron plates, riveted together in the shape indicated, and for convenience in keeping cable at a certain height this framework stands about 16ft. high, and the sheaves on either side are mounted on high A frames to correspond.

The mounting of the bow and stern sheaves is specially designed to eliminate all side friction between the cable and cheeks of sheaves when the strain comes on sideways. The bow sheave is illustrated in Fig. 74, in which it will be seen that the sheave is mounted on a framework in bearings (A B) capable of turning sideways about a horizontal axis, so that in picking up or paying out, if the ship's course, owing to currents or weather, is not exactly in the same line as the cable, the sheave takes up at once the position of least strain. Further, by means of a chain attached to the framework at the lower extremity of the sheave on either side, the latter can be set up to any angle with the ship, and secured in that position if re-

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quired. Both bow and stern sheaves are of precisely similar construction, the platform being right over the respective wheels, and built out a considerable distance from the ship. This vessel has seen good service in repairs to cables in the deep waters of the Atlantic. One specially smart piece of work was the repair of the Direct United States cable in a depth of 2,680 fathoms, when the whole operation took no more than 48 hours.

logs give only at their best the speed of ship through the water. What her speed is over ground as affected by leeway or currents the log cannot indicate, and, therefore, there has always been more or less uncertainty as to what slack is being payed out. In order to register correctly ship's speed over ground, Messrs. Siemens pay out alongside and simultaneously with the cable a pianoforte steel wire, which, having a breaking strain of 170 tons per square inch, is paid out perfectly taut, so that it lies with-

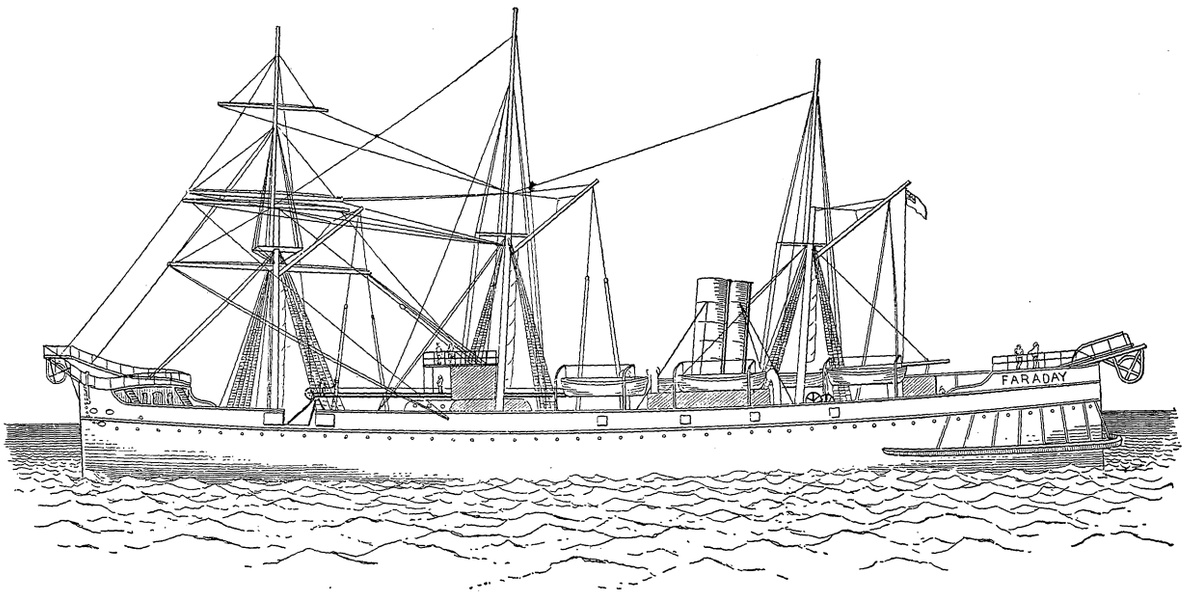

FIG. 73.—Cable Ship "Faraday." (5,000 tons.)

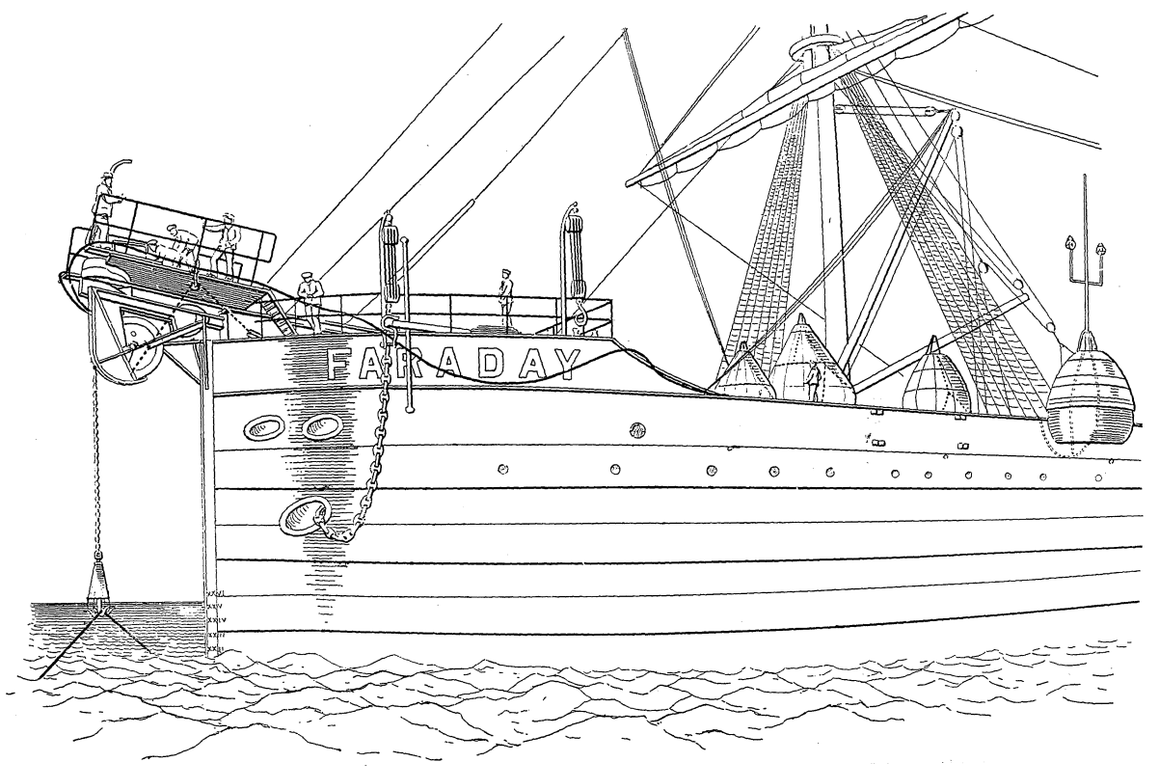

FIG. 74.—Bows of the "Faraday."

Turning now to the arrangements for paying out cable, it will be remarked that the vessel, as illustrated (Fig. 73), has a guard or crinoline fitted round her stern. The object of this was to prevent cable fouling the propellers, but after considerable experience it was found that the inconvenience of the crinoline was greater than its advantages, and it has, therefore, been discarded for some time. The paying-out machinery on this vessel is so constructed that cable can be laid with a fixed percentage of slack. The most approved automatic registering out slack on the sea bed. The excess in the length of cable over the length of wire payed out per hour at once gives the amount of slack. By an ingenious apparatus the percentage slack is continuously recorded. The two axles, whose speeds have to be continuously compared, namely, the axles of the wire and cable drums respectively, are caused to set in rotation two distinct parts of this apparatus, one being a wooden cone mounted on its axis between bearings, and the other a long screw, also mounted between bearings, and in a position parallel to the side of the

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cone. The speeds of rotation of these two parts of the apparatus, which are quite independent of each other, are then proportional to the rates of paying out of wire and cable respectively. On the long screw is a circular nut, whose edge bears against the cone. If the cone was running slower than the screw, or say stopped altogether, the nut would run along the screw in one direction; but if the cone rotated, and the screw was stopped, the nut would be rotated by the cone, and travel along the screw in the opposite direction. Hence, the position of the nut is determined by the difference of speeds of the cone and screw, and its movements are indicated on a scale conveniently marked in percentages of slack. The brakesman can therefore adjust the brake on the cable drum as cable goes out, so as to pay out at a constant percentage of slack. By means of a train of clockwork and travelling paper-slip the nut is made to imprint a continuous record of the percentage slack paid out. The economy effected in cable payed-out amply covers the cost of the steel wire.

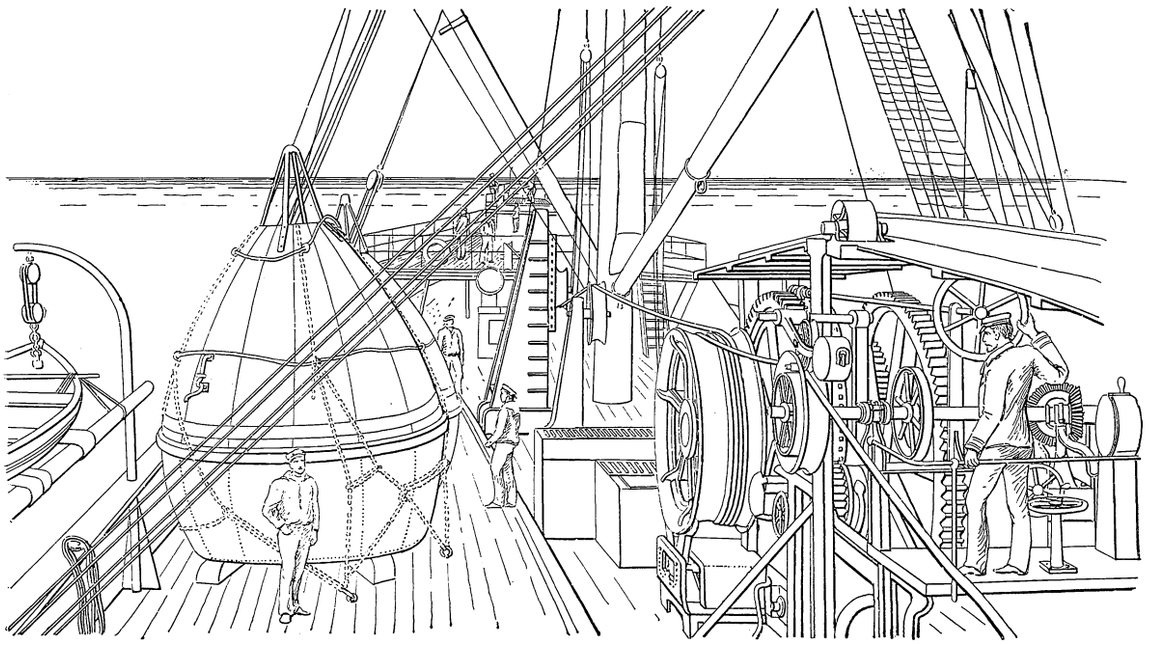

FIG. 75.—Forward Deck of the "Faraday."

The "Faraday" has made 23 cable-laying expeditions. The most noteable cables laid by her are mapped out in Fig. 77, her first expedition after launching being to lay the Direct United States cable in 1874 to '75, connecting Ireland (Ballinskellig) with the United States at Rye Beach, calling in at Tor Bay (Nova Scotia)—3,101 knots. In 1879 she laid a cable for the Compagnie Française de Télégraphe de Paris à New York, from France (Brest) to Boston (Cape Cod), calling in at St. Pierre (Newfoundland)—3,069 knots. In 1881 to '82 she laid two cables for the Western Union Telegraph Company from Cornwall to Canso (Nova Scotia)—5,107 knots, and completed these cables to New York in the year 1889 (1,577 knots). In the year 1884 she laid the two cables of the Commercial Cable Company from Ireland to New York and Ireland to Rockport, both cables touching at Canso, and it is remarkable that this large amount of cable (6,098 knots) was manufactured and laid within one year from the date of order. This vessel has therefore laid 18,952 miles of trans-Atlantic cables. The other cables marked on the map bring this total up to 20,130 miles, these being laid between St. Pierre and Louisburg, Brest and Cornwall, Waterville and Le Havre, and Waterville and Weston-super-Mare. When at home the "Faraday" lies in the Thames off Messrs. Siemens' Works, at Charlton Pier, Woolwich.

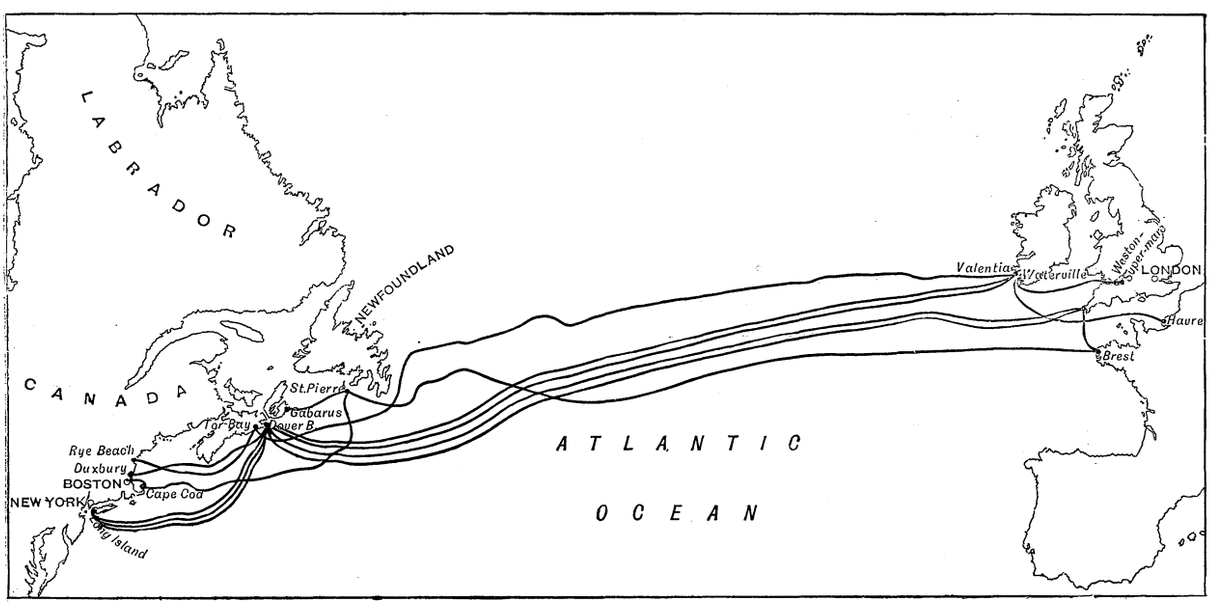

FIG. 77.—Atlantic Cables laid by the "Faraday." (20,130 miles).

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The cable ship "Pouyer-Quertier," constructed in 1879 to the designs of Messrs. Siemens Bros., for the Compagnie Française, mentioned above, was built on the same lines as the

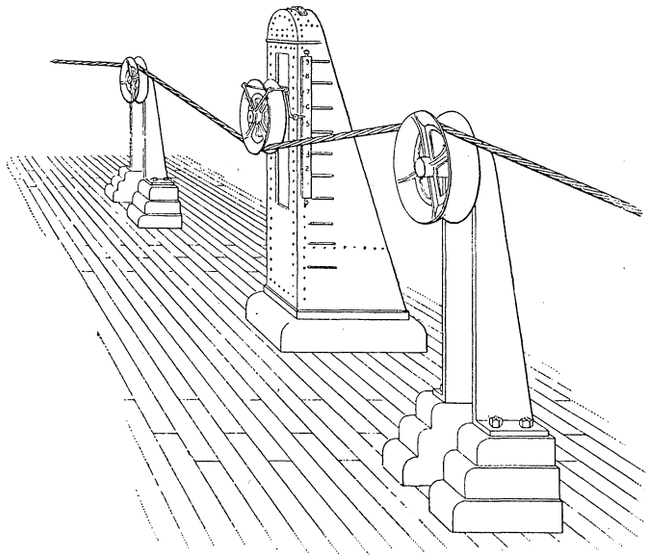

FIG. 76.—Forward Dynamometer on the "Faraday."

"Faraday," although smaller (1,385 tons). This vessel is stationed at Havre, and keeps in repair the two Atlantic cables of the French Company.

(To be continued.)

LEGAL INTELLIGENCE.

Hopkinson v. The St. James' and Pall Mall Electric Lighting Company (Limited).

On Wednesday last this case came before Mr. Justice Romer in the Chancery Division of the High Court of Justice, Sir R. Webster, Q.C., Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. Hopkinson, Q.C. (instructed by Faithful and Owen), appeared for the plaintiff; Sir Horace Davey, Q.C , Mr. Finlay, Q.C., and Mr. Roger E. Wallace (instructed by Mr. A. C. Curtis-Hayward), for the defendants.

Sir RICHARD WEBSTER, in opening the case, said that his client, Dr. John Hopkinson, was Senior Wrangler, and for many years had occupied a distinguished position. He was well acquainted with all the modern developments and discoveries in electrical branches of knowledge. The plaintiff sued for infringement, and the defence was, shortly, that there was no invention, as the alleged invention was either obvious or invalid. The patent taken out by the plaintiff (No. 3,576*, 1882), was not a "casual" one, but was the outcome of much experiment and research. The patent in question was now equitably owned by the Westinghouse Company, but the legal estate was still vested in Dr. Hopkinson, and the Court of Appeal has decided that the action should be brought in his name. The specification, as amended in June, 1891, contained descriptions of two inventions. One of these, he alleged, was infringed by the defendants, and both were attacked by them in their defence. The plaintiff's system was known generally as the three-wire system of electric lighting by incandescent lamps. Dealing first with the principal invention. Here there was no substantial dispute as to the fact that if the patent be upheld the acts of the defendants amounted to an infringement of it. The case turned on the question of validity. In any system of electric lighting there must be a source of electricity, be it primary or secondary batteries or a dynamo; conductors or mains to conduct the electricity to the place where it was to be used and distributed, and lamps to utilise the electricity. In this case they have only to deal with the mains or conductors. He was not aware of any case of recent years in this branch of electric lighting. Before the date of Dr. Hopkinson's invention, one of the great objections to the introduction of electric lighting was the expense of copper, which was the metal most suited for conductors. The invention was described at he time as being most meritorious and useful. It fulfilled a want, and overcame a difficulty which had been long felt by men of eminence. This invention was made almost contemporaneously by Dr. Hopkinson in this country and Mr. Edison in America. On the latter attempting to patent it here he discovered he was forestalled by Dr. Hopkinson. It was important to remember this when his lordship considered the point made by the defendants that the alleged invention was obvious, and, therefore, not subject-matter for a patent. The current, from whatever source, on leaving the generating station, would be of a certain quantity and at a certain pressure—"pressure," or "difference of potential," as it was also called was measured in "volts." "A current of so many volts" meant a current at a pressure of so many volts. To borrow an analogy from hydrostatics, pressure corresponded to "head of water." It was most important to remember that in arc lighting the lamps were arranged "in series"—that is, that the whole current goes through each lamp in succession, while in the incandescent systems the lamps were arranged "in parallel"—that is to say, the whole current flowed from the generator in the main to the place where the installations were fixed; then it was divided and flowed through the lamps, each taking a portion, and then reunited and returned by the other conductor to the source of electricity, thus completing the circuit. The difference of potential or fall of pressure through each lamp should be the same, and equal to the difference of potential between the mains at the place where the installations were. But where lamps were placed "in series," as in arc lighting, the difference of potential between the mains is the sum of the differences of potential at each lamp; consequently, it was important in such cases to have the quantity constant, and the pressure varying with the number of lamps. In parallel lighting, on the other hand, the quantity of current varied, and the object was to keep the difference of potential at the installation end of the mains constant. [The learned counsel illustrated his remarks here and throughout his speech by reference to models.] These *desiderata* were known, and many skilled electricians worked at the problem, but none of them hit on Dr. Hopkinson's and Mr. Edison's solution. It was found that the cost of conductors could be lessened by conveying the current at a high pressure, and the device adopted was to arrange the lamps in a combination of "parallel" and "series"; a certain number were placed in series, and then several series so arranged were placed "in parallel," so that the current on dividing, when leaving the outgoing (or "flow") conductor, passed through several parallel sets of lamps in series on its way to the "return" conductor. The difference of potential required was much greater than in a purely "parallel" system, and thus the current could be generated at a much higher pressure. Taking the difference at the mains at 100 volts, then each series of lamps would consist of two 50-volt lamps or four 25-volt lamps, and so on. This device, however, did not secure equal difference of potential at each lamp, for the turning out of one series only caused a redistribution of current amongst the others. The fall of pressure between two points on a conductor measured in volts was equal to the product of the resistance of that part of the conductor in ohms by the current in amperes. As the resistance in each lamp was fixed by the dimensions of its filament, the amount of current passing through it was proportional to the difference of pressure. Hence, if this difference of pressure be not kept constant the current would vary; if too large it would destroy the lamp very soon; if too small it would not give light. Again, in a complete circuit, the total difference of pressure at the dynamo ends of the mains was distributed throughout the circuit in proportion to the resistances of its parts; that was to say, the fall in pressure along the circuit varied from point to point with its resistance. If the pressure at the engine-room be maintained constant, the turning on or off of house installations varied the resistance of the middle portion of the system, and hence varied the distribution of pressure throughout the circuit, and so varied the difference of pressure between the mains at the lamps. More lamps being turned on tended to diminish the effective difference of pressure. It was essential to keep the difference of pressure constant at the lamps, and not at the engine-house. Gentlemen of the greatest eminence had experienced this difficulty, but had not seen their way out of it. The plaintiff's invention consisted in using three conductors instead of two, coupled up with two dynamos "in series." One outer wire formed the "flow" conductor of one dynamo and the middle one the "return." The middle wire was coupled up as the "flow" conductor of the second dynamo, and the other outer one as its "return." Hence the middle one only served to convey the "balance" of the two systems, hence could be of much smaller dimensions. The house installations were distributed equally between the two systems (preferably house by house alternately), so that the result practically was that the dynamos worked "in series" and the middle conductor had not much current to convey. He was much honoured in his assistant [Lord Kelvin here assisted with the model], and he would now illustrate what he had said by the model. [Detailed experiments were then made.] When all the lamps forming one system were "off," it was reduced to the old two-wire system, but commercially and practically this never occurred. This invention had been very largely used and commercially successful. It was the most important invention in electric lighting since that of the incandescent lamp itself. [The learned counsel then read and commented upon the specification (see page 7) in detail.] The combination claimed involved two essential details—(1) two dynamos coupled in series, and (2) balance by arranging the consumers on either side of the middle conductor so that it had only to convey the "balance" current. It was the old system simply and solely with the addition of what was necessary to bring the balance back. What was the defence set up on this part of the case? The peculiar construction of certain well-known machines! He would postpone for the present dealing with that by simply remarking that if that were so, eminent electricians would have effected enormous savings by acting on that knowledge. There was no allegation of prior publication by description, but they alleged it was used publicly by Messrs. Crompton and Co. at the Alexandra Palace and at the Glasgow General Post Office. He must wait till they attempted to prove those and other instances they mentioned. Their assertion that the three-conductor system was known simply amounted to this, that the middle conductor in such alleged anticipations to which they referred, was the *return* for both dynamos, which is another matter altogether. He should claim for his client that his invention was one of high merit and great success, and was as much subject-matter for a patent as the whole train of those supported by previous decisions. The alleged infringement was admitted to this extent, that the physical arrangement of the defendants' system would be

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an infringement of the plaintiff's patent if it could be supported as a valid one. He must now direct his lordship's attention to the second invention of the plaintiff's. This had not been infringed by the defendants, but they (and in so doing were quite within their rights) attacked the validity of the plaintiff's patent on the ground that this portion of his invention was not new nor subject-matter for a patent. In arc lighting the lamps were arranged in series, the whole current going through every lamp, the pressure required being the sums of that required for each lamp—in other words, a certain current being required, and the resistance of the circuit being increased with each lamp, the total pressure must be increased in the same proportion. In incandescent lighting, the lamps being arranged "in parallel," each lamp took its share of the current. To maintain a constant current in each lamp constant difference of pressures must be maintained. Hence constant difference of pressure between mains at installations was essential. The resistance of a conductor was a known thing. It was proportional to its length and inversely as its cross-section; hence in the mains the resistance of any part might be taken as proportional to its length. Now the pressure fell owing to increased resistance, hence there was a uniform fall of pressure along the "flow" main to the installations, and also along the "return" main from the installation to the generating station. It would be proved that this fall of pressure increased with the current. When more lamps were turned on they took more current, and, consequently, if the initial pressure be constant that at the installations would decrease. The greater the distance of the installation the greater the fall of pressure, and the greater the pressure necessary at the engine-room to compensate for it. When an installation was, say, 1½ miles away the engineer was much troubled about the pressure at the installation, the current took care of itself. Various devices were used to give this information, one by means of "pilot" wires from engine-house to the other end of the main. [The learned counsel illustrated this on the model.] The plaintiff's invention proceeded on different lines. He solved the problem by taking an old expedient and applying it in a new way to a new object. A "voltmeter" was an instrument used to measure differences of pressure between certain points. It consisted of a wire of known resistance wound round an electromagnet. If the wires of the voltmeter be attached to the ends of the mains in the engine-house, the total pressure of the current was thereby measured. Again, the fall in pressure along the main, whose resistance was known and constant, was proportional to the current passing along it. The plaintiff added to the ordinary voltmeter a short, thick coil, wound in the opposite direction to carry the whole or part of the main current. This coil produced an effect on the needle proportional to the fall of pressure in the main. The combined effect on the needle was that it indicated not the total pressure at the engine-house, but that pressure less the fall in he mains, so that the voltmeter, as improved by the plaintiff, indicated in the engine-house at once the pressure at the other end of the main where the installations were. The needle might be used either as an indicator, or else to regulate the current automatically by means of a relay or other device. [The learned counsel here explained the invention in detail by referring to the specification.] In considering this case they must be careful not to use the knowledge of 1892 in dealing with a publication of 1882. The plaintiff was dealing with something which depended on the customers and not on the engineer. It was quite a different problem from those arising in arc lighting. The defendant said: "No, these things were used before for a like purpose." "Yes," said the plaintiff, "but you never had an instrument devised for indicating in an engine-room the pressure at a distant point." In arc lighting the problem was to bring the carbons to, and keep them at, a certain distance apart by mechanical means. Here the indicator could be used to automatically regulate the current. There was no trace of any such arrangement having been used for a purpose like the plaintiff's. What did the defendants set up in their defence? First they set up six specifications as anticipations. He would show that they contained no such anticipations. They next said the device was well known, and relied on certain instances. These were the Brush, Crompton, Pilsen, and Siemens lamps, in all of which the function of the regulator was to bring mechanically together certain pieces of carbon, and had nothing to do with a varying pressure, each was applied to a separate lamp, with no indication how the combined effect could be read in the engine-room. There was no suggestion of its ever having been applied to a multicle parallel bridge. All they said was that the analogy of somewhat similar apparatus should deprive this of being good subject-matter for a patent. He knew of no case in which such would be held to anticipate. The alleged anticipations afforded no means of solving the problem. This patent was never challenged before. Dr. Hopkinson's invention was the same as a *subsequent* one of Mr. Edison's. Other electricians were at the problem, and thought *subsequently* they had invented it. He had not pretended to explain this case with scientific accuracy, and he protested against the speeches of counsel being fastened upon as declarations of their clients in regard to matters of scientific details. It was by the evidence, and by that alone, his lordship would be guided in his decision in this case.

The Court then adjourned until yesterday (Thursday).

London County Council v. Carwardine and Co.

This case, stated by a metropolitan magistrate on an information relating to an alleged "sky sign," came before Mr. Justice Mathew and Mr. Justice Bruce on Tuesday. Mr. Avory and Mr. Daldy appeared for the County Council; Mr. Pattisson (Mr. Poland, Q.C., with him) appeared for the respondents.

The structure in question is over the premises, 84 and 86, City-road, belonging to the respondents. It consists of a tower 50ft. high, composed of a framework and balks of timber 10in. square, braced together by other timbers and by iron rods. At its lower end is securely tied down to the girders which support the top floor of the premises. Rather more than half-way up the tower is a square gallery, with a railing consisting of large wooden letters, 3ft. 6in. high. At the top of the tower are windmill "floats" in a circle 28ft. in diameter, which are brought round to the wind in the ordinary way by a rudder. The rudder is necessary to enable the structure to be used as a windmill. The structure is provided with special mechanism and gearing to enable it to be used as a windmill, in particular a system of counterbalanced weights by means of which the floats of the mill automatically open and shut according to the force of the wind, so that they revolve nearly at a uniform rate. Over the roof of the premises was fixed at one time an arc light, which was used at night for lighting up the structure and the front of the premises. This was removed in December last. The windmill drives two pairs of millstones, which grind wheat into meal on the respondents' premises below. They will produce, with an ordinary wind, three to four sacks of meal a day. The windmill was used for hoisting weights from one floor to another; and also drives a dynamo which generates electricity for supplying light. The magistrate dismissed the summons, being of opinion that the structure must be considered as a whole, and was a windmill not within the Sky Signs Act, 1891. The County Council's contention was that the structure was a sky sign within this Act. The respondents contended that it was primarily erected and used for grinding meal, and generating electricity, and hoisting sacks, and that structures erected or used mainly or primarily for trade purposes, and not for purposes of advertisement, were not structures in the meaning of the Act, and that the Act, therefore, did not apply. The Court held that the structure was a sky sign.

Mr. Justice MATHEW said that as the structure now stood it was within the Act. The Court was not called on to express any opinion as to what would follow if the letters on the tail or rudder were painted over and those on the balustrade removed.

Mr. Justice BRUCE was of the same opinion.

Hooper v. The Western Counties and South Wales Telephone Company (Limited).

In the Chancery Division of the High Court of Justice, before Mr. Justice Chitty, on Saturday last, this case came on for hearing. The case involved an important question of Company law as to the meaning of the term "reconstruction of a company." It appeared that the defendant Company was a provincial telephone company, incorporated in 1884, with a capital of £400,000, divided into 20,000 preference shares of £5 each, and 300,000 ordinary shares of £1 each. The defendant Company had subsequently issued debentures to the amount of some £60,000 or £80,000. The plaintiff was the holder of nine debentures of the defendant Company of £100 each, bearing interest at 5 per cent. The debentures were redeemable at par in 1896, but there was a proviso that the defendant Company might, at any time after the expiration of one year from the date of the debenture, redeem the debenture by giving three calendar months' notice to the holder, and paying to the holder £105 for every £100 capital secured, with interest up to the date of payment. There was also a further condition that, if the defendant Company commenced to be wound up "otherwise than for the purposes of reorganisation or reconstruction," the principal money secured by the debentures was to become immediately payable. In June, 1892, a provisional "agreement for amalgamation" was entered into between the defendant Company and the National Telephone Company providing for the sale to the National Company of all the business and property of the defendant Company, in consideration of the allotment of shares in the National Company to the defendant Company's shareholders in exchange for their shares in the defendant Company, and also in consideration of a provision for the exchange at par of the debentures of the defendant Company for debentures of the National Company, or of a sum in cash equal to the par value of the preference shares and debentures held by persons not consenting to exchange. Special resolutions were subsequently passed by the defendant Company that the "agreement for the amalgamation of the two Companies by a transfer of the business and property" of the defendant Company be approved, and for the voluntary winding-up of the Company, and the appointment of a liquidator for the purpose of giving effect to the agreement and winding-up the Company's affairs and distributing its property. The large majority of the debenture-holders consented to the proposed exchange, and the remainder accepted the full par value of their debentures, with the exception of the holders of debentures to the amount of some £1,800, amongst whom was the plaintiff. The contention of the plaintiff was that the contract by the defendant Company to pay a premium of £5 for each £100 on redemption before 1896 was not rendered null and void by the liquidation, inasmuch as the transaction between the two Companies was merely tantamount to "a re-organisation or re-construction" of the defendant Company, and was within the exception of the condition specified. It was stated that the defendant Company was prosperous and solvent, and that the National Company was another telephone company with far wider operations and a far larger capital.

Mr. Justice CHITTY said that, on the face of the special resolutions, the purpose was to carry into effect an agreement for amalgamation. But the substance of the transaction was to be looked at, and it must be seen whether it was an amalgamation or whether the transaction fell within the words of the condition, and was a reconstruction or reorganisation of the Company. The words reconstruction and reorganisation had no technical meaning. No text-writer on company law, when writing on the reconstruction of companies, used the word "reconstruction" so as to include a transaction like that in question in the case before the Court. The condition in question plainly included a voluntary winding-up origi-

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nating from the Company. There was one mode of reconstruction which might possibly be said to be within the strict sense of the term. That was when a company made an arrangement with its creditors by a voluntary winding-up under the Companies Acts, and then proceeded to stay the winding-up by means of an order of the Court or otherwise, and proceeded to reconstruct itself according to the arrangement or scheme and go on as the old company. That would certainly be reconstruction within the present condition. The Company would still continue to exist. But the meaning of the word could not be confined simply to a transaction of that kind. That would be too narrow. A company might adopt another mode of reconstruction. The Company might go into voluntary liquidation, and propose as a scheme for reconstruction the formation of a new company, the shareholders of the original company taking shares in the new company. There it was obvious that the original company did not continue to exist. Then there was in form a sale to the new members, and the original company in point of law ceased to exist. It might, no doubt, be said that there was no power in such a case to compel dissentient members to come in, but such a scheme was not put on foot until practically it had been ascertained that the old shareholders would come in. Mr. Palmer, in his work on company law, used throughout the word reconstruction as referring to the plan of forming a new company to take over the business of the old company, and he treated it as essential to a scheme of reconstruction that a new company should be formed. The same text-writer, when subsequently dealing with amalgamation, treated that as a sale by a liquidating company of its assets to another existing company for shares in the latter company. Another writer treated reconstruction as the transfer of the assets of an old company to a new company formed for the purpose of acquiring its business. Other writers wrote to a like effect. The clue to the meaning of the word as used in a clause like the present was whether a new company was practically the same as the old, even although in law it was a separate corporation. In the present case the transaction was not a reconstruction. With regard to the term reorganisation, it appeared to him to be merely an alternative expression, or anyhow, to be used in no wider sense than reconstruction. The present case was that of a comparatively small company joining with a comparatively large company, and the transaction might be compared with that of, say, a great railway company buying up a small railway company on terms that the shareholders of the small company should receive shares in the larger company. If the scheme was sanctioned by Act of Parliament and the shares accordingly allotted, would any reasonable person call that a reconstruction of the small company? It appeared to him that such a term would be wholly inaccurate. The illustration was analogous to the position of the two companies in the present case. The view he took was that the defendant Company had not undergone reconstruction, and the plaintiff's proceedings must be dismissed with costs.

Telephone Rentals.

At the Sheffield County Court, on Saturday last, the National Telephone Company sued George Bramhall, fishmonger, of the Market Place, for a half-year's telephone rent, due June 30th last. An agreement produced by the plaintiff Company showed that the defendant had agreed to pay £8. 10s. per annum, but the defence now set up was that the defendant took the telephone on a then reduced rental of £8. 10s., in order to induce customers to take it, and that by verbal arrangement with Mr. Tasker, of the Sheffield Telephone Exchange, it was agreed that he should give it up whenever he liked, without notice. When the Sheffield Exchange Company was taken over by the National Company he gave notice to have the telephone taken away, but the Company sued under the agreement, although the rent had been reduced since it was drawn up. The case was ultimately adjourned.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 21, 1892.

New York Street Railway Franchises.—Mayor Grant signed all the nine street railway franchises which were recently passed by the Board of Aldermen with the exception of one, granting the privilege to the Metropolitan Traction Company on 9th Avenue; this was returned to the Board with the request that it be reconsidered. At a meeting of the Board of Aldermen, held on Monday of last week, that franchise was reconsidered, and passed with the following amendment:—"After the words 'to be operated by power other than horses or locomotive steam power' to be inserted the words 'or the power known as the trolley system, or any motive power operated by means of electricity through an overhead wire.'" This action will prevent the Metropolitan Traction Company from operating any of its proposed extensions by the trolley system. That Company states that the cable system will be introduced, but it is probable that at least the 9th Avenue Line will not be equipped until public opinion has changed sufficiently to admit of the employment of the trolley.

Storage Battery Traction in New York.—Some time ago it was rumoured that the Second Avenue Surface Line was to be equipped with the storage battery system, but at that time the report could not be confirmed. It is now definitely announced that the Waddell-Entz Company is to place in active service upon that route 10 cars equipped with storage batteries and motors of their own manufacture. A power house is to be erected immediately. The generators will be of the Waddell-Entz type, directly coupled. The Waddell-Entz battery uses copper for the positive and iron for the negative plate, and the liquid is a zincate solution of potash. The containing box is of iron instead of hard rubber or glass, as is usually the case. The voltage of this cell is very low, and it is claimed that a discharge rate of 1,000 amperes can be maintained without injury to the cell. The weight for a given output is considerably less than is the case with the ordinary lead batteries. The motors are of the gramme ring type, with single reduction gear, and very low speed. The controlling device will, it is understood, regulate the speed by grouping the batteries; and it is proposed to make use of the momentum of the car in going down hill to recharge the cells. The result of this practical application of the storage battery to traction work will be awaited with considerable interest. Thus far the storage battery has not proved successful from an economical standpoint in this country, although it has been given several very fair trials. This line, however, will offer an unusually good opportunity to test the merits of this system, as it is practically level, and the traffic is comparatively heavy.

The New York-Chicago Long Distance Telephone.—On Tuesday of this week the long distance telephone line between New York and Chicago was formally opened by Mayors Grant and Washburn in their respective cities. Conversation could be heard over the line almost as distinctly as on the ordinary local telephone. One of the interesting incidents connected with the opening was the talking from the New York end of the line of Prof. Alexander Graham Bell with Mr. Wm. H. Hubbard at Chicago, who assisted Prof. Bell in the installation of the first telephone line ever erected, at the Centennial Exposition in 1876, and with whom he had not conversed through a telephone since that time. The line is constructed of No. 8 hard drawn copper-wire, weighing 435lbs. to the mile. The utmost care has been given to the matter of insulation, and the use of cables has been avoided wherever possible. The two wires forming the circuit are run on what is called the balance principle, that is, the wire from New York passes on the north side for a short distance, then crosses to the south side, then back to the north side again, and so on. The transmitting instrument is the ordinary long distance telephone. The length of the line is about 950 miles, which is more than twice the length of the longest line which existed prior to its completion. The line passes through Easton, Harrisburg, Pittsburg, Newcastle, Youngstown, and other cities, with branch lines to Cleveland and Toledo. The New York end is connected with almost all of the more important cities of the East, including Boston, Philadelphia, Baltimore, Washington, and Buffalo, so that all of the important points in the section through which the new line runs are now in telephonic communication.

CORRESPONDENCE.

BARE COPPER UNDERGROUND CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A good deal has recently been written on the heavy leakages and other troubles due to electrolysis which have taken place in the underground main system employed by several of the Paris Companies. This has been attributed to the extensive use of bare copper conductors supported on insulators. We take this opportunity of pointing out that such troubles have not occurred in England, although the use of bare copper conductors has been very extensively adopted in London and in other towns. As we were the pioneers in the matter we wish to explain the points wherein our success-

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ful English practice differs so very completely from the unsatisfactory practice that has been adopted in Paris.

Seven years ago, when we were responsible for the design as well as for the contract for the works of the Kensington and Knightsbridge Company, we proposed to the Directors the use of bare copper conductors, and accepted all the heavy risk and money responsibilities which such a novel system of underground conductors would have entailed if it had turned out to be a failure. Now that its success has been proved we consider we are entitled to whatever credit and saving has attended the system.

In working out our system of bare copper underground mains we, at an early date, saw the absolute necessity of so arranging the insulating supports that everyone of them could be instantly accessible for the purpose of being cleansed or replaced. We therefore devised means of putting our conductors under considerable strain so that the number of insulating supports could be reduced to about 120 per mile, that is about 14 yards apart, instead of being spaced about 2 yards apart as is necessary if the bare conductors are supported on mere notches in earthenware or other insulating bridges. Those who have examined our system in the West End of London and elsewhere will have noticed at intervals of about 14 yards the covers of the openings at which access can be given to every insulator. We use separate cylindrical insulators of the lipped or telegraph form, one for each conductor, which gives great insulating surface and prevents the accumulation of moisture, and as a result we can guarantee a degree of insulation that is quite impossible when a large number of mere notched insulators are used even when the latter are quite new. Our system, commenced seven years ago, has yielded unexpectedly satisfactory results. The means that we have adopted to prevent the access of water and gas have been perfectly successful, the insulation resistance of the whole system has been far higher than has ever been the case where continuously insulated cables were used, for reasons which will be readily understood by those practically acquainted with the maintenance of an underground network connected direct to the houses. All practical engineers in charge of such systems know that 90 per cent. of such leakage as exists on a supply company's system occurs either at the junction of the house service lines to the company's mains or on the service lines themselves just within the consumers' premises. As in our bare-copper system these junctions are made in the street boxes and can be instantly examined or detached for testing purposes, it is found in practice that the localisation of leakages is greatly simplified, and hence the leakage itself greatly reduced.

If we are right in insisting that the culverts should be made impermeable to water and gas and that the insulators should be so arranged as to give great insulating surface and be completely accessible for cleansing and repairing purposes, it will be seen that the troubles in Paris can be readily accounted for. The Paris engineers came over to see our system during its earlier stages and copied it in some respects, but in others fell into the very errors that we had already avoided. They still continue to use a great number of insulators placed close together, these insulators being of a poor insulating quality, and the great majority of them being completely inaccessible. They take no pains to make their culverts impermeable to water and gas and no arrangements have been made to enable them to inspect or clean their system. We think that the unsatisfactory results in Paris should be a warning to some English engineers who appear to think that the good results we have obtained can be equally well obtained by the use of mere notched insulators placed close together, but we very much fear that the great reduction of surface and difficulty in keeping these surfaces clean will cause a repetition of the Paris troubles. The fact, however, has now been proved beyond doubt that a well-designed bare copper underground system is superior to any existing system yet tried for a low pressure distribution network. Such a system costs less for maintenance, testing, cleaning, and coupling up to than any other system with which we are acquainted.—Yours, &c.,

R. E. Crompton, Managing Director

London, E.C., Nov. 1, 1892. (Crompton and Co., Limited).

THE LOWEST TENDER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I venture to make a few remarks on the subject of the "lowest tender," dealt with in the article you quote from the *Engineer* this week. I think the true and fair solution is that arrived at by the writer, viz., to always state clearly that the lowest tender is not entited to acceptance as a matter of right, when firms who incurred expense in preparing estimates could do so at their own risk and with their eyes open. There not only are, but there undoubtedly ought to be, many reasons besides price to influence the engineer who has to make the selection, and this may be so even when the firms tendering are of similar reputation. The trouble lately has rather been that the lowest tender has been accepted blindly irrespective of the question whether it was possible to do good work at the price.

But there is one crying evil which does call for immediate remedy. I refer to the plan of inviting tenders to give an appearance of impartiality when it has been already settled privately who is to have the work. There is no doubt that this does occasionally take place, and no one will deny that it is most unjust to a firm which has gone to expense in preparing a tender that is not intended to be seriously considered.

A further matter is the question of deposits on applying for specifications. Now the only legitimate excuse for these is to avoid expense being caused by bogus applicants. For this one guinea is amply sufficient; and we ought to have no more of these three and five guinea deposits. It is enough to put the contractor to the expense of tendering, without trying to make money out of him as well.—Yours, &c., Russell.

Amberley Cottage, Maidenhead, Nov. 1, 1892.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

Tenders Invited.—The Magistrates and Town Council of Paisley invite tenders from companies or persons willing to take over the powers contained in their Electric Lighting Order, 1891. Further particulars are given in our advertisement columns, and all information can be obtained from Messrs. Young and Martin, Town Clerk's Office, Municipal Buildings, Paisley. The tenders must be in by the 28th November.

——— The Commissioners of Hove, Sussex, are inviting schemes, accompanied with plans, specifications, and tenders for wiring the Town Hall, and for providing fittings and lamps. Further particulars are given in our advertisement columns, and tenders must reach Mr. H. Endacott, town clerk, Hove, not later than the 8th inst.

——— The Stornoway Pier and Harbour Commissioners invite tenders for the supply of greenheart timber. Tenders must be sent in to the Secretary of the Pier and Harbour Commissioners by the 18th inst.

——— The Midland Railway Company invite tenders for the supply of various stores, including telegraph instruments, wire, &c. Tenders must be in by 9 a.m. on the 10th inst.——The Great Northern Railway Company of Ireland invite tenders for the supply of various stores during the year 1893, including brass and copper sheet, tube and wire, india-rubber goods, iron tubes, and wire, &c. Tenders must be in by the 21st inst.——The Cheshire Lines Committee also desire tenders for the supply during 1893 of general stores, including telegraph materials (instruments, wire, &c.), wrought-iron tubing, galvanised iron wire, &c. Tenders to be in by December 3rd.

——— The Direction-Générale des Postes et des Télégraphes of France invite tenders for the supply of annunciators for telephone offices. Applications for permission to tender must be made to 103, Rue de Grenelle, Paris, before the 6th inst., and the adjudication will take place at 11 a.m. on the 16th inst.

——— Tenders are invited for the electric lighting of the towns of Orihuela and Huesca, in Spain, offers to reach the municipality by the 19th and 21st inst. respectively.

Change of Address.—Messrs. Hodges and Todd have removed their works from 19, Kirby-street, to larger premises at 82, Turnmill-street, E.C., owing to increased business. A considerable extension of manufacturing plant has been put down.

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VACANT APPOINTMENT.—The vestry of St. Pancras require a dynamo and switch-board attendant for their Regent's Park Station. Applications, with particulars, must be sent in to Mr. Pyecraft, Chief Clerk Electricity Department, Vestry Hall, St. Pancras-road, N.W.

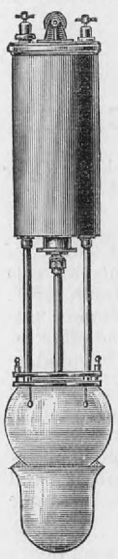
——— We would remind our readers that Wednesday next, the 9th inst., is the last day for sending in applications for the appointment of electrical engineer, required by the Oldham Corporation.

DISSOLUTION OF PARTNERSHIP.—We are asked by Mr. Rashleigh Phipps to notify that by mutual consent the partnership hitherto existing between Messrs. Rashleigh Phipps and Dawson has been dissolved. Mr. Rashleigh Phipps has started business under the title of Messrs. Rashleigh Phipps and Co., at 102, Oxford-street, W.

ECLIPSE ELECTRIC LIGHTING SYNDICATE (LIMITED).—At meetings held on October 6th and 25th, a resolution was passed and confirmed that the Syndicate be voluntarily wound up, and that Messrs. John Garford, 3, Vernon-chambers, Southampton-row, W.C., and W. H. Powers, 2, Pancras-lane, E.C., be the liquidators.

INTERNATIONAL ELECTRIC SYNDICATE (LIMITED).—A petition for the compulsory winding up of this Syndicate was presented on October 25th by Mr. G. H. Hodgson, of Shipley, and will be heard at the Royal Courts of Justice, London, on Wednesday next, the 9th inst.

MESSRS. EVERED AND CO. (LIMITED).—In an article in our issue of October 21st reference was made to a new wall socket made by this firm, but we omitted to call attention to the special device by which short-circuiting is completely obviated. By a simple contrivance on the base of the socket, short-circuiting is rendered impossible, even as the result of an accident. This is a feature which Messrs. Evered and Co. claim no other wall socket, either with or without switch arrangements, possesses, and for which their instrument has been particularly designed.



THE BROCKIE-PELL ARC LAMP.—Messrs. Johnson and Phillips send us particulars of a new type of the Brockie-Pell arc lamp which they have specially designed for the lighting of shops and similar establments, where space is of considerable importance. The lamp, which is focussing, gives a perfectly steady light with either continuous or alternating currents of from 5 to 10 amperes, either in parallel, with 50 volts, or 2 in series with 100 volts and upwards, or any number in series. Our illustration shows the lamp on a scale of about one inch to the foot. No less than 50 of these lamps have been installed at the extensive stores of Messrs. Jones Brothers, Holloway-road, London, N., in the installation which Messrs. Sharp and Kent have recently completed, and which forms one of the best lighted groups of shops in the Kingdom. The lamp sells complete at £10.

ELECTRIC LAUNCHES.—Messrs. Woodhouse and Rawson United (Limited) have received instructions for the construction of a new launch for Mr. J. West. The launch is to be 35ft. in length, and will be built to travel fast. Inquiries regarding electric launches are, we understand, increasing from all parts of the world.

LITHANODE AND GENERAL ELECTRIC COMPANY (LIMITED).—This Company have just issued illustrated particulars of their batteries, and the uses for which they are specially designed.

MESSRS. W. H. ALLEN AND CO.—This firm have just issued their new illustrated catalogue of patent dynamos and high-speed engines. A set of useful tables accompanies the catalogue. Several of Messrs. Allen and Co.'s special makes of dynamos and engines in a separate and combined form are shown, including direct-acting engines and dynamos for cargo boats and yachts.

NEW EDISON AND SWAN SERIES LAMP AND HOLDER.—We are compelled to leave over to our next issue a detailed account of a new Series Lamp just brought out by the Edison and Swan Company. These lamps are of the ordinary 3½ watt type, and are made in two sizes, for 6·8 and 10 amperes, stock sizes being 16, 32, and 50 c.p.

HENLEY'S CABLES.—The Paper read by Mr. Preece upon the Specification of Insulated Conductors has resulted in a marked improvement in the arrangement of Cable Price Lists. We have received from W. T. Henley's Telegraph Works Company a copy of their last list, in which we find all the information that can be desired. The particulars of the conductors themselves are repeated on each page ; the thickness of the insulation is given in every case, which, with the megohm test, clearly defines the qualities of the various types of cable. We recently alluded to twin flexible cords, and of these a great number of varieties are given. The pure rubber classes are composed of 23, 35, 70, and 130 strands of No. 40, while a new class, covered with vulcanised rubber, 300 megohms, contains 12, 18, 36, and 61 strands of 0·008, a size between No. 35 and No. 36, S.W.G.

"EXCELSIOR" WICK CARBONS.—We have received printed particulars, giving sizes and prices, of the "Excelsior" wick carbons manufactured by W. Grüdelbach, of Dinslaken-on-the-Rhine, and for which the "Excelsior" Carbon Company, 80, Queen Victoria-street, E.C., are representatives in this country. Mr. Grüdelbach claims that by his special dry process of manufacture many advantages are secured to carbon consumers, and in particular that the carbons give a very steady white light and are very durable. Testimonials from Herr Krupp, and from the Royal Institutions of Electrical Engineers at Munich and Magdeburg, accompany the particulars.

SCIENTIFIC NOVELTIES.—The General Electric Company forward us a price list of scientific novelties which they are bringing out for the Christmas market. Amongst the novelties illustrated are several mechanical toy tools. These models are all worked with toy motors from E.C.C. dry batteries. The list also gives illustrations of the E.C.C. night light.

THE ELECTRICAL TRADES UNION.—A public meeting, under the auspices of the above Union, was held at the Tate Institute, Silvertown, E., on Monday last.

ASTON.—The new Technical School at Aston shortly will be commenced, and will be lighted throughout by electricity.

BELFAST.—The subject of electric lighting has taken strong hold of the Belfast public, and as a preliminary to its introduction for the lighting of the district, Mr. John H. Greenhill, who is well known to many of our readers, will give a lecture on electric lighting, which will include a number of illustrated experiments. A number of gentlemen, including Profs. Fitzgerald and Everett, will join in the discussion.

BUXTON.—A Committee has been appointed to make inquiries as to the cost of supplying the electric light to the district of the Buxton Local Board.

COLCHESTER.—A special committee of the Colchester Town Council which was empowered to go to the expense of £150 in obtaining a Provisional Order have reported that the cost would be £300. Additional powers to expend that amount have been accorded them.

EASTBOURNE.—The Board of Trade have notified the Eastbourne Town Council that they are satisfied that the Eastbourne Electric Light Company are in a position to discharge the obligations imposed under the Eastbourne Electric Light Supply Order, 1890.

ELECTRICITY POPULARLY EXPLAINED.—Mr. Alfred Slatter is contributing a series of articles on the Electric Telegraph to the *Church Monthly*.

HECKMONDWIKE.—The Electric Light Committee of the Local Board, at their meeting last week, instructed the clerk to write to a number of firms for the terms upon which they are prepared to put down an electric lighting plant at their own cost, and to supply the electric light, leaving power for the Board to purchase the plant by agreement at the end of a term of years.

HULL.—Reports from Hull regarding the electric lighting installation state that the Electric Lighting Committee, at their meeting on Thursday last, received a large number of applications for the light from leading firms in the district, and also from the local School Board. It is anticipated that as soon as the central station is ready, previous applications for the light will almost exhaust its capacity.

HOTEL LIGHTING.—The Great Northern Railway Company have recently bought and completely renovated the old Victoria Hotel at Bradford at a cost of £40,000. The hotel is lighted throughout by electricity, nearly 600 incandescent lamps being installed.

ILFORD.—The Ilford Local Board has agreed to receive a deputation of the ratepayers on the subject of the electric lighting of the district at their next meeting.

JOHANNESBURG (S. A. R.).—A large new building has been erected as an assay office and laboratory for the Standard Bank, which has been equipped in a most complete manner. Messrs. Johnson and Matthey have supplied the necessary assay apparatus. The electrical fittings, including bells, lighting, telephones, and lightning conductor, have been supplied by Mr. R. Lewis Cousens, the representative of Messrs. Woodhouse and Rawson United (Limited) at Johannesburg. The technical manager of the office is Mr. Cross, who was formerly with Messrs. Johnson and Matthey in England, and is the son of Mr. Andrew Cross, celebrated in the early part of this century for his researches in electrolysis.

LANCASTER.—The Lancaster Corporation are the owners of the borough gasworks, and have also powers to supply the town with electricity. A sub-Committee of the Corporation who have visited the various central stations in England and submitted a report

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recommend the adoption of the low tension system. We understand that complete schemes and detailed specifications for the lighting of the borough and estimates of cost are to be invited from the Brush Company, Messrs. Crompton and Co., and Messrs. Mather and Platt. The report was adopted.

LIGHTING THE GUILDHALL.—At a recent sitting of the Court of Common Council it was agreed that £1,750 should be contributed towards the cost of an installation of the electric light at Guildhall, and that £500 per annum should be allowed for current and maintenance. The work is in the hands of Messrs. Lund Bros.

METROPOLITAN ASYLUMS BOARD.—At a meeting of the Metropolitan Asylums Board on Saturday last, the North-Western Hospital Committee asked for authority to obtain expert advice on the subject of the lighting of the hospital by electricity. Complaint was made that it is necessary to supplement the gas lighting by oil lamps, and that before making any recommendation on the subject the Committee would prefer to have advice. Permission was granted.

MILL LIGHTING.—Mr. G. Combe, of High-street, Belfast, has just completed an extensive installation of the electric light at Mr. Abraham Wilson's Spinning Mills at Newry, Ireland. One of Holmes's "Castle" dynamos is used, power being obtained from the mill engines. About 220 incandescent lamps are used.

MUNICIPAL LIGHTING.—A sub-Committee of the Local Authority of Newport, Mon., visited the St. Pancras electric lighting station last week for the purpose of making inquiries with regard to the proposed installation of the electric light at Newport. A similar visit was paid by the Hampstead Vestry, who also have in contemplation the introduction of the electric light.

NORTH BIERLEY.—At the last meeting of the Local Board it was decided to appoint a committee to consider the question of lighting by electricity, and to report as to the advisability of applying for a Provisional Order.

PERTHSHIRE.—As previously mentioned in these columns, the extensive Mansion House of Demalistair, occupied by Mr. Bunting, has been lighted throughout by electricity. Water-power is used, two 12⅓ H.P. turbines having been supplied by Messrs. Gilbert Gilkes and Co., of Kendal. Edison-Hopkinson dynamos have been supplied, the electrical plant having been erected by Messrs. Mavor and Coulson, from designs by and under the superintendence of Mr. Angus Murray. The installation has cost about £3,000.

SHOREDITCH.—The report on the electric lighting of the parish is postponed until the next meeting of the Vestry.

SHIP LIGHTING.—The new fleets of steamers now building at Belfast for the Pacific Steam Navigation Company, and for the Union Steamship Company, are all being installed by Messrs. W. H. Allen and Co. with their complete system of electric lighting, including engines and dynamos of their own make.

WILLESDEN.—The Willesden Local Board have intimated that they contemplate applying for powers for supplying the electric light in the district. This notification has been made in response to a request for their support to an application by a private company.

COMPANIES' MEETINGS & REPORTS.

Eastern Extension, Australasia and China Telegraph Company (Limited).

The thirty-eighth ordinary general meeting of this Company was held on Wednesday last at Winchester House, 50, Old Broad-street, Sir John Pender, G.C.M.G., M.P., presiding.

The SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting and the minutes of the previous meeting, which were signed by the Chairman as correct.

The Directors' report and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen—I shall, as usual, give you some details, as to the working of the past half-year. The gross receipts for the half-year under review have amounted to £246,988, against £264,878 for the corresponding period of 1891, showing a decrease of £17,890, of which over £8,000 is due to "loss on exchange," and the balance to the reduced rates with Australia. (At this point Lord Tweeddale entered the room, and was cordially welcomed by the shareholders, most of whom were aware from the evening newspapers that his lordship had been one of the passengers by the ill-fated Scotch express, which came to grief near Thirsk the same morning.)

The CHAIRMAN, continuing, said: I am sure, gentlemen, that you will join me in congratulating Lord Tweeddale, who was unfortunately in the sad disaster that has taken place at Thirsk. I am sure he has made a considerable sacrifice to come here to-day, and I think we may congratulate not only ourselves but also him in having had such a narrow escape (applause). With regard to the falling off in the receipts from the Australasian traffic, it is proposed, at the request of the Colonies, to shortly raise the tariffs to Australia by 9d. per word, so as to diminish the losses arising from the guarantee arrangement, which amounted to over £55,000 during the first year of the experimental tariff. Personally, your Directors would have preferred continuing the 4s. tariff a little longer, in order that it might have been fairly tested, but as the Colonies are suffering from severe commercial depression, and intimated that unless the tariffs were increased they might have to cancel the guarantee at the end of the second year, we had no alternative but to acquiesce in their views. This is the first time, gentlemen, in my recollection when a Government has asked us to put up the tariff. We have generally been pressed on all sides, not only by Governments, but by commercial bodies, to reduce the rates. When negotiating with the Colonies I urged them very strongly to make the rate 5s. instead of 4s., believing that such a large reduction as from 9s. 4d. to 5s. would meet the requirements of the telegraphing public, and give the Company nearly as much money as they were getting at the higher rate. That is now the view taken by the Colonies themselves, and while, as I have stated, we should have been better pleased to have tried the 4s. rate another year, it is our business to meet the wishes of the Colonies as far as we can in all financial matters, and I hope that the traffic will be as large at 4s. 9d. as it has been at 4s., in which case the loss will be insignificant (applause). The "loss on exchange" had been a source of anxiety for a long time past, and as there appears to be little or no prospect of any permanent improvement in the near future, your Directors are seriously thinking of adjusting the tariffs at the stations affected by the depreciation, so as to collect from the public the full value of the charges to which the Company is entitled. The changes will probably take effect from January 1st next. The working expenses have amounted to £79,281, against £71,476 for the corresponding period of 1891, showing an increase of £7,805, but as the ships' expenses are £9,041 more than for the same period of last year, the expenses over which your Directors have control really show a decrease of £1,236. The usual interim dividends at the rate of 5 per cent. per annum have been distributed for the past half-year amounting to £62,500, and the substantial balance of £70,271 is carried forward. I think you will agree with me that this is a very substantial and satisfactory position to occupy. With regard to the cable operations, a further length of 443 knots of the Rangoon-Penang cable has been picked up during the half-year, making, with the cable previously recovered, a total of 825 knots picked up out of the 855 knots originally laid. Most of the cable was found to be in good condition, and has been valued at £42,324, of which £20,000 has been credited to capital expenditure to replace the amount originally taken from capital towards the cost of the Rangoon cable, and the balance of £22,324 has been credited to the general reserve fund, as shown in the printed accounts. Now, gentlemen, I have often referred to our picked up cable, and I think I have shown you that when a cable that has been down for some years, can be picked up again, and laid elsewhere, we have, after all, a property which we can deal with, and that is a very great deal to say of a submarine telegraph system. Out of the picked up cable a triplicate line, 381 knots in length, has been laid between Penang and Singapore costing £25,974. The Foochow-Shanghai section has also been strengthened during the half-year by the partial renewal and alteration of the line at the mouth of the Yangtsze-Kiang river, where interruptions from ships' anchors were becoming frequent. The cost of the operation amounted to £5,307, and with the cost of the triplicate Penang-Singapore cable has been charged to the general reserve fund, which now stands at £426,642, after having expended £1,162,694 out of revenue on cable renewals, duplications, &c., since the formation of the Company (cheers). In other words, we have, without increasing our capital, practically doubled the carrying capacity of your system, besides largely adding to our reserve power by adopting the duplex system of working. The contract for the laying of a submarine cable between Acheen and the Company's system at Sumatra on account of the Netherlands-Indian Government has been successfully carried out and the line opened for traffic. The cost of the work has, of course, been defrayed by the Government, and the line will, I hope, eventually become an important feeder to our system. For some years we have not been as friendly in our relations with New Zealand as we should have liked, although we did everything in our power to conciliate the authorities. We duplicated their cable, and fully met the requirements of the telegraph service, but somehow or other in the Colonies strong ideas prevail of their own power and resources, and they have not always recognised the benefits conferred upon them by having been brought into such close contact with the mother country, and when New Zealand intimated that she would put down a cable for herself, we thought it was very hard, and took measures that we thought we were entitled to take, to protect the Company's interests, with the result that our relations are now perfectly satisfactory with that Colony. (Applause). The Government has done not only what we asked them in fairness to do, but they have joined the general federation of the other Colonies in taking part in this reduction of tariff, which has been so beneficial to the latter. Consequently, the tariff between Europe and New Zealand will be reduced from 10s. 2d. to 5s. 2d. per word for ordinary telegrams, and the following reductions will be made over the New Zealand cables, viz.:—For intercolonial messages, from 8s. 6d. to 2s. per ten words; for international messages, from 1s. to 3d. per word, the Government guaranteeing the Company against three-fourths risk of any loss that may arise from the reductions, and the Company bearing one-fourth. The value of the traffic in question is £26,258, and the Company's risk £4,386 if no increase of traffic results. But with 50 per cent. increase, which would not be an excessive estimate for such substantial reductions, the Company's liability would be only £3,297. The date for bringing the new tariffs into force has not yet been definitely settled, but it will probably be December 1st next. For the last 20 years our relations with Queensland have been rather strained, the Government having endeavoured to thwart us in every possible way. They are now enjoying all the benefits of our enormous system of telegraphy, and the amount that the Government would have to pay to participate in the reduced tariffs which the others enjoy would be less than £1,000 a year, a sum so insignificant that I can only

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say, with such very distinguished and able men at the head of affairs—Sir Thomas McIlwraith and Sir Samuel Griffith—I am surprised that they have not adopted a more enlightened policy. This unsatisfactory state of things is due to the fact that, in the early days, we did not give Queensland direct cable communication. Hence, there has been an antagonistic feeling to us ever since. The Government want low rates, but unfortunately they don't wish to put their hands in their pockets to the extent of the insignificant sum I have mentioned. The merchants in London recently approached one of the Ministers here—the Hon. W. Wilson—and urged upon him the desirability of getting his Government to join the other Colonies, but so far nothing has resulted from their representations. The Company have also endeavoured in every possible way to conciliate Queensland and get her to become a party to what I may call a moderate agreement. The result of our last appeal is conveyed by the following telegram from the Company's manager at Melbourne, namely :—

"Member of Queensland Parliament, in referring to cable charges, said that inferior position Queensland held in relation to other Colonies was prejudicial to Colony. Thought she should be on same footing, and increased expenditure would be advisable to remove present disabilities.

"Postmaster replied that Government would not join any agreement which would give assistance to monopoly. Government had made agreement with another Company for cable to New Caledonia, and thought they would be defeating their own object by helping to pay subsidy to present Company.

"Matter allowed to drop."

I believe they have agreed to pay £2,000 a year towards it, but that the Company is simply a myth. Whether or no such a small amount is only a drop in the ocean, so far as a Pacific cable is concerned, we cannot see how it will be beneficial to them. Altogether, I have come to the conclusion that if the Government drop that small paltry policy which they are pursuing against this Company, they would very largely benefit the interests of the Colony, and I am not without hope that this will eventually be insisted upon (hear, hear), and the sooner the better. I think, gentlemen, that is pretty much all that I have to say to you to-day. I have given you every possible information on the different points of interest to you. We have had some little trouble, but we have also had successes, and I think, putting the one against the other, I doubt whether I have ever been able to submit to you a more satisfactory statement than I have to-day (applause). I therefore move :—

"*That the report and accounts of the Directors, now submitted, be received and adopted.*"

Mr. F. A. BEVAN seconded the resolution, which was unanimously adopted without discussion.

The CHAIRMAN having intimated that this concluded the business,

Mr. JOHN NEWTON, in proposing a vote of thanks to the Chairman and Directors, wished to emphasise the observations of the former in respect to the portion of the Rangoon-Penang cable which had been picked up and again utilised. He thought that this was one of the most convincing evidences of the valuable character of the property in which they had invested. He also wished to add a word of congratulation to Lord Tweeddale in escaping any injury from the Thirsk collision (applause).

Mr. GIVENS having seconded the motion, it was cordially passed.

The CHAIRMAN said : In returning thanks for your continued support of those on this side of the table, I may tell you that at the present time the depression in our Colonies is very marked indeed, and when we are able, even with all this depression of trade, and in the face of a scarcity of money there, to show such grand results, I think we ought to be very satisfied indeed (cheers). Mercantile men in the Colonies are obliged to button up their pockets, while others have little left to button up. But all this is periodically rectified by "booms," which we see come round from time to time bringing with them returning prosperity. I have been talking recently with men from Queensland, and they tell me that though property has fallen there to the extent of something like 50 per cent., they do not at all despair, believing that the future is bright and full of promise. All that they want is a little time to recover themselves, and then they will go ahead again till another period of over-speculation comes about. But in the midst of this depression, gentlemen, when we continue to pay you the dividend we are paying and carry forward the handsome sum we do to-day, I think we have every reason to congratulate ourselves (applause). I thank you very much for your presence here to-day, and for your unanimous support, as well as for your approval of the report that I have laid before you.

The proceedings then terminated.

Monte Video Telephone Company (Limited).

The annual ordinary general meeting of this Company was held at the offices of the Company, 96, Gresham-house, Old Broad-street, E.C., on Monday last. Mr. Herbert Ward presided.

The SECRETARY (Mr. E. M. Reiss) read the notice calling the meeting, and the report and statement of accounts were taken as read.

The CHAIRMAN said : Gentlemen, with reference to the second paragraph of this report I would call your attention to the fact that during our last business year, ended July 31st last, we have realised an increase of profit over the previous year equal to about 1½ per cent. on our preference share capital. This profit, I must explain, is entirely due to economy in management. Shareholders will observe that Mr. E. F. Powers has resigned the post of Managing Director, which results in a saving of considerable importance. The London expenses have now been reduced to their lowest, and it is the earnest desire of the Board, particularly at the present period, to strengthen the Company in every possible manner in Monte Video, in order to ensure sufficient service, prompt attention, and economy. We have adopted a new plan in connection with the payment of our *employés* who answer the telephone call bells. By this new system we pay each person according to the number of calls answered, so that each assistant receives pay according to the work done. By this means it will be apparent that the attentive *employés* receive a greater percentage of salary than the inattentive. The natural consequence is that all our assistants are constantly on the alert. This system serves to give each one a personal interest in the Company's success. Should it be possible in Monte Video to make any further reduction compatible with efficient management and efficient maintenance of plant, I shall spare no effort to do so, although, at the same time, I must frankly say that in my opinion the expenses have reached the minimum. I next come to the purchase of the Central offices in Monte Video. An explicit account of the circumstances by which we effected this purchase will be found in the third paragraph of the report. I can only assure you that this step has been taken only after the most mature consideration. Here will be found the gist of our financial situation. We have earned a dividend, but we have expended the money in purchasing our central offices. Latest advices received from Monte Video inform us that the lower portion of the premises has been let for £254 per annum. Last April I took the opportunity of visiting Monte Video in order to examine the condition and general management of the Company. I visited all the district offices and interviewed our general manager upon all matters affecting the general working and welfare of the Company and its property. As the result of my investigations, I am glad to be able to report most favourably upon the orderly management that prevailed, and also upon the condition of the Company's property. As most shareholders are doubtless aware, affairs in Monte Video had been and still are in a very unsatisfactory condition, and bearing this in mind I think the shareholders ought to be well satisfied with the report we present. If we continue to do as well in proportion when prospects in Uruguay brighten our position will be a highly satisfactory one. It is the affirmed object of the Directors to present the shareholders very soon with a sound six per cent. paying stock, which, indeed, we hope will be assured at the next yearly meeting. I beg to move the adoption of the report and accounts.

Mr. C. H. SANFORD seconded the motion.

Mr. PRAED asked what was the nature of the negotiations which led up to the purchase of the central offices in Monte Video, and said that he thought that some scheme should be devised by which the preference shareholders should get their interest.

Mr. SANFORD said that he had been very much opposed to the purchase of the building in question, and the Directors had tried to get the owner to continue the lease until such time as they could see their way to get the purchase money. In the first instance they tried to raise money on debentures ; but that could have been possible only at a great sacrifice. The negotiations went on for six months, and eventually the proprietor intimated that they must either purchase the property at once or remove. They could not adopt the latter alternative because it would have been detrimental to the interests of the Company. Hence the reason for making the purchase, the money for which was payable by monthly instalments, terminating on the 2nd of February, 1893, when the Central station would become the freehold property of the Company.

Mr. LOCK, while congratulating the Company on the increased profit earned, thought that the revenue ought not to be diverted from its proper purpose, and while the shareholders would have no objection to lend the Company the money realised by their trade, they should get some acknowledgment for it in the shape of deferred warrants.

After some further discussion to the same effect, the report and accounts were adopted subject to the following rider, proposed by the CHAIRMAN and seconded by Mr. PRAED :—

"*That a dividend at the rate of 3 per cent. per annum be declared on the Preference Shares of the Company, such dividend to be not immediately payable, and that a Committee be formed to agree with the Directors as to the best way of carrying out or securing the payment thereof.*"

The following gentlemen were then constituted the Committee :—Messrs. Praed, Lock, Touch, and Killik.

The CHAIRMAN moved the re-election of Mr. Sanford as a Director of the Company.

Mr. JONES seconded the motion, which was agreed to *nem. con.*

On the motion of Mr. PRAED, seconded by Mr. RATHBONE, the auditors, Messrs. Gerard, Van de Linde and Son were unanimously re-appointed.

Mr. TOUCH proposed a hearty vote of thanks to the Chairman and his colleagues on the Board for their conduct of the Company's business and for the kindly spirit in which they had met the wishes of the shareholders.

A SHAREHOLDER seconded the motion, which was passed, and

The CHAIRMAN having expressed his acknowledgment, the proceedings terminated.

Western and Brazilian Telegraph Company (Limited).

The following is the report of the Directors to be presented at the twenty-fourth ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Thursday next, the 10th inst., at 12 noon :—

The total earnings for the half-year ended June 30th amount to £84,021 16s. 9d., as against £104,962. 9s. 7d., a decrease of £20,940. 12s. 10d. compared with the half-year to June 30, 1891. The working expenses amount to £39,140. 16s. 8d., as against £38,638. 10s., an increase of £502. 6s. 8d. Including the amount brought forward from 1891 (£4,486. 18s. 2d.), the balance to the credit of the revenue account is £49,367. 18s. 3d., from which has to be deducted £12,489. 10s. for deben-

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ture interest, and £6,610. 10s. for the debenture redemption fund, leaving £30,267. 18s. 3d., of which £14,000 has been placed to the reserve fund. This leaves £16,267. 18s. 3d. The Directors recommend the payment of a dividend of 3s. per share, free of income-tax, on the ordinary shares for the half-year, being at the rate of £2 per cent. per annum, carrying forward £1,662. 5s. 3d. The shareholders will note that the falling off in the dividend is mainly attributable to the heavy loss on exchange, which, for the period of which the accounts treat, averaged 11½d. per milreis, as against 18d. for the corresponding period of 1891.

The duplication of the cables between Santos and Chuy has been successfully carried out by the Telegraph Construction and Maintenance Company (Limited), thus duplicating the system throughout between Pernambuco and the River Plate. The cables have also been duplexed between Pernambuco, Rio Janeiro and Santos, and a contract has been entered into and is now in course of completion, the materials being on the spot, for the extension of the duplex system to Monte Video. It will be seen from the above that the Company will shortly have the duplicated line duplexed throughout the entire length of its main system, viz., from Pernambuco to the River Plate.

The competitive cable projected between Senegal and Pernambuco, Brazil, has now been laid.

Since the last meeting the Pacific and European Telegraph Company, the object of which was then fully explained, has been formed, and the erection of the lines between Buenos Ayres and Valparaiso is being actively pushed forward and approaches completion.

The s.s. "Viking," after a service of nine years, was brought home for a new boiler and general repairs, and has left for the coast. The building of the new steamer progresses satisfactorily.

The dividend warrants will be posted on November 11th.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322, *&c., &c.*]

ALKALI SYNDICATE (LIMITED).—This Company was registered on October 26th, with a capital of £20,000, in £5 shares, to carry on the business of alkali manufacturers, and of the plant, machinery, and materials necessary for such manufacture; to acquire, develop, and turn to account patents, particulars of which are not given, and to carry on the business of civil, mechanical, and electrical engineers.

DOMINION ELECTRICAL COMPANY (LIMITED).—This Company was registered on October 29th, with a capital of £25,125, divided into 5,000 ordinary shares of £5 each, and 500 founders' shares of 5s. each. The objects are to carry on the businesses of telephone, telegraph, and electric light, heat, and power companies in all or any of their respective branches; to acquire, establish, work, manage, control, and regulate works and conveniences for the supply of electric light, heat, and motive power, and for the transmission of telegraphic and telephonic communications; to construct, maintain, lay down, carry out, manufacture, sell, work, let on hire, and deal in telephones, cables, wires, lines, accumulators, meters, lamps, &c.; and to carry on the business of electricians, electrical contractors, electrical and mechanical engineers, suppliers of electricity, and manufacturers of, and dealers in, all kinds of apparatus and things required for or capable of being used in connection with the generation, accumulation, supply, distribution, and utilisation of electricity. The subscribers are:—

	Shares.
Thomas A. Kerr, Tregarthen, Upper Norwood	1
William R. Morton, 12, Whiteley-road, Gipsy Hill, S.E.	1
John F. Lea, Saxonhurst, Fox Hill, Upper Norwood, S.E.	1
George A. Kerr, Woodside, Upper Norwood, electrician	1
Ernest A. Horne, 1, Harvey-terrace, Harvey-road, Leytonstone	1
Herbert T. Sayle, 57, Arlingford-road, Brixton, S.W.	1
William B. Campbell, 61, Farquhar-road, Upper Norwood, S.E.	1

The number of Directors is to be five, the first to be appointed by the above-named signatories.

JULIUS SAX AND CO. (LIMITED).—This Company was registered on October 28th, with a capital of £20,000, in £10 shares. The objects are to acquire and take over as a going concern the business of Julius Sax and Co., carried on by Messrs. Alfred Sax and Charles W. Sax; to carry on the business of supplying electricity in all its branches; to construct, lay down, establish, fix and carry out all necessary cables, wires, lines, accumulators, lamps and works; to generate, accumulate, distribute and supply electricity; and to carry on the business of electricians, electrical and general contractors, mechanical engineers, suppliers of electricity for all purposes, and manufacturers of, and dealers in, all apparatus and things required for or capable of being used in connection with the generation, accumulation, supply, distribution, and utilisation of electricity. The subscribers are:—

	Shares.
John Martin, Mornington-road, Woodford	1
Arthur G. Hales, Somerset-road, Tottenham	1
Frederick Blackhall, 139, Antill-road, Tottenham	1
Charles Keick, 4, Hope Villas, Henslow-road, S.E.	1
W. E. Higgins, Albert Villa, Tower Hamlets road, Forest Gate, E.	1
F. W. Ward, 50A, Trinity-square, S.E.	1
C. F. Young, Courthill-road, Lewisham, S.E.	1

The number of Directors is not to be less than two nor more than five, the first to be appointed by the above named signatories.

NEW BRITISH ELECTRICAL INSTALLATION CONTRACTORS (LIMITED).—This Company was registered on October 28th, with a capital of £25,000, in £5 shares. The objects are to acquire, take over as a going concern, carry on, develop, and extend the business carried on at Worcester by the British Electrical Installation Contractors (Limited), with a view thereto to enter into and carry into effect an agreement to be made with the said Company; to construct, execute, lay down, fix, maintain, and repair engines, dynamos, mains, wires, cables, accumulators, &c., and to carry on the business of electricians, electrical contractors, electrical and mechanical engineers, suppliers of electricity, and manufacturers of, and dealers in, all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation, and employment of electricity. The subscribers (with one share each) are Samuel T. Castle, A. Hill Parker, J. S. Cook, Robert J. Surman, Alfred Usher, William H. Walter, and James Duce, all of Worcester. The number of Directors is not to be less than three nor more than five, the first to be appointed by the above-named signatories.

MISCELLANEOUS.—J. DUNNELL GARRETT AND CO. (LIMITED), iron-founders, mechanical, and electrical engineers, &c.; capital £3,000, in £1 shares.——MASBRO' FOUNDRY COMPANY (LIMITED), electrical and mechanical engineers, ironfounders, &c.; capital £10,000, in £10 shares.

BABCOCK AND WILCOX (LIMITED).—The annual return of this Company made up to October 4th, was filed on the 6th. The Company was registered with a capital of £240,000, divided into 10,000 preference and 14,000 ordinary shares of £10 each. At the time of making up, all the shares were taken up, of which 7,999 have been issued as fully paid. Upon the remainder the full amounts have been called and paid.

ERNEST SCOTT AND MOUNTAIN (LIMITED).—The annual return of this Company, made up to October 19th, was filed on the 20th. The Company was registered on November 17, 1890, with a capital of £70,000, in £10 shares. At the time of making up, 4,653 shares had been taken up, of which 2,200 had been issued as fully paid; upon 1,981 shares £6. 5s. had been called, while upon the remaining 472 shares the full amount had been called, resulting in the payment of £17,099. 10s., leaving £1. 15s. in arrears.

IPSWICH ELECTRICITY SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to October 28, 1891, was filed on October 20, 1892. The Company was registered on June 28, 1890, with a capital of £100, in £1 shares. The return just filed, however, shows that up to October, 1891, the negotiations between the Brush Electrical Engineering Company (Limited) and Messrs. Laurence, Scott, and Co. (Limited) respecting the transfer of the latter Company's Ipswich works to the Ipswich Electricity Supply Company (Limited) were still uncompleted, as only seven shares had been taken up, and no calls had been made.

MATHER AND PLATT (LIMITED).—The statutory return of this Company, made up to September 7th, was filed on the 14th. The Company was registered on May 4, 1892, with a capital of £200,000, in £10 shares. At the time of making up, the shares issued, with £9 paid, were the only ones taken up.

CITY NOTES, &c.

ALUMINIUM COMPANY (LIMITED).—The accounts for the year ended June last show a debit balance of £81,989, as against a debit of £71,049 brought forward from the previous year. The Directors, however, consider the prospects of the Company to be more hopeful, and believe that the current year will see their policy of perseverance justified. Within the last few months Mr. Castner has invented a new electro-chemical process, the test results of which are so encouraging that the Directors have decided to put up plant. They now propose an issue of £12,000 10 per cent. "B" debentures.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended October 31 were £889, as against £802 for the corresponding period of last year, being an increase of £87. The total receipts for half-year amount to £14,272, against £12,973 in the corresponding period of 1891, being an increase of £1,299.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts for the month of October were £3,400, as compared with £3,366 in the corresponding month of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The Company announce that they are prepared to issue to the holders of their Five per Cent. Debentures, redeemable at par in August, 1899, an equal nominal amount of their Registered Perpetual £4 per Cent. Mortgage Debenture Stock in exchange. Full particulars and the necessary forms can be had on application at the Company's office, or at their bankers, Messrs. Glyn, Mills, Currie, and Co., Lombard-street, London, E.C. The option to exchange must be exercised on or before Nov. 15th.——The traffic receipts of the Company for the month of October amounted to £61,069 and to £60,784 in the corresponding period of last year, an increase of £285.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of October amounted to £43,342, and to £42,246 in the corresponding period of 1891, or an increase of £1,096.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—Notice is given in our advertisement columns that on the 14th inst. 328 Five per Cent. First Mortgage Debentures of £100 each will be drawn for payment on January 14th.

GENEVA ELECTRICAL COMPANY.—This Company made a net profit of £5,228 last year, and declare a 5½ per cent. dividend. On May 31, 1892, there were 8,261 lamps supplied, against 6,500 at the same date in 1891.

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NATIONAL TELEPHONE COMPANY (LIMITED).—Application has been made to the Stock Exchange Committee to appoint a settling day in and to grant a quotation to this Company's Third Preference Shares, Nos. 1 to 90,950, and to quote in the Official List a further issue of 6,368 ordinary shares, Nos. 447,435 to 453,812.

REUTER'S TELEGRAM COMPANY (LIMITED).—Application has been made to the Stock Exchange Committee to quote a further issue of £1,000 of this Company's shares in the Official List.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Oct. 28, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,099.

WESTERN UNION TELEGRAPH COMPANY.—The Directors have declared a stock dividend of 10 per cent.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended October 31st show an increase of £67, as compared with the corresponding period.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 26.	Price Wednesday, Nov. 2.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 2.	
						£ s. d.		Highest.	Lowest.
			TELEGRAPHS						
£1,247,720	Stock	12/6	Anglo-American	50½ 51½	50⅝ 51⅛	4 17 1	Jan., Apr., July, Oct.	51	50½
£2,876,140	Stock	25/0	Do. Preferred	91 92	91 92	5 15 5	" "	91¾	91¼
£2,876,140	Stock	5/0	Do. Deferred	11¼ 11¾	11¼ 11¾	..	" "	11¾	11⅜
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July	..	..
130,000	£10	4/0	Brazilian Submarine xd and bonus	11 11½	10¾ 11¼	5 15 7	Mar., June, Oct., Dec.	11⅛	10 15/16
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	103 107	103 107	4 13 6	June and December	..	..
$7,716,000	$100	$1¾	Commercial Cable Capital Stock	168 173	168 173	4 0 11	Jan., Apr., July, Oct.	170½	..
16,000	10	8/0	Cuba Submarine	11¼ 12½	11½ 12½	6 19 2	February and August	..	..
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	3¼ 3¾	3¼ 3¾	4 16 9	April and October	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11½ 11¾	11⅛ 11⅜	5 19 2	Jan., Apr., July, Oct.	11¾	11¼
400,000	10	2/6	Eastern	15 15¼	14⅞ 15⅛	4 5 10	" "	15⅛	15
70,000	10	6%	Do. 6 per Cent. Preference	15⅛ 16	15½ 16	3 15 0	" "	16	15 11/16
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock xd	112 115	110 113	3 10 10	May and November	111½	111
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅜ 15⅝	15½ 15⅝	4 10 4	Jan., Apr., July, Oct.	15 9/16	15⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	111	110⅜
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103 106	103 106	4 14 4	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103 106	103 106	4 14 4	" "	105	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	103 106	3 15 6	February & August	..	..
180,227	10	1/0	Globe Telegraph and Trust	10¼ 10½	10⅜ 10⅝	4 11 7	Jan., Apr., July, Oct.	10 7/16	10 5/16
180,042	10	6%	Do. 6 per Cent. Preference	15¼ 15½	15⅜ 15⅝	3 18 1	" "	15⅝	15 1/16
150,000	10	5/0	Great Northern	18½ 19	18½ 19	4 9 6	Jan., April, and July	19	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	105 108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European xd	43 45	43 45	5 11 1	May and November	44¾	..
38,348	10	4/0	London Platino-Brazilian	6 7	6 7	5 14 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	106 109	106 109	5 10 1	March & September	..	..
10,802	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October	..	..
3,381	£100 Cert.	30/0	Submarine Cables Trust 6%	118 122	118 122	4 18 4	" "	..	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	..	..
30,000	10	2/0	West Coast of America	3 4	3 4	..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	103 107	103 107	7 9 7	June and December	..	..
88,321	10	6d.	West India and Panama	1⅜ 1⅝	1⅜ 1⅝	..	" "	1½	1 1/16
34,563	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10 10½	5 14 3	May and November	10⅝	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½ 9½	8½ 9½	6 6 4	" "	9	..
64,242	15	6/0	Western and Brazilian	8½ 9	8½ 9	6 13 4	" "	..	..
33,129	7½	1/6	Do 5 per Cent. Cumulative Preferred	6 6½	6 6½	5 15 3	" "	6 1/16	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2½ 3	2½ 3	..	" "	..	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	105 108	5 11 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	105 108	5 11 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage xd	123 128	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	3 4 0	..	..	..
224,800	14/0	1½d.	Consolidated Telephone Const. & Maintenance	⅛ ⅜	⅛ ⅜	6 10 10	May and November	..	..
220,000	£1	4⅜d.	Oriental (11s. paid)	5/16 5/16	5/16 5/16	7 18 2	Yearly	..	..
438,984	5	3/6	National	4½ 5	4⅜ 4⅝	6 3 1	June and December	4⅞	4⅜
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 14½	14 14½	4 2 9	" "	14⅛	14
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13½ 14	13½ 14	4 5 9	" "	..	..
420,000	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	111 113	111 113	3 19 8	January and July	..	..
48,000	£10	..	New Telephone, Limited (£2 paid)	1⅞ 2¼	3⅛ 4	..	..	2	1 1/16
58,000	5	1/0	United River Plate	2¼ 2⅝	2¼ 2⅝	..	January and July	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	..	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	10¾ 11¼	10½ 11	..	..	10⅛	10⅝
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	.. ..	2¼ 3⅛	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	.. ..	5 5⅛	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	.. ..	5¼ 5⅜	5 4 4	January and July	..	..
30,000	£5	4½% '91	Liverpool Electric Supply (£3 10s. paid)	3 7/16 3 9/16	3 7/16 3 9/16	3 15 9	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 1/16 5 3/16	5 1/16 5 3/16	4 6 9	March	..	..
111,000	5	..	London Electric Supply	¾ 1	¾ 1	..	..	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6¼ 7	6½ 7	..	..	..	..
£50,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	104 107	104 107	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	..	..	..	..
18,680	£5	2/6	St. James' and Pall Mall	7¾ 8¼	8 8¼	..	..	8¼	8⅛
7,900	£5	7%	Do. 7% Preference	8 8½	7¾ 8¼	..	..	8⅝	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 10 0	..	5⅝	5½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1 9/32	Brush Electrical Engineering	3 3½	3 3½	..	..	3½	3 1/16
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2⅛ 2⅜	5 1 1	..	2 1/16	2 1/16
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5¼ 5⅜	6 7 3	January and July	..	..
12,139	5	17%	Edison and Swan United	.. ..	.. ..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	.. ..	2⅜ 3¼	..	..	..	..
45,000	10	12/0	Electric Construction	4¼ 4⅜	4¼ 4⅜	..	..	4 1/16	..
70,000	2	10/0	Elmore's Patent Copper Depositing	1⅞ 2	1¼ 1½	..	..	1 7/16	1 3/8
20,000	5	..	Fowler-Waring Cables (fully paid)	1 2	1½ 2½	..	..	2	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½ 22½	21½ 22½	5 11 1	February & August	22	21¾
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	1 3/16 1	1 3/16 1	..	..	..	..
78,949	5	2/9⅜	Swan United (£3. 10s. paid)	3½ 4	3½ 4	9 12 6	May and November	3¾	3 5/8
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	44 46	5 4 4	March and July	45½	..
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	104 106	102 105	4 15 3	January and July	..	..
—	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..	⅜ ¾	..	..	..	..
—	£5	8%	Do. Preference (fully paid)	..	2⅜ 3	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
50,000	£10	½%	City and South London Railway	2⅜ 3½	2½ 3½	1 8 6	..	..	..

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—THE—

INDIA RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS CO.,

LIMITED.

ELECTRICAL ENGINEERS,

AND

INDIA RUBBER AND GUTTA PERCHA MANUFACTURERS.

MANUFACTURERS OF

CABLES, WIRES, INSTRUMENTS, INSULATORS, DYNAMO MACHINES, MOTORS, ARC LAMPS & FITTINGS, BATTERIES, CARBONS, TORPEDO APPARATUS.

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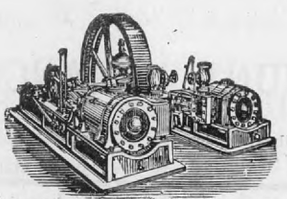
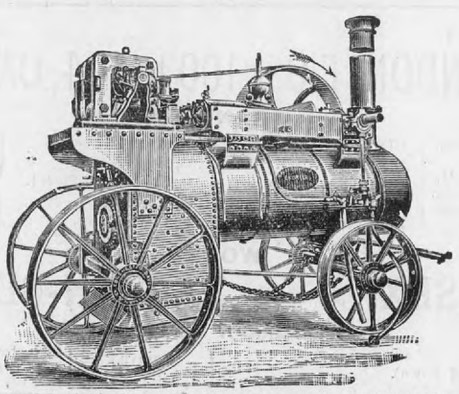


Coupled Horizontal Engine, 40 to 200 H.P. nom.



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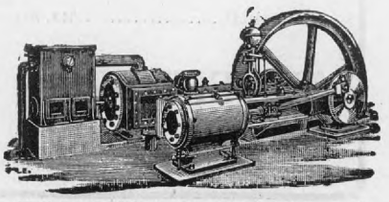

Horizontal High Pressure Coupled Compound Engine. 12 to 100 H.P. nom.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 756.—Vol. XXX. FRIDAY, NOVEMBER 11, 1892. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6.

NOTES.

Prof. Ewing has recently conducted a set of tests on the Parsons steam turbine, and his report, of which we print an abstract in another column, shows that great improvements have been introduced in the construction and mode of use of this ingenious engine. In 1888 a test at an exhibition gave a consumption of steam of about 60lbs. per electrical horse-power-hour, and although the conditions were very unsatisfactory, the steam turbine was generally supposed to be as wasteful in steam as the majority of rotary engines, while the very high speeds employed were enough to deter many engineers. Under these circumstances, when this engine was being pushed some eighteen months ago, we naturally asked for further information about the steam consumption, but nothing was published until January last, after a series of trials by Prof. Ewing. The results showed that 37lbs. of steam per Board of Trade unit, or in figures more easily understood by engineers, 27·6lbs. per electrical horse-power-hour were used. Our previous attitude had been fully justified by the only tests which were published, but we lost no time in bringing these new figures before our readers on January 8th (*The Electrician*, Vol. XXVIII., p. 255). The use of superheating and other modifications have resulted in a further economy of about 27 per cent., bringing the steam consumption down to less than one-third of the 1888 tests. Prof. Ewing finds that the combination of turbine and dynamo in its present state is eminently fitted for central station use. In so peculiar an engine as this, ordinary modes of construction must be modified, and while the inventor has arrived step by step at an excellent result, steam users must be allowed also to form their opinion by degrees from such tests as those which Prof. Ewing has made, and from accounts of practical experience as regards wear and tear. The intermittent admission of steam seems to be an excellent way of governing this engine, so long as no serious fluctuations in the speed are introduced.

Although the Presidential Address of Dr. J. Hopkinson, which we print in another column, was delivered before a junior society, we have no hesitation in presenting it in full to our readers. No such careful examination of the comparative cost of different systems of electric supply has been made since the A. T. *v.* B. T. battle of 1888. The idea of comparing the cost of maintaining a supply station with steam up, and an engine or two just turning round, for a year, with the same station running at full load continuously from year's end to year's end, is a very bold one, and few men would dare to illustrate a thoroughly commercial Paper by such purely hypothetical cases which can neither occur nor be approached in practice. But the result is of great interest, and the general principles of his argument are so clearly expressed that anyone in possession of figures relating to any particular case may fill them in, and prove for himself the application of this comparison. The conclusions about the use of batteries will of course fail to meet with acceptance in certain quarters, but the object of this Paper was not to teach the young engineer how to design a station.

The system of charging for electrical supply advocated by Dr. Hopkinson is admirable from the supply companies' point of view, but we are inclined to doubt whether it will be popular among consumers. Dr. Hopkinson does not, however, encourage the modest consumer, but offers special advantages to selected customers. There is no trick about this system. It is suggested that a fixed charge be made for the privilege of being able to turn on the light, and that a small charge of say 2d. per unit be made for the actual quantity consumed. This means a "reduction on taking a quantity," but comes to 8d. per unit if the supply is taken for less than 500 hours per annum. This is equivalent to turning on the light at dusk and extinguishing it at 7.30 all the year round, so in the case of shops which close at about this hour the system does not appear to offer much advantage. On the other hand, in residential lighting in which the privilege of switching lights on and off is well appreciated, the whole period from dusk to 11 p.m. is about 1,800 hours. A supply at a given rate for 1,800 hours appears, on Dr. Hopkinson's curve, to be charged at about 3½d. per unit. But in domestic lighting the maximum number of ordinary lamps are lighted for only an hour or two each night, while occasionally a considerable proportion of additional lamps are used. This normal maximum, as well as the occasional maximum, will seriously interfere with the attractive 3½d., and the benefits of this system will be best appreciated by clubs and other establishments in which a constant number of lamps are burned for some 2,000 hours.

The interpretations which Prof. Fitzgerald suggests in our Correspondence Columns to account for the connection between sunspots and magnetic storms are very interesting. M. Ricco in his communication to the Académie des Sciences,

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which we printed last week, only vaguely suggested that the vast movement and contact of vapours at different temperatures might generate electricity; and that masses of dense iron vapour might be the cause of electric or magnetic action or induction. It is very difficult to imagine an electro-magnetic beam like that of a lighthouse; but as we know that there is a shear in latitude of the sun's surface there might also be a radial shear which would point such a ray backwards. The hypothesis of charged atoms is of much greater interest, and fits well with the phenomena of comets' tails and the rays of the corona, which are known to be associated with sun-spot regions. The earth would take 25 to 30 hours to pass through the cone of 15 degrees or 20 degrees to which Prof. FITZGERALD alludes, and we would again ask for further information as to the rise and fall and general character of a magnetic storm as a whole. M. RICCO endeavours to take only the instant of maximum disturbance. Comets' tails are of a conical shape, but coronal rays appear in photographs to be of a flame-like form. If this is their real outline, perhaps they only lick the earth with their tips. It has been on more than one occasion suggested that convection currents in the atmosphere may form the "return circuit" of earth currents existing on the earth's surface; but Prof. FITZGERALD is, we believe, the first to suggest the possibility of such currents existing between the sun and the earth. The amount of matter needed to carry the atomic charges turns out to be surprisingly small.

ONE of the most striking advantages of the electric welding processes, both of ELIHU THOMSON and BENARDOS, is the absence of scale and oxidisation. Electric forging has been suggested, and the tempering of springs by electrical heating is a well-established operation. One of the latest applications of an electric current to metal working is the production of ornamental twisted bars, instead of heating these in a forge in the usual way. Any portion of a bar can be heated by means of a current passing between clamps, and the requisite twist can be applied by a crank. The amount of twisting may thus be regulated to a nicety. The work can be done very rapidly and is of course free from scale and oxidisation.

ANOTHER of the numerous legends with regard to intense and wide-reaching disturbances due to the presence of magnetic rocks has been exploded by measurements recently made on board the French research steamer "La Manche," which has been cruising about during the past summer in the neighbourhood of Spitzbergen, Iceland, and Jan Mayen Island. In a Paper presented to the Académie des Sciences, at its last meeting, Commander BIENAIMÉ says, "The truth is that the horizontal component, diminishing rapidly as one approaches the Pole, local influences cause a very sensible effect on the compass which one has to take note of all the more because the dial is a long time in again assuming the position of equilibrium from which it has been deflected." Nevertheless, observations made on land at Reykjavick, under the best conditions, never gave a larger disturbance than 2 deg. or 3 deg., whilst at sea the phenomenon was quite negligible.

THIS result is in complete accordance with those obtained by Profs. RÜCKER and THORPE in their magnetic survey of the United Kingdom, and with the phenomena observed by H.M.S. "Penguin" in the Pacific. Writing to *The Times* with reference to the opinion generally entertained at the time that the loss of H.M.S. "Serpent" off Cape Finisterre just two years ago was due in some way to the malign influence of magnetic rocks, Profs. RÜCKER and THORPE showed the extreme improbability of the hypothesis, and instanced Compass Hill, Canna Island, which, although powerfully magnetic, has no appreciable influence on a compass 200 yards from its base. Almost at the very moment that this letter was being penned some observations were being made by H.M.S. "Penguin," off Bezout Island, North-West Australia, which confirmed this view in a still more remarkable manner.

ON November 6th, 1890, the "Penguin" being two miles north of Bezout Island, a deflection of 22 deg. was observed. The ship was immediately anchored and the matter investigated. On the island itself the magnetic elements were found to be normal. But 2·14 miles to the north the S. dip varied by 33 deg., but became normal again within a few hundred yards in any direction. At the centre of the disturbance the *deflection* was nearly normal, but 100 feet to the south it was 55 deg., the compass being more or less affected over an area of about one square mile. The notion that ships' compasses may be disturbed out of sight of land by magnetic rocks on or near land, may now surely be relegated to the realms of scientific myth.

PROF. TILDEN'S letter to *The Times* on scientific titles, to which we briefly alluded last week, has called forth only one reply. In this, the writer unconsciously exemplifies the confusion which is daily increasing between education and knowledge. Because a University graduate "might well be excused from replying" if any one were to "suddenly question him in Greek, or even Latin," or if required "to solve a Cambridge problem in the higher mathematics," it is suggested that a University degree may "be in some sense a bogus title." All the miscellaneous information which is imparted by technical colleges is called education, and because it has a high utilitarian importance it is assumed to be of great educational value. Teach a lad how to set a slide valve, intelligently of course, and after any elementary acquaintance with the steam engine, and as long as he remembers, he knows something useful, and is able to perform this useful operation. If he forgets it he loses ground to that extent. But teach him the fifth proposition of Euclid, after a grounding in the first four, and whether he forgets them or no, is of little importance, they have no more utilitarian value than Greek. Education consists in learning and in appreciating, not in retaining the knowledge. An educated man may degenerate, say after spending thirty years in the Australian bush, but broadly speaking, the faculties which are developed by true education remain in readiness for attacking the problems of after life.

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Wycombe.—The Town Council has decided to apply for an Electric Lighting Provisional Order.

Telephones in Denmark.—The Danish Government, it is stated, has decided to take over the telephones.

Poplar.—The Poplar District Board of Works have intimated their intention of applying for an Electric Lighting Provisional Order.

Royal Holloway College.—The Governors of this college have appointed Mr. H. L. Callendar, Fellow of Trinity College, Cambridge, to the professorship of physics.

Sir John Pender.—The King of Portugal has conferred upon Sir John Pender the Grand Cross of the Most Distinguished Order of Nossa Senhora do Conceicao de Villa Vicosa.

The Stranding of H.M.S. "Howe."—Reports from Ferrol state that the lightening operations connected with H.M.S. "Howe" are being much facilitated by the electric light from H.M.S. "Rodney."

Fareham.—The Directors of the Fareham Electric Lighting Company have given notice to their customers that from the 1st inst. they will supply the light by meter only, at a fixed rate of 8d. per unit.

Antwerp.—The agreement between the Antwerp Municipality and M. Van Rysselberghe with regard to electric lighting and distribution of power was signed last week. The work will be commenced at once.

Glasgow University Physical Society.—At the first ordinary meeting for the Session of this Society, the President, Mr. James H. Gray, delivered an inaugural address on "The Electro-Magnetic Theory of Light."

Bristol.—On Wednesday last, on behalf of the Electrical Committee, there was a motion to add to the area of supply under the Electric Lighting Order, 1883, the area included in Schedule B. This practically means the whole of the city.

Proposed Electric Railway for Barry Island.—At a special meeting of the Directors of the Barry Railway Company, held on Wednesday last week, the scheme for the construction of an electric railway to Barry Island was discussed, and it is expected the work will be taken in hand forthwith.

Electrical Trades' Union.—In connection with the Glasgow branch of this Union, Mr. H. A. Mavor (of Messrs. Mavor and Coulson) delivered the first of a course of six lectures on Friday evening last at the St. Andrew's Hall, Glasgow, the chair being taken (in the absence of Lord Kelvin) by Mr. Wm. M'Whirter. There was a large attendance.

Belfast.—At the meeting of the Town Council on the 1st inst., Alderman Johnstone proposed that the minutes of the meeting of the Council in Committee of October 13th, so far as they referred to the question of electric lighting, should be confirmed. An amendment in favour of a 50,000-light plant as against the proposed 10,000-light plant was defeated by 21 votes to 7, and the original motion passed.

Paisley.—At the last meeting of the Town Council it was stated that the Electric Lighting Committee had not seen their way to recommend the Council to proceed with the laying down of an installation for the electric lighting of the town under the Order obtained last year, the probable demand for the light not being sufficient to warrant the expenditure involved. It was remitted to the Electric Lighting Committee to consider and report what they would advise to be done, as the Order expires in July next.

Liverpool Overhead Railway.—The first train was run on this railway on Tuesday last, carrying the Directors and their friends. The trip was satisfactory, the behaviour of the generating engines and dynamos being all that was anticipated. There were present the Chairman of the Railway Company, Sir William Forwood, and the whole of the Directors; Mr. J. H. Greathead and Mr. Francis Fox, the engineers. The contractors, the Electric Construction Corporation, were represented by Mr. Thomas Parker.

Obituary.—The death is announced, on the 30th ult., of Dr. L. Loewenherz, Director of the technical division of the Physikalisch-Technischer Reichsanstalt.——The death is also announced, at Blenheim Palace, at the age of 48, of the Duke of Marlborough, who, after having long taken considerable interest in electricity, and contributed several popular articles on its applications to various magazines, became within the last few years prominently connected with electrical company promotion. The deceased was Chairman of the Brush Electrical Engineering Company, the New Telephone Company, and the Electric and General Investment Company, and a Director of the City of London Electric Lighting Company.

Royal Society.—The following is a list of names recommended by the President and Council for election into the Council for the year 1893, at the anniversary meeting on November 30th:—President, Lord Kelvin; treasurer, Sir John Evans; secretaries, Prof. Michael Foster and Lord Rayleigh; foreign secretary, Sir Archibald Geikie; other members of the Council, Captain W. de W. Abney, Sir Benjamin Baker, Prof. Isaac Bayley Balfour, W. T. Blandford, Prof. Carey Foster, R. T. Glazebrook, F. Duncane Godman, Prof. John Hopkinson, Prof. J. Norman Lockyer, Prof. J. G. M'Kendrick, W. D. Niven, W. H. Perkin, Rev. Prof. B. Price, the Marquis of Salisbury, Adam Sedgwick, and Prof. W. A. Tilden.

The Plymouth Tramways and Electric Traction.—At Wednesday's meeting of the Plymouth County Council the Works Committee presented a report by Mr. J. Clifton Robinson as to the present position and future prospects of the tramways recently purchased by the Corporation. The report concludes with a strong recommendation in favour of the adoption of electric traction, at a total estimated cost of £50,000. Mr. Robinson estimates that the earnings of eight cars, running 80 miles a day, at a cost of a shilling per mile run, would be £11,680 per annum. The annual cost of working is set down at £7,800; and in this sum Mr. Robinson has included nearly £2,000 on account of sinking fund. There would thus be a credit balance of £3,800, equal to 7½ per cent. on the total capital outlay.

Society of Arts.—The first meeting of the 1892-93 Session of the Society will be held on Wednesday, November 16th, when the opening address will be delivered by Sir Richard Webster, Q.C., M.P., Chairman of the Council. Previous to Christmas there will be four ordinary meetings, in addition to the opening meeting. A Paper will be read in the course of the Session by Prof. George Forbes on "The Utilisation of Niagara." Cantor lectures will be delivered by Prof. Vivian Lewes on "The Generation of Light from Coal Gas, and its Measurement," on November 21st, 28th, December 5th, 12th; by Dr. J. A. Fleming on "The Practical Measurement of Alternating Electric Currents," on January 30th, February 6th, 13th, 20th; and by Prof. W. Chandler Roberts-Austen, on "Alloys," on March 6th, 13th, 20th.

The Smoke Nuisance in Boston.—The Boston (U.S.A.) electric light and traction companies are much exercised over a recent ordinance of the municipality, laying down that "No person shall use bituminous coal for the purpose of generating steam in boilers in any building, unless the furnace in which the coal is burned is provided with some effectual device for consuming its own smoke." Upon this the inspector of buildings ruled that a smoke-consuming device, in order to be approved, must consume at least 90 per cent. of the smoke emitted. Up to the present no device has been forthcoming fulfilling these requirements, and the authorities have suspended the enforcement of the ordinance during such time as may be necessary to allow the inspector to investigate and report upon the merits of devices on the market. If no smoke annihilator is discovered, and the ordinance comes into force, it will mean an addition of £4,000 a year to the coal bill of the Boston Electric Light Company alone. The local Edison Company is said to use about 44 tons, and the Boston Company about 49 tons of soft coal per diem.

Royal Institution.—At the general monthly meeting of this Institution on Monday last, the special thanks of the members were returned to Mr. Thomas G. Hodgkins, of Brambletye Farm, Setauket, Long Island, New York, for his most valuable gift of $100,000 (£20,523 6s. 11d.) The special thanks of the members were returned to the Goldsmiths' Company for their generous grant of £1,000 "for the continuation and development of the valuable original research which the Society is engaged in carrying on; and especially for the prosecution of investigations on the properties of matter at temperatures

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approaching that of the zero of absolute temperature." The special thanks of the members were returned for the following donation:—Mr. F. D. Mocatta £50, for carrying on investigations on liquid oxygen.

Carlow.—The Gas *v.* Electric Light question came before the last Carlow Quarter Sessions. Several householders having substituted electricity for gas, continued to hold on to the meters, so as to be able to fall back upon the gas in case of a failure in the electric supply. At the last session the Gas Company brought an action against such a householder to compel him to give up the meter, as it was the property of the Company. The County Court Judge, without deciding the question that had been raised as to the right or wrong of the Company refusing gas to the private consumer when he pays for what the meter registers, dismissed the case on the ground that the Company had no right to remove the meter until they had first cut off the connection with their mains.

Opposition to the Overhead Trolley System in New York.—Alluding in a recent leading article to the prejudiced opposition of the New York daily press to the introduction of the trolley system, our New York contemporary the *Electrical Engineer* delivers itself as follows:—"According to the Mohammedan faith the day of judgment has three periods, each of which is heralded with a blast. The first of the blasts is Consternation, to which succeeds Examination, the final one being that of Resurrection. Our New York papers have fired off their blast of Consternation about the trolley in magnificent style. The skill shown by some of them in blowing their own trumpet has come in very handily. Just now we are being treated to the blast of Examination, from which good results may be expected; and then, later on, we shall see a change of heart, when our contemporaries will rise on the stepping-stones of their old ignorance to higher things, and come to acknowledge in the hour of intellectual Resurrection that the Trolley, equally with the Newspaper, makes for public welfare."

Old Students' Association.—The annual dinner of this Association was held at the Holborn Restaurant on Oct. 28th. The report, which was read by the honorary secretary, showed that the Association is in a very satisfactory condition, both as regards the number of members, and as to its finances. In the course of the speeches which alternated with some excellent music, Mr. Mordey, in proposing "The City and Guilds of London Institute," observed that Prof. Ayrton had the whole world for his class. Prof. Ayrton made a most amusing reply, saying that he had received a threat that if he didn't make a speech, the Secretary would discover an entirely new theory of magnetism. Mr. H. C. Saunders, Q.C., said that the three colleges of the City and Guilds of London held a unique position which was very gratifying to the governing body whom he represented. Mr. Esson, the retiring president, announced that the ballot for officers for the next year had resulted in the election of Mr. Ll. B. Atkinson as president, and Mr. Vignoles as hon. sec. Mr. Esson alluded to the new president as a "drehstrom sort of man, a good engineer, a good electrician, and one who would be a good president."

"Industries."—Our contemporary's special number of last week dealing with the engineering features of the Houses of Parliament was of the exhaustive and exhausting character usually associated with such efforts. On the principle that he "who drives fat oxen should himself be fat," our contemporary argues that a body which has for the past fifty years devoted so much of its valuable time to sanitary legislation, should at least set its own house in order and make it a model of what should be done wherever circumstances permit. It is, therefore, satisfactory to learn that the Houses of Parliament satisfy our contemporary's syllogism. We always understood that our legislators were extremely well off in the matter of fresh air and freedom from noxious fumes, but we did not realise until we perused the very lucid and interesting article which appeared in *Industries* of November 4th what an onerous business the ventilation and sanitation of the Legislature really was. We must congratulate our contemporary on having brought out a thoroughly readable account of an important, but not always interesting, piece of engineering. The illustrations, as all illustrations should, illustrate the text and are no mere pictures.

The Incandescent Lamp in America.—The electric lighting industry in the United States appears, says *Industries*, to be passing through an anxious crisis now that the Edison patent has been upheld. If the General Electric Company adopt the policy of charging comparatively small royalties, of course it will be easy to arrange a scheme of working. The General Electric Company alone have not at present the means of making all the lamps that are required in the United States, so it would be disastrous to have the other factories closed. On the other hand, it may be easy for them to enlarge their output, and perhaps to take over the trained hands from the other lamp works. If they adopt the policy of declining to supply lamps except where their dynamos are used, they may cause a great deal of trouble. On the other hand, the Westinghouse firm profess to have a lamp ready for the market which is no infringement of Edison's patent, and which is much better than the ordinary kind. We have heard of this lamp before. It turned up every one or two weeks in this country when Edison's patent threatened to prove valid. As soon as the monopoly was established by law the improved lamp seemed to find the atmosphere uncongenial, and it has apparently gone over to Pennsylvania for change of air. On the other hand, the Westinghouse firm have a very able staff of electricians, and the improved lamp may really be on the point of coming into existence in America.

Brighton.—We have received a copy of a rather long letter which was addressed by Mr. R. Hammond to the *Daily Telegraph*. Mr. Hammond contends that when a Corporation takes the supply of gas, water, or electric lighting into its own hands, it should take over at a valuation the works of the private company that has hitherto had such supply in its hands. Though the Brighton Electric Supply Works, which were founded in 1881, have carried on electric lighting in Brighton and Hove, the Corporation of Brighton a year ago, says Mr. Hammond, actually started opposition works, and refused to treat with the Brighton and Hove Electric Light Company on any terms whatever for the acquisition of its undertaking. The Company offered to charge the Corporation for the lighting of the sea-front at the same price as gas; but this offer was declined with thanks. The Brighton Electric Light Company has not confined the electric light supply to any particular portion of the town, but has run its wires in every direction, wherever the demand arose, the circuit at one time measuring 20 miles. The Corporation, which obtained Parliamentary powers as far back as 1883, neglected to do any work whatever. The engineers followed the then universal custom of placing the cables overhead; but in 1888 the Company made application for a Provisional Order to place its cables underground. The Corporation, however, not consenting to the granting of the Order, the Board of Trade held a local inquiry in April, 1889. The Corporation opposed the grant of the Order to the Company upon the grounds that electric lighting was in an experimental stage; that no system was reliable; and that when such was discovered the Corporation intended to supply the light themselves, under the Order which had been granted to them, and which, up to the date of the inquiry, and indeed till July, 1889, had been a dead letter. The inspector reported in favour of an Order being granted to the Company for Brighton, but the Corporation sent a deputation to the Board of Trade to assure the President of their intention to carry out the provisions of their Order upon which the Company was refused the Order which they had been invited to apply for. The Corporation applied to the Local Government Board for sanction to borrow some £30,000. The proposed expenditure by the Corporation was sanctioned, and the Corporation works erected. The Town Council confidently expected that the opening of the works a year ago would result in the immediate ruin of the Company; but, continues Mr. Hammond, the Company has gallantly held its ground, beating the Corporation at every point, and actually doubling its business during the past twelve months. As this letter was not published by the *Daily Telegraph*, we have pleasure in laying the main facts before our readers.

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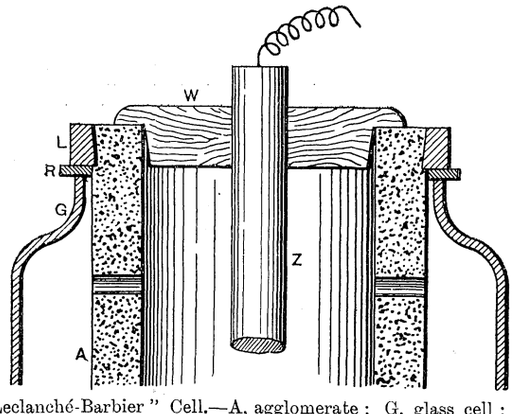
IMPROVEMENTS IN THE LECLANCHÉ BATTERY.

Peroxide of manganese was first used in a voltaic battery, we believe, by De La Rive, but numerous difficulties presented themselves in practice, and it was not until the late M. Leclanché, of the Eastern Railway of France, combined the peroxide with crushed carbon, and packed the mixture in a porous pot, that this type of cell came into common use. Since 1866 a number of modifications have been made, some have been improvements, but others have been of doubtful value. M. Leclanché's brother introduced the agglomerate block, which dispensed with the porous pot, thus lowering the internal resistance. The most elaborated form of this type is the six-block agglomerate cell which is largely used by the Post Office. Here six rods of agglomerate are bound to a grooved carbon block by sackcloth and rubber bands. A sheet zinc cylinder surrounds the negative element, thus bringing the resistance down to about 0·2 ohm. A retrogression in a somewhat important point may here be noticed. The old Leclanché battery could be easily sealed up, small vent holes being provided either by glass tubes or by short pieces of cane. The porous pot was almost always sealed thus, and the whole cell is often covered in the same way with pitch. But the agglomerate blocks did not afford such facilities for sealing, and in the six-block pattern no provision is made, in many cases, for retarding evaporation. A modification of the Leclanché battery has been made by Lacombe & Co., who use a cylindrical shell of carbon resting on a china or glass ring. Within this a perforated china cylinder is set, and the space between was filled with crushed carbon and peroxide of manganese. A cover, in which



The "Leclanché-Barbier" Cell.—A, agglomerate; G, glass cell; L, lead collar; R, rubber ring; W, wood plug; Z, zinc.

the zinc rod is fixed, rests on the cylinders. It is claimed that a very perfect chemical action takes place, because the depolariser forms a continuous sheet between the zinc and the carbon, and the hydrogen must, therefore, traverse the whole thickness. The cylinders stand a little higher than the top of the glass jar, leaving a narrow gap through which evaporation can take place. The internal resistance of such a cell is lower than that of the old Leclanchés, but we have no information as to the relative resistances of this type and of the best agglomerate Leclanché. We observe that the Lacombe cell is illustrated in Messrs. J. Verity's catalogue.

The latest modification is to be found in the Leclanché-Barbier cell, which is being introduced by Mr. R. Aylmer. The cell consists of a cylinder of carbon and peroxide agglomerate, but the mixture differs in several respects from the well-known blocks of the Silvertown Company. Graphite appears to be used, at all events, on the surface. We are informed that it is active throughout, being thoroughly porous. The distinctive feature in the arrangement of the battery is that this agglomerate cylinder rests not on the bottom of the jar, but on its lip. The upper end of the cylinder is slightly bevelled, and a ring of lead is cast round it, forming an attachment for a terminal and a collar for supporting the cylinder. A rubber ring is placed between this collar and the lip of the jar, thus making a fairly tight joint. The zinc is fixed in a paraffined wooden cover, and is tipped with a piece of rubber, preventing accidental contact with the agglomerate cylinder. This cover enters a little into the cylinder, fitting loosely, and allowing escape of gas, but preventing evaporation. So effective is this sealing that such batteries, as we are informed, have stood for four years without losing more than a millimetre of solution by evaporation. As in the Lacombe cell the agglomerate cylinder is perforated to allow circulation of the solution.

There is a great diversity of opinion, strange to say, as to the best strength of the sal-ammoniac solution for the Leclanché battery. A majority of text-books recommend a saturated solution, but others prescribe two ounces of sal-ammoniac to a pint of water (Allsop), dilution of a saturated solution by one-tenth of its bulk of plain water (Kempe), and even a half-saturated solution (Sprague). The well-known trouble of creeping salts seems to be connected both with the degree of saturation of the excitant, and indirectly with the evaporation of the water. A weaker solution seems only to have been suggested in order to avoid this creeping; but it appears that if an effective sealing is adopted, and if the porous pot is dispensed with, creeping does not occur.

More than one improvement has been suggested in connection with the excitant. It is important that sal-ammoniac should be free from lead and other minerals. We are not inclined to notice secret preparations in these columns, but a special salt for the Leclanché-Barbier battery may be mentioned. We understand that it cannot be used with agglomerate blocks, since it attacks the rubber bands. The advantage which is claimed for it lies in the absence of the insoluble crystals which form round the zinc rods of Leclanché batteries. The zincs are often corroded at the water line, but with this salt they taper off downwards and present a uniform grey surface, with no signs of crystals.

We have received a sample of "Electrogen Traub," another secret preparation. The agents inform us that no incrustation takes place, the zincs wear evenly, and the current is "considerably intensified." We have made inquiries about the strength of solution recommended, but can only learn that 90 grammes suffice for a cell which requires 150 grammes of sal-ammoniac.

The latest form of "dry" battery consists of a thick cylinder of agglomerate, which is surrounded by the zinc, the two elements being separated by a moist conducting cement. The advantage which is claimed over other dry cells consists in the ease with which this cell may be revived when run down or partially dried up. To do this, the hollow in the middle of the cell is merely filled with sal-ammoniac, and allowed to stand for a few hours. For temporary telegraphic work, as at race meetings, where cells are generally charged and the solution thrown away after the work is done, these cells should be very useful, as they can be knocked over, or worked while lying on their sides, without disadvantage. These cells are to be found in the latest list of the Silvertown Company, who originally introduced the Leclanché cell into this country, and are supplied also by Mr. Aylmer.

THE COST OF ELECTRIC SUPPLY.*

BY DR. JOHN HOPKINSON, F.R.S.

The interests of an engineer are many-sided. If he is to successfully use the forces of nature for the service of man he must understand how those forces work; he must, in fact, be scientfic. It may be that his ideas are arranged differently from the ideas of those who study science for its own sake, and without regard to practical applications, but if he is to succeed they must be so arranged that he can deduce from knowledge already acquired, knowledge which is applicable to new cases which have not as yet come under his observation. The engineer who can only do that which he has seen done before may be a practical man, but he will always belong to a lower grade of his profession. The scientific engineer is one who by his knowledge of nature is able to deal with new engineering problems and provide useful solutions of those problems. But a practical man must be something more than a man of science, or rather he must look at matters from a different point of view. He cannot choose some feature of a problem, concentrate all his attention upon that, and leave other matters out of consideration,

* Presidential address delivered November 4th, 1892, before the Junior Engineering Society.

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which is the process by which most scientific advance has been made; but he must always deal with the whole matter before him and leave no relevant question out. But an engineer may be scientific, inasmuch as he has knowledge of nature and the power of applying that knowledge in new cases; he may be practical in the sense that the means he devises to attain his ends may be complete at all points, and not break down from trifling defects, and yet may find that there are other subjects which he has to consider. Our complete engineer must give his attention to commercial matters as well; he must know if, when he has devised the means to attain the ends in view, those ends when attained will result in a profit. He must recognise the conditions which render an undertaking economical to work, and which secure that it shall bring in a large return. When it has been my lot to address engineers I have usually directed attention to some scientific point which I thought would be of interest to them. This evening I should like to go to the other extreme and deal with a purely commercial question, with a matter into which no science enters, and which relates entirely to pounds, shillings, and pence.

You are all of you familiar with the fact that the expenses of an undertaking may be broadly divided into two classes. On the one hand there are expenses which are quite independent of the extent to which the undertaking is used, and on the other, expenses which are absent unless the undertaking is used, and which increase in proportion to the use. For example, the charges for interest on the construction of a bridge are the same whether that bridge is used much or little or at all, and the cost of maintaining the bridge is also practically independent of its user. The same is true in a large measure of a harbour or a dock. Such undertakings lie at one extreme of the scale. It is less easy to find good examples at the present day of the other extreme, as nearly all undertakings with which engineers have to deal require the employment of some capital, and there will be a fixed charge for the use of that capital and for maintaining against the assaults of time the things in which the capital is embodied. But we can readily see for example in the case of a cotton mill that, if on the one hand there are expenses for interest and dilapidation which are independent of the amount of yarn actually manufactured in a given factory, there are other expenses for material and labour, and even for actual wear of machinery which will be very nearly proportional to the output. Undertakings vary enormously in the proportion of these two classes of expenses, in some the expense is quite independent of the extent of the user, in others it is for the greater part proportional to the user.

But undertakings differ from each other in another respect. In some cases the service which the undertaking is designed to render can be performed at a time selected by the undertaker; in others at a time selected by him to whom the service is rendered. In the case of most manufactures it matters not if the thing made is made to day or to-morrow, in the morning or the evening, for it will not be used for a month hence, perhaps; the thing can in fact be extensively stored and kept till it is wanted. Other services must be rendered at the moment the person served desires. For example, the Metropolitan District Railway must be prepared to bring in its thousands of passengers to the City at the beginning of the day and to take them back in the evening, and for the rest of the day it must be content to be comparatively idle. In this case the services cannot be stored. The line must be of a carrying capacity equal to the greatest demand, and if this be great for a very short time the total return for the day must be small in comparison with the expense of rendering the service. In such a case it would not be inappropriate to charge more for carrying a person in the busy time than in the slack time, for it really costs more to carry him.

Let us see how these considerations apply to the supply of electricity for lighting. Electrical engineers now realise that they have to provide the same plant and no more to give a steady supply day and night as to give a supply for one hour out of the twenty-four. They also now realise that if they are to be ready to give a supply at any moment, they must burn much coal and pay much wages for however short a time the supply is actually taken. Indeed, the term "load factor," proposed by Mr. Crompton, is as constantly in the mouths of those who are interested in the supply of electricity, as volt or ampère or horse-power. The importance of the time during which a supply of electricity is used was so strongly impressed on my mind years ago that in 1883 I had introduced into the Provisional Orders, with which I had to do, a special method of charge intended to secure some approach to proportionality of charge to cost of supply. Unfortunately the orders of that day all came to nought.

A supply of electricity must be delivered at the very moment when the consumer chooses to use it, and as long as and no longer than he pleases to use it; it cannot be very readily or cheaply stored, and much of the cost of production is the fixed charge for plant and conductors. Furthermore, the provisional orders require that the supply shall be available at all hours; hence coal must be consumed, and workmen must attend, though but few consumers are drawing a supply. The service of supplying electricity has, from an economic point of view, a great deal of similarity to the service of providing a breakwater for a harbour. A great deal of the expense is independent of the number of hours in the day during which the supply is used. To put it in another way, the cost of supplying electricity for 1,000 lamps for ten hours is very much less than ten times the cost of supplying the same 1,000 lamps for one hour particularly if it is incumbent on the undertaker to be ready with a supply at any moment that it is required.

The actual importance of considerations of this kind can only be realised by examining figures. The figures may as well be estimated figures, because the circumstances vary from one neighbourhood to another. No criticism of the details of the figures will affect the general character of the conclusion. Let us, then, imagine a station capable of supplying 40,000 16-candle lamps at one time, with mains and spare machinery enough to ensure that the supply shall not fail, and let us see what the charge for running such a station will be; firstly, on the hypothesis that it is always to be ready to supply the 40,000 lights at half-an-hour's notice day or night, but that the lights are hardly ever actually required; secondly, on the hypothesis that the 40,000 lights are steadily and continuously supplied day and night. These are the two extreme cases possible. In the former the load factor is nil; in the latter it is 100 per cent. If the charge is by meter at 8d. per unit, in the former case the revenue will be nil; in the latter it will be £730,000 a year.

We are going to divide the cost of supplying electricity into two parts—a part which is independent of the hours the supply is used, and a part which is directly proportional thereto, and we are going to estimate the amount of each element. It is for the purpose of ascertaining these elements that we consider two quite hypothetical cases—cases which can themselves never actually occur,

We must first have an idea of the capital outlay required. To provide the maximum of 40,000 lamps we need to deliver 2,500 units per hour, and we may estimate the capital outlay as follows:—

Land	£25,000
Buildings	15,000
Boilers and pipes	14,000
Engines	24,000
Dynamos	15,000
Switchboard and instruments	2,000
Feeders and mains	50,000
	£145,000

Let us deal with the annual charge for each item of capital separately on the two hypotheses. The charge for land and for buildings including repairs is clearly the same in the two cases, say at 4 per cent. £1,000 for the land, and at 10 per cent. £1,500 for the buildings. The boilers, engines, and dynamos will have a charge for interest, and a charge for writing off or amortization as the French call it, that is, for writing off the value of the plant before the time at which it becomes antiquated—exactly the same in the two cases. The boilers, too, will require exactly the same repairs whether they are merely keeping steam or whether they are generating steam continuously; but the machinery will certainly require more for repairs and renewals if it is all running than if a part only is running without load and the rest is standing ready for a load if required. I take 4 per cent. as the charge for interest; 3 per cent. for amortization; 8 per cent. for repairs and maintenance. Of the repairs of engines and dynamos I assume that 2 per cent. will be applicable if the plant runs light, the remaining 6 per cent. if it is fully and continuously loaded. The expenses connected with conductors and switchboard, &c., will be exactly the same whether the current is passing or not; these I take at 15 per cent. The rates I put down at £500 a year. The account, then, for the fixed charges already enumerated would stand as follows:—

	Running Light.	Fully Loaded.
Land	£1,000	£1,000
Buildings	1,500	1,500
Rates	500	500
Boilers	2,100	2,100
Switchboard and conductors	7,800	7,800
Engines	2,160	3,600
Dynamos	1,350	2,250
	£16,410	£18,750

We now come to a most important item in the account—the coal. There is no doubt that with uniform and continuous load a unit of electric energy—1⅓ H.P. for one hour—can be produced for less than 3lbs. of coal; it is also pretty much admitted that with a load factor of about 12 per cent., but continuous maintenance of pressure, the consumption of coal in good practice is something like 7lbs.; that is to say, to keep the boilers warm, turn round the

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machinery for 24 hours, and deliver full current for 24 hours, will require 72lbs. of coal per kilowatt; whereas to keep the boilers warm, turn round the machinery, and deliver current for 3 hours, will require 21lbs. of coal. The boilers being kept warm, it will take 51lbs. of coal to generate steam enough to give a unit per hour for 21 hours; 58lbs. to give a unit per hour for 24 hours; subtracting this from 72lbs., the amount required both to generate steam and keep the boiler warm, we may infer that to keep the boiler warm and merely turn the machinery in readiness to meet a demand will take about 14lbs. of coal per day for every unit per hour the plant is capable of producing. In 1889, for the Society of Arts, tests were made of a Paxman compound engine, from which it appears that a boiler which when fully loaded consumed 40lbs. of coal per hour, required 4lbs. per hour to keep steam up to normal pressure when the engine was standing; that is, 10 per cent. of the coal used was used to maintain the steam pressure. Remembering that in addition we keep some of our machinery moving, this may be said to confirm the figures adopted. Thus, if the plant runs light all the year round 12,775,000lbs., or, let us say, 6,000 tons of coal will be consumed. If the plant runs fully loaded, 65,700,000lbs., or, let us say, 30,000 tons would be consumed. If we suppose the coal to be best smokeless it might cost 20s. per ton. Next we have water, oil, and petty stores; say, £600 and £3,000 in the two cases. Wages will be a little less if we run light than if we run fully loaded, and, of course, will largely depend on local circumstances; let us say, £5,000 and £7,500 in the two cases. This gives us substantially all the expenses which have to be met and our account will then stand thus :—

	Running Light.	Fully Loaded.
Fixed charges	£16,410	£18,750
Coal	6,000	30,000
Stores	600	3,000
Wages	5,000	7,500
	£28,010	£59,250

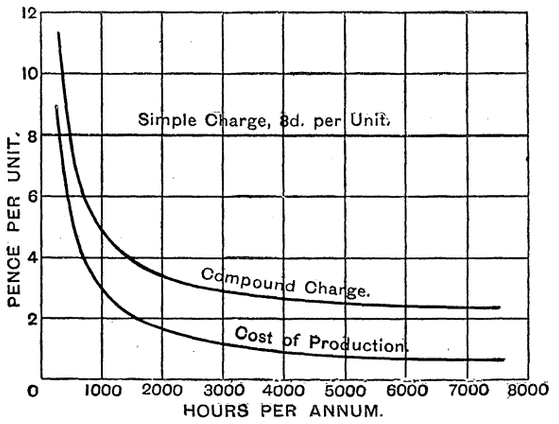
Thus the cost of merely being ready to supply 2,500 units per hour at any moment throughout the year will be £28,010, and the cost of actually supplying 2,500 units per hour for every minute in the year will be £59,250. The undertaker, therefore, who incurs the liability to supply, ought to receive £11 per aunum per unit per hour from those on whose behalf he incurs the liability, and if he receives the £11 he need not charge more than $\frac{1}{3}$d. per unit for what he actually supplies to cover his expenses. That these figures are fair approximations can be seen as follows :—According to this calculation the cost of supplying 2,500 units for one hour per day is £28,010 + 2,500 × 365 × $\frac{1}{3}$d. = £29,277, and the charge for the service at 8d. a unit would be £30,417; it is doubtful if such a supply would pay. On the other hand, an indicated horse-power on such a scale could certainly be supplied continuously for from £12 to £14 per annum, and according to this calculation an electrical horse-power will cost just under £18 per annum. No account is taken of expenses peculiar to companies, such as directors' fees and the cost of forming the company. It will also be noted that it is assumed that accumulators are not used.

The charge for a service rendered should bear some relation to the cost of rendering it. If it is a matter of open competition the matter will settle itself, for no one will for long be able to supply some customers at a loss, and recoup himself by exorbitant profits from others. If the matter be a case more or less of monopoly, the adjustment is less certain; thus, the Post Office charges $\frac{1}{2}$d. postage for a printed circular and 1d. for a written letter, the two costing the Post Office exactly the same. What a boon to the public it would be if the Post Office would charge more for printed trade circulars, which in nine cases out of ten are a nuisance to those who receive them. The supply of electricity is not quite a monopoly; companies compete with each other, and there is always the competition with other methods of illumination such as gas and paraffin. It is clearly to the advantage of the undertaker to secure all those customers whom it pays best to supply, and as far as may be, to compel those who are unrenumerative to adopt these other methods. The ideal method of charge, then, is a fixed charge per quarter proportioned to the greatest rate of supply the consumer will ever take, and a charge by meter for the actual consumption. Such a method I urged in 1883, and obtained the introduction into certain Provisional Orders of a clause sanctioning "a charge which is calculated partly by the quantity of energy contained in the supply and partly by a yearly or other rental depending upon the maximum strength of the current required to be supplied." In fixing the rates of fixed charges it must not be forgotten that it is improbable that all consumers will demand the maximum supply at the same moment, and consequently the fixed charge named might be reduced or some profit be obtained from it. There is no object in reducing the cost of electricity for lighting in the case of any customer much below the cost of equivalent lighting by gas, unless there are competitors in the field willing to do it, hence the current charge proportioned to the power supplied may safely be increased. In certain recent cases in which I am acting as engineer, the Board of Trade have sanctioned on my application, "for each unit per hour in the maximum power demanded, a charge not exceeding £3 per quarter, and in addition for each unit supplied, a charge not exceeding two pence." It is sometimes said as an objection to this method of charge, the public will object to pay a fixed charge whether they make use of their lights or not, and that, in fact, they will not pay it. The best answer that can be made is to give everyone the choice of being charged the maximum simple rate provided by the Order, or by the compound rate as they prefer. What is wanted is not so much an increased charge for those consumers whose lights are used for a short time, as such a special reduced charge for those whose lights are used long as will induce them to use the supply.

It is instructive to compare the cost to different classes of consumers of electricity and gas for lighting with 16-candle gas. Flat flame burners must be large and of first-rate quality to give more than two candles per cubic foot of gas per hour; the large majority of burners give much less than this even at their best, and as a rule the pressure of the gas is not regulated, and much gas is wasted as far as the production of light is concerned. Incandescent lamps give about one quarter of a candle per watt; hence a Board of Trade unit is equivalent to 125 cubic feet of gas. Thus we readily arrive at the following comparative table, the charge being at the rates recently sanctioned by the Board of Trade :—

Hours of use per annum.	Load Factor.	Price of Gas at which cost of lighting by electricity and 16-candle gas are equal.
480	5·5	5s. 4d.
960	10·9	3s. 4d.
1,440	16·4	2s. 8d.
1,920	21·9	2s. 4d.
2,880	32·9	2s. 0d.
3,840	43·8	1s. 10d.
7,680	87·6	1s. 7d.

In the accompanying curves are shown the cost of production, and the charge per unit at the compound and simple rate. The ordinates represent pence and the abscissæ the number of hours per annum the supply is used.



It is obvious that those whose user is long will find the electric light economical to themselves and that it will be profitable to the undertaker. With a cheap light which is free from the products of combustion there will be extensions for the hours of use. Shops may find it worth while to continue the light after closing, as an advertisement.

We have so far assumed that the supply of electricity is carried on without the aid of accumulators. Let us first compare the cost of an electric accumulator with the cost of a gas-holder containing the same possibility of producing light. A gas-holder is at present being put up in Manchester to hold seven million cubic feet of gas and is to cost complete with its tank £60,000. With 16-candle gas seven million cubic feet are equivalent to 56,000 Board of Trade units. Accumulators, capable of storing a ten hours' supply, cost about £50 per unit. The equivalent accumulator will therefore cost about £280,000. But this is not all; the gas-holder is comparatively permanent; the accumulators require frequent renewals and repairs; the gas-holder gives back all the energy put into it; the accumulators waste at least 20 per cent.; the gas-holder may be emptied as fast as you please; the accumulators, not faster than a certain rate without diminishing their capacity. Taking all into

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consideration, the cost of storing energy by the aid of accumulators, and storing it in a gas-holder are quantities of a different order of magnitude. If no gas-holders were used, and all the gas had to be made just as it was wanted, its cost for lighting would be several fold what it now is, even if gas producers could be found capable of instantly varying the supply as the demand varies. The gas-producing plant would have to be enormously increased; so would the size of the mains, and so would the wages of labour. If electric power could be stored as cheaply as gas, there would soon be little hope that the gas companies would maintain their dividends.

Let us see from a financial point of view whether accumulators can be used economically for storing up electrical power continuously produced during the 24 hours, and used rapidly for a short time.

Assume that the whole of the plant with the accumulators is capable of supplying 40,000 lights for ten hours continuously, and that during that time half the power is supplied from the accumulators. Ten hours in the twenty-four hours is not an unreasonable allowance, for we have melancholy experience in London of continuous fog for days, and this would tax the plant we are considering to the utmost. We are to be ready, then, at any time on short notice to supply 40,000 lights, and to continue to supply them for ten hours. Compare the cost firstly of maintaining this state of readiness with the accumulators and with a plant without accumulators. We shall require a battery capable of giving 1,250 units for ten hours; such a battery costs not less than £50 per unit, or in all £62,500. To maintain it will cost from 10 to 15 per cent. on the cost; there will also be interest on the outlay and amortization, say in all 20 per cent., or £12,500 a year. If we assume that the batteries are distributed at the various points of the system of conductors, we may also assume that the charges for land and buildings will be much the same as for the plant without accumulators. The boilers, engines, and dynamos will be just one-half. The switch board and instruments will be much the same. But the conductors will be reduced, smaller or shorter feeders being necessary, probably £40,000 will go as far with accumulators as £50,000 without. The coal bill may be dispensed with entirely, as we may assume that steam could always be got up during the time in which the demand increased from nothing to one half of the maximum, and that therefore all the coal burned can be assumed to be burned for producing current. That is to say, we assume the quantity of coal burned is proportional to the quantity of electric energy, and that, therefore, when no electricity is actually used, no coal will be burned. The wages may be reduced, for we have only to be ready to run half the plant, and a small wage will suffice for attendance on the accumulators. The wages of linesmen and the like will remain the same. Assume the total wages to be £3,500 instead of £5,000, the account will then stand thus:—

Land	£1,000
Buildings	1,500
Rates	500
Accumulators	12,500
Boilers	1,050
Engines	1,080
Dynamos	675
Switchboard	300
Conductors	6,000
Wages	3,500
	£28,105

practically the same result as we obtained before.

Now consider another hypothetical case, which, of course, can never occur in practice. We are to supply 40,000 lamps for ten hours every day with the plant just described, charging the accumulators during twelve and a-half of the fourteen hours during which the light is not required, twelve and a half hours' charging giving ten hours' discharge of the same energy. The coal would cost the half of £30,000 if the machinery had to run the whole of the 24 hours. It has to run 22½ hours, but the boilers have to be kept warm the whole time, hence the coal will cost the half of £6,000 for keeping the boilers warm, and $\frac{22\frac{1}{2}}{24}$ths of the half of £24,000 for generating steam. The wages may fairly be taken as £4,750, and the account will stand:—

Land	£1,000
Buildings	1,500
Rates	500
Accumulators	12,500
Boilers	1,050
Engines	1,800
Dynamos	1,125
Switchboard	300
Conductors	6,000
Wages	4,750
Coal	14,250
Stores	1,425
	£46,200

The cost of supply for the same ten hours without accumulators would be as follows:—

Land	£1,000
Buildings	1,500
Rates	500
Boilers	2,100
Switchboard and conductors	7,800
Engines	2,760
Dynamos	1,725
Coal	16,000
Stores	1,600
Wages	6,000
	£40,985

a cost of about 11 per cent. less than where accumulators are used.

Putting it another way, the cost of being ready to supply and to continue to supply, is about the same whether accumulators are used or not; the additional cost of actually supplying current is about 40 per cent. more where accumulators are used than where they are not used. It may be safely inferred that the use of accumulators does not seriously alter the conclusions I have drawn as to the proper method of charging consumers for a supply of electricity.

The question of whether the great cost of a supply for short hours can be removed by the use of accumulators may be looked at in another way. Will it pay a consumer to put in his own accumulators and charge them from the station supply? We may reasonably suppose the undertaker will remit the fixed charge in consideration of the consumer only taking his current at slack times. His accumulators, if they are to be of capacity to maintain his supply through a foggy day, will cost him £50 per unit per hour (or per kilowatt), and the annual charge in respect of them will be £10 per year, which, if we add a rent for the space the battery occupies, gives us a charge not differing materially from the fixed charge made or suitable to be made by the undertaker. But in order to obtain 2d. worth of electricity he must purchase 2½d. worth for charging his battery.

A word or two more about the use of accumulators. These have certainly improved, and they will continue to improve. They will become more durable and more economical of power in working, and their first cost will become less. An inspection of my tables of cost shows that a very little improvement would render them valuable even in very large stations for the mere purpose of diminishing the machinery required, by storing the energy developed at slack times to be used in busy times. The certainty of improvements in accumulators, and the possibility that the improvement may be considerable, is a strong argument for the use of the direct current wherever it is not precluded by the distance of transmission being too great.

It will be noted that I have assumed a very large station. Accumulators have another use which greatly increases their advantage in smaller stations. There are many hours in the twenty-four when it is absolutely certain that the demand will be small. If accumulators are used the attendance of the staff may be dispensed with during those hours, and a considerable sum in wages will be saved. The proportion of wages to the whole of the charges is much greater in small stations than in large. In most small stations giving continuous supply, accumulators ought to be used notwithstanding their expenses and defects, and I believe the day is not far distant when they ought to be used in connection with most large stations also.

If, instead of a continuous current, an alternating current with transformers is used, the modification in the account will be that the cost of conductors will be diminished, but the cost of transformers will have to be added. If the distances are small, the increased cost of transformers will exceed the saving in the conductors; if the distances are considerable, the cost of transformers will be less than the saving of conductors. In both cases the general character of the result will be the same as before, the cost of being prepared to give a supply will be considerable, and the cost of actually giving the supply will be much smaller than is generally supposed. Indeed, with the alternating current this peculiarity will be even more marked, for the machinery has not only to be kept in motion, however small the consumption may be, but a certain current must be maintained in every transformer. With the best transformers this current may only have an energy 1½ per cent. of the energy of the current when the transformer is fully loaded. This would increase the coal bill in the case considered by about £500 per year whether the supply was used or not.

It is possible, indeed probable, that some of my assumed figures may be shown to be too high or too low for the generality of cases. It is of no moment; let each one take any figures he pleases within reason; let him assume that the supply of electricity is made by any system he pleases; he will arrive at a result broadly similar to mine. To be ready to supply a customer with electricity at any moment he wants it will cost those giving the supply not much less than £11 per annum for every kilowatt, that is for every

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unit per hour, which the customer can take if he wishes; and afterwards to actually give the supply, will not cost very much more than ½d. per unit. This is the point I have been labouring to impress, for I take it it is essential to the commercial success of electric supply. It is hopeless for electricity to compete with gas in this country all along the line if price is the only consideration. But with selected customers electricity is cheaper than gas. Surely it is the interest of those who supply electricity to secure such customers by charging them a rate having some sort of relation to the cost of supplying them.

FURTHER EXPERIMENTS ON THE SPECIFIC INDUCTIVE CAPACITY OF ELECTROLYTES.*

BY EDWARD B. ROSA, PH.D.

I. In a note appended to an article on the "Specific Inductive Capacity of Electrolytes," in the *Philosophical Magazine*† for March, 1891, I referred briefly to some experiments then under way on the behaviour of glass in a non-uniform electrical field in different liquids. The experiments were undertaken with a view of verifying the results of previous work, which indicated that water and alcohol possess genuine specific inductive capacities much larger than most other liquids, although not infinite as sometimes stated.

The energy of an electrical system is

$$W=\frac{1}{8\pi}\iiint K H^2 \, dv.$$

Supposing the media isotropic, and the system to consist of a solid dielectric immersed in a fluid, we may write

$$W=\frac{K}{8\pi}\iiint H^2 \, dv+\frac{K_1}{8\pi}\iiint H_1^2 \, dv,$$

where the first integral is to be taken throughout the fluid and the second throughout the solid. If $K_1 > K$ the force in the fluid near the solid is increased, while within the solid it is decreased, as compared with the forces in the absence of the solid. The total energy is, however, increased by the presence of the solid, and if the field is variable the solid is acted upon by a resultant force which urges it toward the stronger parts of the field. If, however, $K_1 < K$ the solid tends to move toward those regions where the electric force is less. This is analogous to the case of magnetic and diamagnetic bodies in a magnetic field.

These considerations lead one to expect that glass (for example) would go toward the stronger parts of the field in air, turpentine, and other dielectrics having a small value of K, and toward the weaker regions of the field in water and alcohol. Moreover, since K for water and alcohol is very large, the glass would experience a force many times greater in water in the one direction than in air in the other. These anticipations have been completely realised.

The Apparatus.

II. In the experiment there were employed two pairs of electrodes, M_1, N_1 and M_2, N_2, shown in section in Fig. 1. They were of platinum, 0·9 cm. in diameter, 5·0 cms. long, and their centres were 2·6 cms. apart. M_1 and M_2 were joined to one pole of a battery furnishing any desired potential up to 140 volts; N_1 and N_2 were joined to the other pole; and a rotating commutator served to give alternations of 50 to 100 per second. Two cylinders, S_1, S_2 of glass, mounted on glass stems, were carried on the arms of a torsion balance, d being the axis of rotation. The deflection was measured by a telescope and scale, and the force determined in absolute measure. The cylinders of glass were subsequently replaced by cylinders of paraffin, beeswax, and other dielectrics, and carbon and brass among conductors. The force f on the cylinders is perpendicular to the direction of the lines of electric force and is proportional to $\frac{d(H^2)}{dy}$ where H is the electric force.

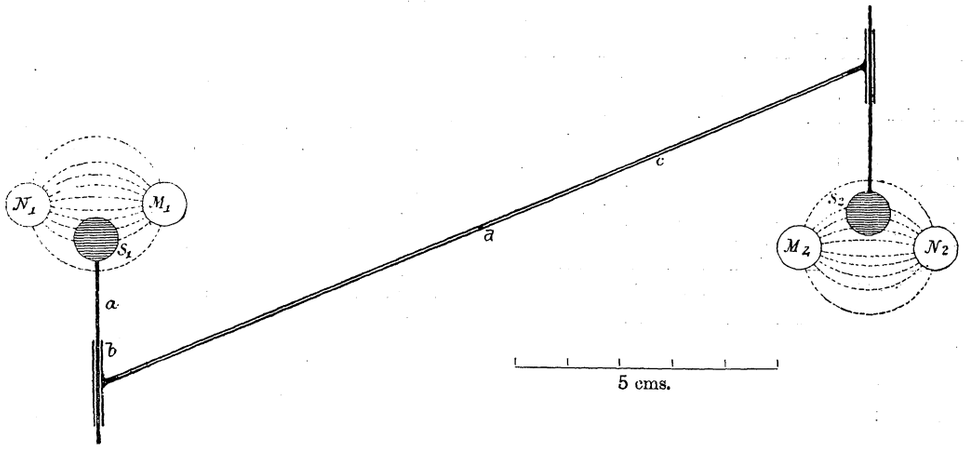
$$H=C\frac{2A}{A^2+y^2},$$

where C depends on the difference of potential between the electrodes. f has a maximum value at a point P where

$$y=\frac{A}{\sqrt{5}};$$

that is, about a quarter of the distance between the axes of the cylinders from the origin. About this maximum point the force varies but little for a considerable distance. This is then a particularly favourable place to put the solid S, as an exact knowledge of its position is not necessary. A fairly accurate adjustment was, however, always made, by first bringing the solid just between the electrodes where the resultant force is zero, and then turning the torsion head, by means of a lever reaching to the telescope, always through the same angle. The resultant force f on the solid is inversely proportional to A^3, and directly proportional to the volume of the cylinder, that is to the cube of its linear dimensions. *Thus changing the linear dimensions of the system does not alter the force on the solid.* The following is a brief statement of the results observed:—

1. Glass cylinders in air, petroleum oils, bisulphide of carbon, turpentine, and benzene are attracted; that is, move into the stronger parts of the field.



2. The force is least in air and greatest in turpentine; in short, is greater in those media having a greater specific inductive capacity, all, however, being considerably less than that of glass. This indicates that the principal change of energy is in the fluid medium.

3. In water, alcohol, and ether (the latter containing water and alcohol as impurities) glass is repelled, the forces of repulsion being nearly in the ratios of 9 : 3 : 1 respectively. In bisulphide of carbon containing about 20 per cent. of the same ether, glass is attracted, but with about 40 per cent. it is repelled.

4. The force of repulsion on glass in water is over 60 times as great as the attraction in air. Since this is approximately the value of the specific inductive capacity of water it suggests, as in the case of glass in liquids of low specific inductive capacities, that the chief change in energy due to the presence of the glass is in the fluid media.

5. The force on the glass is proportional to the square of the difference of potential between the electrodes, and, therefore, to H^2. In the case of water and alcohol this was verified quite accurately; and in the case of the other liquids, where the forces were much smaller, it was verified approximately.

Conducting Cylinders.

III. If the cylinder is a conductor and is surrounded by a non-conducting medium, the lines of force are drawn toward it, as lines of magnetic force are gathered up by a piece of iron put into a magnetic field. The resultant force is *always one of attraction toward the electrodes.* This follows from the tendency of the lines of force to shorten, and being more numerous on the side toward

* Abstract from the *Philosophical Magazine.*

† The results obtained at that time by Mr. Rosa, together with others obtained by Herr Tereschin and Herr Lecher, were republished in *The Electrician*, April 3, 1891, page 661.

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the origin, the conductor is drawn in that direction. If the surrounding medium is a conductor, the case is not modified providing the solid is a very much better conductor. Thus, suppose the cylinder is carbon and the medium water. The latter is a fair conductor, yet carbon conducts millions of times better than does distilled water, and the lines of force will be arranged sensibly the same as though water were a non-conductor and carbon a perfect conductor. The resultant force on a cylinder in a given field will evidently be proportioned to the specific inductive capacity of the medium of the field. This is a much simpler case than that of a dielectric solid in a liquid, where the conductivity of the liquid and the specific inductive capacity of the solid affect the result. As before, an accurate adjustment of the position of the conducting cylinders is not necessary, and using the same cylinders with the same difference (or known differences) of potential, this would seem to be an excellent method of measuring the specific inductive capacity of liquids. Accordingly, cylinders of carbon (cut out of an arc-light carbon) were mounted in the torsion-balance and the force of attraction under various conditions measured.

1. The force, as we should expect, is accurately proportional to the square of the difference of potential for air and all liquids, conducting and non-conducting.

2. The force is approximately proportional to the volume of the cylinder. This was found to be roughly true for three pairs of cylinders of nearly equal length but of very different volumes, *i.e.*, 0·73, 5·7, and 10·0 cubic cms. respectively. The force increased somewhat faster than the volumes, which would be expected, as the larger cylinders extend farther into the stronger parts of the field near the electrodes. For small changes in the volume the force may be taken as proportional to the volume.

3. The following tables give series of measurements made with the second pair of cylinders (volume 5·7 cubic cms.) in air and turpentine. Other measurements agreed with these almost exactly.

Table I.—*Air.*

V = Potentials.	Deflexions.	Squares of $\frac{V}{100}$.	Quotients of Deflexions by $\left(\frac{V}{100}\right)^2$.
105·0 volts.	2·02 cms.	1·102	1·83 cms.
107·0 ,,	2·08 ,,	1·145	1·82 ,,
132·5 ,,	3·15 ,,	1·755	1·80 ,,
118·2 ,,	2·53 ,,	1·397	1·81 ,,
	Mean for 100 volts		1·815 ,,

Table II.—*Turpentine.*

V = Potentials.	Deflexions.	Squares of $\frac{V}{100}$.	Quotients.
101·4 volts.	4·48 cms.	1·028	4·36 cms.
,,	4·44 ,,	,,	4·32 ,,
,,	4·45 ,,	,,	4·33 ,,
101·5 volts.	4·48 ,,	1·030	4·35 ,,
,,	4·47 ,,	,,	4·34 ,,
101·2 volts.	4·47 ,,	1·024	4·36 ,,
	Mean for 100 volts		4·34 ,,

$$\frac{4\cdot34}{1\cdot815} = \mathbf{2\cdot39} = \textit{specific inductive capacity of Turpentine.}$$

In the same way other liquids were treated, and the following values of their specific inductive capacities obtained :—

Water at 16°·5 C.	K=70.
Alcohol, about 93 per cent.	K=30·9.
Ether (with water and alcohol impurities)...	K= 8·4.
Turpentine	K= 2·39.
Petroleum oil, 300deg. test	K= 2·04.
Petroleum oil, light illuminating.....	K= 1·97.

The difference between the above value for alcohol and that previously given for absolute alcohol (25·7) is readily accounted for by the water present in this. Pure ether has a much smaller value than that given above.

This method is capable of giving tolerably accurate results, although it cannot be used with heavy oils ; for the force to be measured is small and the volume of the cylinders is considerable ; hence the latter move very slowly through a quite viscous liquid. The method given in the paper already referred to is applicable to such liquids, and is perhaps more convenient for all.

THE PARSONS STEAM TURBINE.*

In December last a condensing steam turbine, combined with a 100-kilowatt alternate-current dynamo, was tested, when it was found that the consumption of steam was 37lb. per electrical unit when the machine was running under full load, 39lb. per unit when the load was 50 units per hour, or one-half of the full value, and 43lb. per unit when the load was reduced to one-third of its full value.

A further series of trials have been made during last month, with the object of testing how far the efficiency has been improved by certain recent changes, and by the use of superheated steam. The same turbine was used in these as in the former trials ; but some additional rings of turbine blades were inserted at the high-pressure end to enable it to deal more effectively with pressures up to 115lb. per square inch (absolute). The chief factor in the improvement which has now been brought about is the use of moderately superheated steam, resulting in a reduction of about 27 per cent. in the steam consumption. There is nothing in the construction or working of the turbine to make it likely that the use of superheated steam will be attended by any drawbacks such as have been experienced in engines of the ordinary type. The steam works without lubrication, it comes into contact with no rubbing surfaces, and there is no packing to be injured.

A general view of the plant tested is given in elevation in Fig. 1, and in plan in Fig. 2. The turbine case (*a a*) contains a series of seven revolving discs, from the surface of which the turbine blades project. They are arranged, on each disc, in a series of concentric rings. The fixed guide-blades stand in spaces between these rings, being carried by annular discs, which are fixed to the case. Thus each revolving disc, with its neighbouring fixed disc forms a series of outward-flow turbines, the steam entering the series inside the smallest ring of blades and escaping at the circumference into a channel, which conducts it between the back of the revolving disc and of the next fixed disc to the inside of the next series of rings. The arrangement will be understood by reference to Fig. 3, which is a section showing the first three turbine discs. The heights and apertures of the turbine blades on each disc are adapted to the increasing volume of the steam as it expands from an absolute pressure of 115lb. per square inch to an absolute pressure of 1lb. per square inch. The first six discs, which are each 15in. in diameter, are designed to expand the steam to about atmospheric pressure, the remainder of the expansion being performed in passing the seventh disc, which is $26\frac{3}{4}$in. in diameter, and has (unlike the other six) a double series of rings of blades, one series on each side, through which the steam flows "in parallel." The height to which the turbine blades project above the discs in which they are secured varies from $\frac{3}{16}$in. to 1in. The whole number of rings of moving blades in the machine tested was 35. The blades are made of strong sheet brass, and show no sign of wear after continued use. Steam enters the turbine case at one end, through a double-beat valve shown in Fig. 3, and after passing the successive turbine discs, is discharged at *b* (Fig. 1) to a condenser. The longitudinal pressure on the turbine shaft, due to the one-sided character of the six smaller turbine discs, is balanced at the high-pressure end by a revolving baffle piston (Fig. 3), with a number of deep grooves on its circumference, which are entered by corresponding projections on a fixed bush resembling a thrust-block. Any small amount of longitudinal thrust which may remain unbalanced is received by an adjustable grooved thrust-bearing at the end of the spindle, beyond the main bearing. This, which is contained in the oil-box *c* (Fig. 3), is shown to a larger scale in section in Fig. 4. The thrust-bearing *d* (Fig. 4) consists of seven collars on the spindle revolving in a grooved bush, which is split longitudinally into halves with separate longitudinal adjustment to allow any wear to be taken up, so that end-shake is prevented, and the endwise position of the shaft is maintained with great precision. This device also gives a means of regulating the amount of clearance over the tips of the turbine blades. The thrust-bearing, like the main bearing, runs in a bath of oil. The main bearings are of a special construction which is admirably adapted to ensure easy running at a high speed, and to damp out vibration. The shaft (Fig. 4) rotates in a phosphor-bronze sleeve, outside of which are slipped three concentric steel tubes fitting loosely over one another. The outermost tube is a loose fit in the casting which forms the seat of the bearing. Oil is continuously and freely fed to the bearing from a cistern above, under a head of some 6in., and drains into a chamber below, from which it is automatically pumped back to the cistern. In this way the small clearance between each tube or sleeve and the one outside of it is kept charged with a film of oil, with the effect that while the shaft retains a necessary small amount of freedom to adjust itself by lateral displacement, the viscosity of the films acts as a powerful damper to prevent oscillation from being set up. The working of the bear-

* Abstract of a "Report on Trials of the Parsons Condensing Steam Turbine, using Superheated Steam," by Prof. J. A. Ewing.

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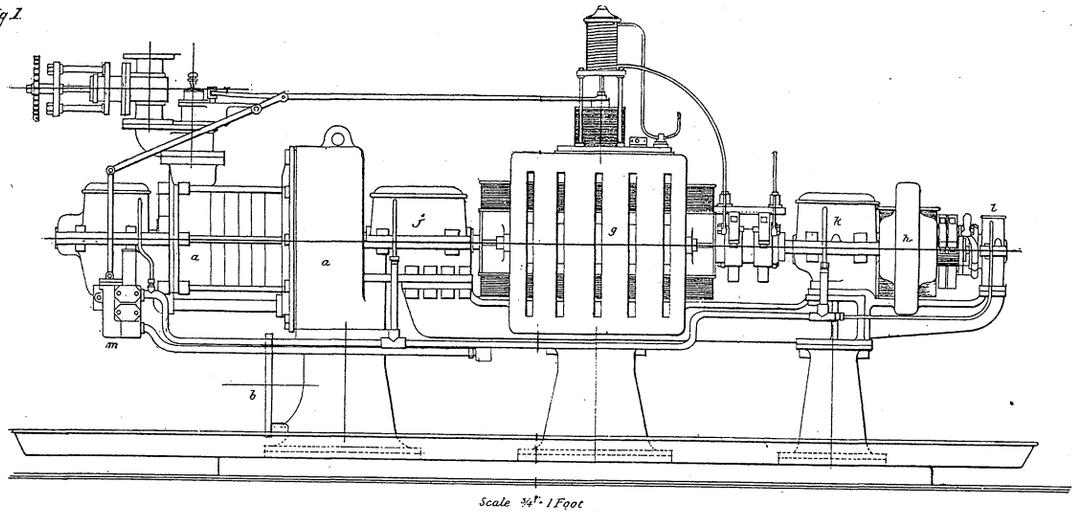
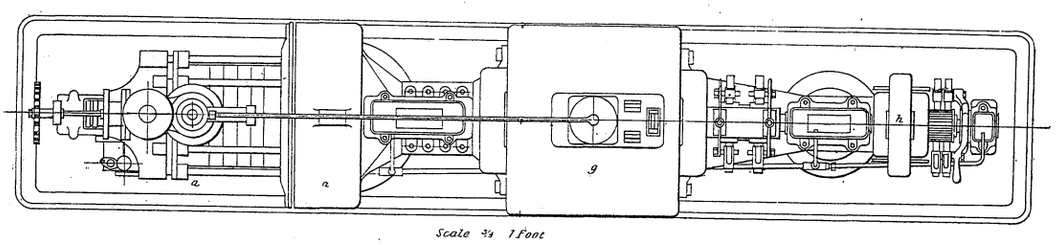
Fig 1.



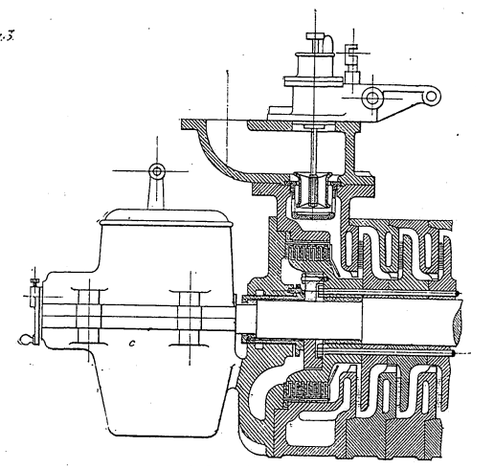
Scale ¾"-1 Foot

Fig 2



Scale ¾ 1 Foot

Fig 3.



Scale. 1½"-1 Foot

Fig 5

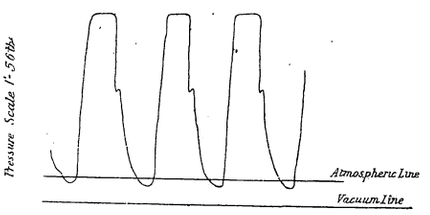


Fig 6

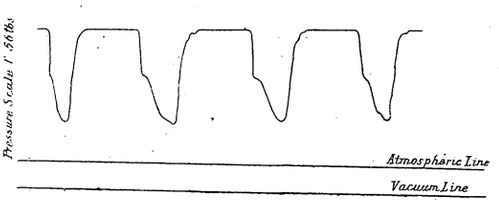
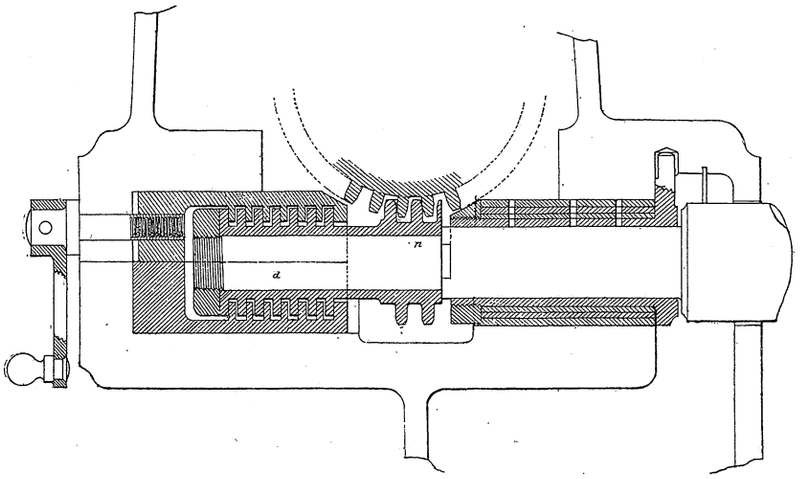


Fig 4.



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ing is perfectly satisfactory, and the damping action is so great that the shaft may even be put considerably out of balance without causing the vibration to become excessive or making the bearings run hot. In the ordinary conditions of balance the shaft carrying the turbines, the main armature, and the exciter armature, runs at 80 revolutions per second with a steadiness and quietness which are most remarkable.

The shaft passes out of the turbine case at each end through a lantern-brass or steam-gland. The whole shaft is in three lengths : the first part carries the turbines, the second carries the armature of the main dynamo *g* (Fig. 1), and the third part that of the exciter dynamo *h*. The parts are coupled by means of a square-bored sleeve slipped over squared ends. The couplings are placed in the middle of long double bearings at *j* and *k*. These, as well as the end bearing at *l*, are all formed by concentric tubes, and work drowned in a sea of oil, as already described for the other end bearing. The oil chambers are connected by pipes, so that a single oil-pump maintains the circulation in all. The pump, which is shown at *m* in Fig. 1, is driven by an eccentric which receives its motion from a worm (*n*) on the main shaft, working in oil, between the main bearing and thrust bearing of Fig. 4.

The governing of the machine tested was accomplished by admitting the steam to the turbine in a series of gusts by the periodic opening and closing of the double-beat lift-valve shown in Fig. 3. The duration of each gust was controlled by an electric solenoid, which was connected as a shunt to the field magnets, but was compounded so as to keep the volts constant. The core of the solenoid was hung from the end of a long lever (Fig. 1). The fulcrum of this lever was periodically moved up and down by means of a link connecting it with the eccentric, which also served to drive the oil-pump. The short end of the lever controlled the valve of the steam relay. Each periodic movement caused a gust of steam to be admitted to the turbine, the duration of the gust depending on the height of the distant end of the lever. The effect was, that at full load the gusts became blended into an almost continuous blast, the lift-valve closing only momentarily, or not at all, in each of the periodic movements, which caused no material throbbing of speed nor any variation of volts sensible on a voltmeter. The whole load, amounting to over 130 E.H.P., was thrown on and off suddenly, without causing more than a momentary variation in the volts.

By applying an indicator at the admission end of the turbine chamber, below the double-beat valve, observation was made of the pressure during the periodic admission of steam; this was done by pulling the paper-drum of the indicator as steadily round as possible by hand while the pencil rose and fell. Figs. 5 and 6 are examples of diagrams obtained in this way. In Fig. 5 the load was about one-half the maximum ; in Fig. 6 it was about three-quarters.

Most of the trials have been made with a continuous-current armature, wound to give 400 amperes at 250 volts. The results of the continuous-current trials, where the electrical measurement of the work done is of a perfectly simple and straightforward character, are in close agreement with those of the alternate-current trials. The main armature was about 2ft. 6in. long over the body by 9in. in diameter. The weight of copper on it was only 33lb., or $\frac{1}{3}$lb. per kilowatt of output.

Steam for the turbine was supplied at a pressure of 100lb. per square inch by gauge. In all the statements which follow of the results of these trials, the quantity of feed-water named is the gross quantity supplied to the boiler, no deduction having been made for leakage, blow off at the safety valve, or other loss.

Three separate set of trials were made, August 11 to 15, 1892. In the first set the steam was superheated by means of the hot gases from the boiler furnace only. The temperature approached but did not exceed 400°F., which, as the boiler pressure was 100lbs. per square inch above the atmosphere, corresponds to about 60° of superheating. In this set of trials the continuous-current armature was used, and the amount of feed-water was determined for six different grades of output, from no electrical load up to a load in which the output was at the uniform rate of 102 Board of Trade electrical units per hour, the current being spent on a bank of coils. The results of this set of trials are set forth in tables and curves. The output stated is the amount of electrical work done upon the external circuit, and does not include the output of the exciter. The volts were measured by three Cardew voltmeters, which were tested against each other, and one of them against a Thomson balance. The amperes were measured in the following way : — A low-resistance frame consisting of many bare thick wires of platinoid grouped in parallel, was arranged as a shunt to a mirror galvanometer, which was provided with a strong controlling magnet, so that the whole current of about 400 ampéres could pass without causing an inconveniently great deflection, and without heating the wires of the shunt materially. In series with this was placed (1) an Evershed ampèremeter which had been carefully calibrated by reference to a Thomson balance, and (2) two Siemens' electro-dynamometers, one of which could take the strongest current while the other was suitable for comparatively weak currents only. The constant of the shunted mirror galvanometer was determined in the low-power trials by comparing its deflection with the readings of the Evershed and of the more sensitive of the two Siemens' instruments. These were then cut out to allow stronger currents to pass, and in the trials under heavy load a further check on the constant of the mirror galvanometer was furnished by the readings of the larger electro-dynamometer. The mirror galvanometer, the constant of which remained unaltered throughout, served to connect the readings of all the currents, from the lightest to the heaviest loads. The agreement between the various measurements was perfectly satisfactory. In the second set of trials the object was to test the effect of additional superheating. In the third set of trials the alternate-current armature was used, giving 2,000 volts at a speed of 4,800 revolutions per minute, which made the frequency of alternations 80 periods per second. Here the current was directly measured by the Evershed and Siemens' instruments, and the volts were determined by (1) a Cardew voltmeter furnished with a resistance specially wound to enable it to read 2,000 volts, and independently (2) by another Cardew voltmeter with a step-down transformer having a ratio of one to twenty. The output was taken to be the product of the effective volts and the effective amperes. In these alternate-current trials the electrical energy was absorbed by a water resistance formed by sticking two rods, to serve as terminals, some ten yards apart in a pond, the amount of resistance between them being adjusted by pulling the rods out or in to expose more or less of their surface to contact with the water. In this third set of trials the steam was moderately superheated, as in the first set, by the hot gases of the boiler flue only—its temperature again approaching 400° Fahr. The close agreement of the results with the corresponding continuous current trials is important, as supplying evidence that in alternate-current trials conducted in this manner the effects of lag in the external circuit are immaterial ; in other words, that the electrical work is properly measured by multiplying the effective volts by the effective amperes. The difference between the alternating and continuous-current measurements is less than 1 per cent. of the output at full load.

The results are exhibited in tables given in the Report, and by the curves, Figs. 7 and 8. The rate of electrical output is shown in relation to the whole consumption per hour, in Fig. 7, and in relation to the consumption of feed-water per electrical unit in Fig. 8. The upper line in each diagram refers to the first set of the present trials—which were made with continuous currents and moderate super-heating. The points of observation are marked by a dot within a circle. The points marked by a cross within a circle, which lie very close to this curve and a trifle below it, are for the tests made with alternating currents. The lower line in each diagram relates to the trials with extra superheating. The points of observation are marked by a line across a circle. To facilitate comparison, the amount of feed-water used per electrical unit at various rates of output, as measured from the curves of Fig. 8, is given numerically in the following table :—

Consumption of Feed-Water at Various Rates of Output, with Superheating.

Rate of output in electrical units per hour.	Feed-water per electrical unit.	
	With superheating to about 400°F.	With extra superheating to 465°F.
20	48	—
40	34½	32
60	30½	28½
80	29	27½
100	28½	(27)

The trials show that a very considerable advantage is realised by moderate superheating, which requires less than 3 per cent. of the heat taken up in the boiler. With steam superheated to this extent the consumption of full load is less by one-fourth than the consumption in the old trials. It is clear, however, that superheating is responsible for a great part of the difference. Apart from the increased volume of the working substance the advantage of superheating is to be ascribed in part to the prevention or reduction of the condensation at entry, which would otherwise take place in consequence of the intermittent character of the admission, and in part to its influence in keeping the steam dry during its expansion, and thereby reducing the internal resistances. At full load, when the steam enters in a nearly continuous blast, the latter effect is no doubt the more important.

After discussing the advantage of superheating, the report goes on to state that the general result of the trials is to demonstrate that the condensing steam turbine is an exceptionally economical heat engine. The application to it of moderately superheated

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steam has put the performance of the turbine on a level with that of the best steam-engines of the ordinary type. A consumption of 27lb. or 28lb. of steam per electrical unit, at full load, and 30lb. or 32lb. at half load, is a result that does not need to have its significance emphasised. The efficiency, under comparatively small fractions of the full load, is probably greater than in any steam-engine, and is a feature of special interest in relation to the use of the turbine in electric lighting from central stations.

The consumption of 28lb. per unit corresponds to 20·9lb. per electrical horse-power-hour. To facilitate comparison with other engine trials, it may be useful to estimate from these results what may, by analogy, be called the "indicated ' horse-power of the turbine—that is to say, the mechanical work done by the steam on the turbine blades. The curves of Fig. 7 are nearly straight lines, and by prolonging them backwards to meet the base-line produced, it appears that the *idle work*—that is to say, the work done without useful output, was equivalent to 27 kilowatts, or 36 H.P.

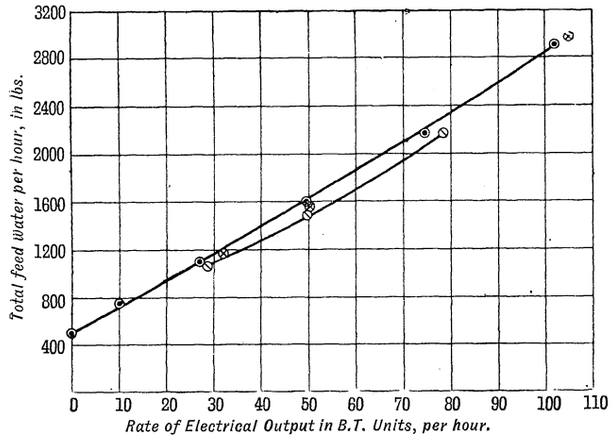

FIG. 7.—Trials of Parsons' Steam Turbine and Dynamo, August, 1892. Top Curve—Steam superheated to about 400°F. ; Dot and Circle = Continuous Current Trials ; Cross and Circle = Alternating Current Trials. Lower Curve—Steam superheated to 465°F. ; Continuous Current Trials.

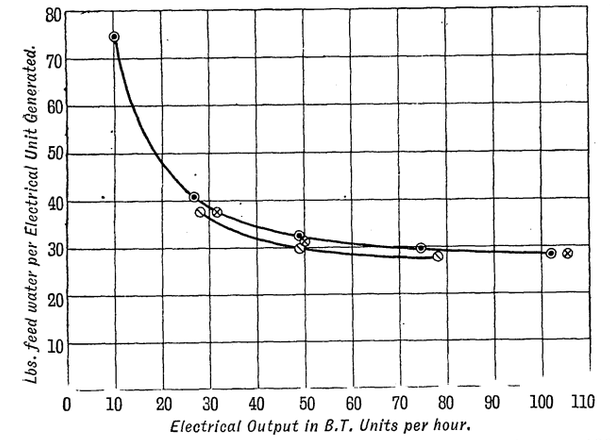

FIG. 8.—Trials of Parsons' Steam Turbine and Dynamo, August, 1892. Top Curve—Steam superheated to about 400°F. ; Dot and Circle = Continuous Current Trials ; Cross and Circle = Alternating Current Trials. Lower Curve—Steam superheated to 465°F. ; Continuous Current Trials.

The effective work at full load, the equivalent of 100 electrical units per hour, was 134 E.H.P., and it will be nearer the truth to assume that the effective work was not more than 75 per cent. of the total work. This would make the total work about 179 H.P. On this basis a consumption of steam at the rate of 28lb. per electrical unit is equivalent to 15·7lb. of feed-water per "indicated" horse-power-hour, and 27lb. per unit is equivalent to 15·1lb. per "indicated" horse-power-hour. Similarly, the consumption of half load is equivalent to about 17lb. per indicated horse-power-hour.

The City Lighting.—Notice is given that a faculty has been granted to authorise the construction of a transformer chamber for the City of London Electric Lighting Company in the churchyard of St. Benetfink, and, if found to be necessary, the removal of the remains of persons buried there.

BOOKS, &c., RECEIVED.

"Text Book of Magnetism and Electricity." By R. Wallace Stewart, B.Sc. (London : W. B. Clive and Co.) 320 pp., crown 8vo. Price, 5s. 6d.

"Practical Physics." By W. F. Barrett, F.R.S.E., and W. Brown. Part I. (London : Percival and Co.) 300 pp., crown 8vo. Price, 4s. 6d.

"Electric Light." By J. Urquhart. Fifth edition. (London : Crosby, Lockwood. 1893.) 412 pp. Crown 8vo.

"Proceedings of the Royal Society." Vol. LII., Nos. 314, 315. (London : Harrison and Sons.)

"Transactions of the Royal Society of Edinburgh." Vol. XXXVI., Parts 2 and 3. (London : Williams and Norgate.)

"Proceedings of the Royal Society of Victoria." Vol. IV., Part 1. (London : Williams and Norgate.) 80 pp , illustrated, demy 8vo.

"Syllabus of Classes at Dundee Technical Institute." (Dundee : John Leng and Co.)

"Iron and Steel Institute in America in 1890." Special Volume of Proceedings. (London : E. and F. N. Spon.) 500 pp., demy 8vo.

"The Cycle Calendar." By Alexander Griffith. (London : Eyre and Spottiswoode.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 11th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. Continued discussion of the Papers by Mr. Williams and Mr. Sutherland : "Dimensions of Physical Quantities" and "Molecular Forces."

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Two short Papers to be read on subjects connected with the testing and calibration of electrical instruments.

TUESDAY, November 15th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be read with a view to Discussion :—(1) "Halifax Graving Dock, Nova Scotia," by the Hon. R. C. Parsons, M.A. ; (2) "Cockatoo Island Graving Dock, New South Wales," by E. W. Young, M.Inst.C.E. ; (3) "The Alexandra Graving Dock, Belfast," by W. Redfern Kelly, M.Inst C.E. ; (4) "Construction of a Concrete Graving Dock at Newport, Monmouthshire." by Robert Pickwell, Assoc.M.Inst.C.E.

ROYAL VICTORIA HALL.

8 p.m. Lecture : "Electric Sparks and Lightning Flashes," by Dr. W. D. Halliburton, F.R.S.

WEDNESDAY, November 16th.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Papers to be read :—(1) "Thunderstorm, Cloudburst, and Flood at Langtoft, East Yorkshire, July 3, 1892," by John Lovel, F.R.Met.Sc. ; (2) "On the Measurement of the Maximum Wind Pressure, and Description of a New Instrument for Indicating and Recording the Maximum," by W. H. Dines, B.A. To be followed by a special business meeting.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Opening Address by Sir Richard Webster, Q.C., M.P., Chairman of the Council.

THURSDAY, November 17th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read (in the event of the discussion on Mr. Swinburne's Paper being terminated) :—"Experimental Researches on the Alternate Current Transformer," by Dr. J. A. Fleming, F.R.S.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting. Paper to be read :—Note on "The Refractive Indices and Magnetic Rotation of Sulphuric Acid Solutions," by S. U. Pickering, F.R.S. ; also other Papers.

FRIDAY, November 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Annual Dinner at the Criterion Restaurant.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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CYRUS W. FIELD.

With "THE ELECTRICIAN" for Oct. 28 was issued a Fine Steel-Plate Portrait of the late CYRUS W. FIELD, Pioneer of Ocean Telegraphy.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Only a fortnight ago we turned to a list of the Council of the Institution of Electrical Engineers and made an analysis of its members, arriving at very much the same result as that which will be found in our Correspondence Columns. We alluded to this analysis in our leading article on October 28th, but the object in view was altogether different from, and the opinions which we then expressed were in some respects opposed to, the conclusions which are drawn by our Correspondents. We agree at once with them that the Council does not represent the profession of electrical engineering, but it cannot be said to have done so at any time, and has none the less done excellent work. In many respects, no doubt, the principles and procedure of the Institution of Civil Engineers may with advantage be imitated by other societies aiming at similar objects, but to copy it in constitution and in routine is, we hold, quite a mistake, if only because of the great difference between the objects of the two bodies. The older Institution embraces all branches of the profession, but strictly civil engineering rather than mechanical or constructive or purely scientific engineering is practised by the majority of those who have attained the standing of members. The younger Institution, on the other hand, consists of men whose work is of a much less professional character. A very large proportion are engaged in manufacture and practically in trade. Trade matters, however, are very rarely discussed at its meetings, and many of the most influential commercial men are never seen at the meetings. The contents of the Papers read are quite sufficient to prove that it is essentially a scientific body, and that the Papers and the discussions thereon are a good test, we need only point out the perfectly

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voluntary character of these contributions. We believe that, as with all other such institutions, the Council is glad enough to receive Papers at the beginning of the session, and is generally overwhelmed at the end, and that refusal of Papers is somewhat exceptional. This Institution, like that of the Civil Engineers, is, therefore, largely what its members choose to make it. Anything that will improve the Institution as a whole should, of course, be adopted, but whether much can done in this direction by modifying the constitution of the Council should be carefully considered.

Electrical engineering differs widely from civil engineering in that it is, on the one hand, far more scientific, and, on the other, much more closely connected with trade, so that there is left but little of the professional element. This new industry depends in a most important degree upon theory, and some branches of it are well nigh swamped with science and mathematics. Civil engineering and mechanical engineering on the other hand develop year by year, and scientific methods and principles are gradually introduced, but not even the influence of technical colleges can smother sound, well-established engineering practice with scientific theories. In electrical engineering there is no such thing as sound, well-established practice. New discoveries such as the drehstrom, or the PARSONS' turbine, threaten to upset our ideas of construction, and we have to keep our minds prepared for the overthrow of theories and for the discussion of brand new hypotheses. If there were not enough of science in the electrical industry to make this the basis of the Institution, the introduction of another element might be advisable, but being composed mainly of science and trade, the Electrical Trades' Section of the London Chamber of Commerce forms an excellent complement to the Institution of Electrical Engineers. Another set of men meet at Botolph House, and experience has shown that the functions of the two bodies do not clash, and that they can work well together when common action is necessary.

If this view of the Institution of Electrical Engineers be a sound one—and we merely throw it out as a suggestion—the preponderance of professors on the Council is no evil. On the contrary, the Institution should be congratulated on attracting nearly all the professors who are actively engaged in electrical teaching or research in London, so long as there are enough men on the Council who are engaged in the practice of engineering to keep it from drifting into a mere electrical society. To tamely imitate the Institution of Civil Engineers is but to compete with it, and this is folly. For not only do many men belong to both Institutions, and some of these will occasionally offer their Papers to the older society, but the Civil Engineers often invite Papers from those who do not in any way belong to their body, as for example, during last session, Mr. ROBERTS-AUSTEN and Mr. J. SWINBURNE. While suggesting that the Institution of Electrical Engineers should specialise rather than compete, it is clear that its objects should not be narrowed, and above all, that it should be properly managed. The constitution of the Institution has not become so crystallised that movements of this kind must either fail, or be carried on with a rather unpleasant struggle. If there are indeed enough engineers with sufficient time to devote to the matter, it would be for the good of all that they should come forward. The only hint that our correspondents give as to the type of member they desire to see elected into the Council is that they should be actively employed in constructive work.

Fate having thus decreed that electrical engineering should be peculiarly scientific, it seems to us that it offers a particularly favourable opportunity for the continued existence of a Society which should be equally representative of Science and Engineering, of Theory and Practice. It is, we know, almost an axiom with some, that such a combination is a physical impossibility, and that, sooner or later, a divorce is certain to take place. However that may be, the attempt is surely worth making, and the first element of success is that the two extreme sections of such a Society should be thoroughly permeated with the spirit of compromise, and if any body of members can show that their numerical representation on the Council is insufficient, and that an appreciable good will result from a more arithmetically accurate state of things, there should be no reluctance in giving way. On the other hand, practical men might forego some of their disparagement of theorists. We await with interest the outcome of this movement.

OBITUARY.

EDWARD GRAVES.

It is our painful duty to record the death on Wednesday morning of Mr. Edward Graves, Engineer-in-Chief to the British Post Office Telegraphs. Mr. Graves had been a sufferer from diabetes for a considerable time past, but continued at his post until within a few days of his decease.

Mr. Graves was born in February, 1834, and after a brief connection with the North Eastern Railway Company, he first became connected with telegraphy in 1852, when he entered the service of the Electric and International Telegraph Company, at York, under Mr. de Chesnel, for whom he acted during a prolonged illness, and in 1856 succeeded, as Superintendent and District Engineer for the East Coast of England and Scotland, extending from London to Aberdeen. As the Company's system developed the district was divided, and at the transfer of the telegraphs to the State in 1870 Mr. Graves was made divisional engineer for the northern district, with headquarters at York. Possessed of great administrative ability and financial acumen, his services were employed in defending the interests of the Post Office during the arbitrations of 1874-8 between the Department and the various railway companies who were entitled to compensation under the Telegraphs Act of 1868, and the success of his efforts was mentioned by Sir Richard Baggallay, then Attorney-General, and other eminent counsel connected with the cases, and received official recognition by the Department. In 1878 Mr. R. S. Culley, the engineer-in-chief, retired from active service, and Mr. Graves was appointed to succeed him in that office, and immediately re-organised the engineering staff. He was a delegate to the Paris Electrical Conference in 1881, and received the Cross of an officer of the Legion of Honour from the French Government; he was a member of the Channel Tunnel Defence Committee in 1882; of the Electrical Standard Units Committee and of the Royal Commission on Electrical Communication with Lighthouses and Lightships, whose report is expected shortly. Mr. Graves was one of the early members of the now Institution of Electrical Engineers, of which he was for many years honorary treasurer, and in 1888 was its president.

The Junior Engineering Society.—At a meeting of this Society on Friday last at the Westminster Palace Hotel, Sir Edward Reed, in vacating the chair, spoke of the great value of such opportunities as those which are afforded by this Society for promoting intercourse between the elder members of the profession and those who had yet the battle of life to fight. Dr. J. Hopkinson, the new President, delivered a very interesting address which will be found in another column. In seconding a vote of thanks for this address, a member, whose name had better be withheld, alluded with most naïve contempt of court to Dr. Hopkinson as having contributed greatly to the advance of electrical engineering by the development of the dynamo and the invention of the three-wire system.

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EARTHING THE MIDDLE CONDUCTOR OF A THREE-WIRE SYSTEM.*

BY VON PH. SEUBEL.

For some time past the *Elektrotechnische Zeitschrift* has been publishing communications on this subject, more particularly in regard to the position which American authorities are taking for and against this matter. The *Elektrotechnische Zeitschrift*, No. 28, contains a communication from the *Allgemeine Electricitäts Gesellshaft*, in which a lecture is mentioned which was given by me before the Association of the Edison Illuminating Companies in 1889. I now beg to report on further experience in this matter. Herr Gräwinkel up to the present has not given us any proof of his assertion made in No. 23, that this putting to earth of the third wire affects the telephones. His further assertion that in America it is not allowed for reasons of public safety can only refer to an order issued by the Board of Electric Control of New York. However, this purely political body can hardly be regarded as a competent authority on this question. It may be at once said that the Edison Illuminating Company of New York has replied to the demand of that body that they will only comply with their order to again insulate the third wire under the express conditions that the Board of Electric Control takes the responsibility for all the consequences arising from such action. As far as I am aware, up to the present, the Board of Electric Control have not agreed to take on themselves this responsibility, and the third wire remains now as it was before put to earth.

It was only after careful discussions between a number of the officers of the Edison General and the Edison Illumination Companies of New York that the third wires were put to earth at all the distributing centres and in the central stations themselves. For three years I was occupied in the construction and maintenance of the underground network of the New York Edison stations, and can state that before we put the middle wire to earth we had very frequent troubles, which, in most cases, were due to electrolysis ; in fact, not a week passed without a number of disturbances in the network, some very serious and some trifling. From the time, however, that we put the middle conductor to earth the network remained perfect and absolutely free from faults for more than three months, and it seemed as if the previously existing strong tendency to electrolytic action had disappeared. Such disturbances as did take place, at very long intervals of time, were such smaller in extent than had formerly been the case, and it was abundantly evident to us that in addition to other advantages which were obtained by this earthing of the middle wire, it was an indisputable fact that it practically freed the network from all faults, whilst no corresponding disadvantages were observed. No complaints from the Telephone Company ever came to hand to my knowledge, notwithstanding that I was in daily active communication with the officers of the Company.

The Edison central station in Boston has also since 1889 had the middle conductor put to earth after Capt. W. Brophy, of the New England Insurance Exchange, had expressed himself as follows about this earthing :—"I have carefully examined the proposal to put the middle conductor to earth in the three-wire system, I fully agree with the opinion of Mr. Edgar to which he has come after the trials made in Boston, when I had an opportunity of observing the effects. For greater reliability I think it necessary that these connections to earth should be made at many points, and whilst, perhaps, it is advisable to have such connection capable of easy disconnection, the possibility of interruption of the system through accidental mechanical disturbances or unexpected electrical influence should be avoided."

The Edison Central Station in New Brunswick, in the State of New Jersey, owns a mixed network in the centre of the town, the conductors are laid underground, whilst the external part of the town is provided with overhead conductors. It was here that the connection of the middle wire to earth was first applied, and at first simply as a protection against lightning, from the effects of which the consumers in the external part of the town had to suffer very considerably. It may be here mentioned that this connection to earth of the middle wire has proved to be a very good protection against lightning, while the advantages previously mentioned were very soon remarked. In this case the connections to earth were carried out by means of copper earth plates. On my suggestion these were taken out and examined after two years' use, and no oxidation of the same could be observed. Prof. Van Dyck of the Rutgers High School in New Brunswick, who is also a member of the Jersey State Board of Fire Underwriters, stated that this innovation in regard to the earthing of the middle wire had his entire approval, as the danger of fire from accidental earth connections is in proportion to the energy developed, the amount of which in its turn depends on the difference of potential ; it was, therefore, wise to reduce the difference of potential to a minimum, and this was practically obtained by putting the middle conductor to earth.

* From the *Elektrotechnische Zeitschrift* of October 21, 1892.

NEW EDISON-SWAN SERIES LAMPS.

In order to meet the increasing demand for series lamps the Edison and Swan Company have introduced a new form of lamp and holder, the stock sizes being 16 c.p., 32 c.p., and 50 c.p. ; the filaments are made in two sizes, for 6·8 and for 10 amperes.

The lamp is of the ordinary 3½ watt type, with very strong filaments. The terminals are constructed with thick copper lugs which conduce greatly to strength and durability. An adapter is used in connection with this in order to avoid capping with plaster which is so objectionable for large current lamps, and it affords thorough ventilation to the terminals. These are made in the Edison screw form with strong brass jaws to take the lugs of the lamp. The neck is gripped by two wire springs in such a manner that it is impossible for the lamp to fall out of the adapter, but at the same time both of these can be removed from the holder in the same way as an ordinary Edison screw lamp.

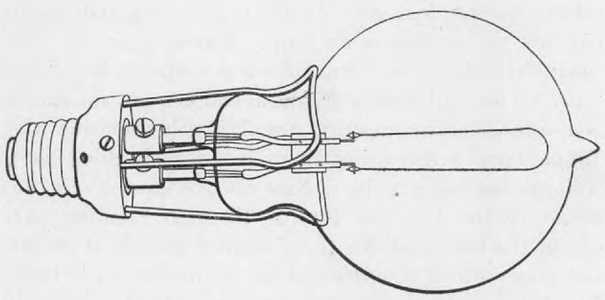

FIG. 1.—The Edison-Swan Series Lamp.

The holder consists, for the main part, of two solid brass castings fitted on to a thick fibre base ; one of these, which extends across the full width of the base, constitutes the framework of the holder and also one terminal, say the positive. From this positive terminal piece are carried up two pillars which support a thick brass ring, which in turn carries an Edison screw socket, and into this the lamp adapter is screwed. Between one of these pillars and the ring is fixed a flat spiral spring of phosphor bronze, one end of which presses against the under side of the projecting arm of the negative terminal, forming the centre contact of the holder, in such a manner that it short-circuits the holder so long as it is maintained in this position. The centre of this arm is hollow, and in it runs a pin rather longer than the contact piece, being brass at the upper end and fibre at the lower. The only excuse for using this form of insulation is

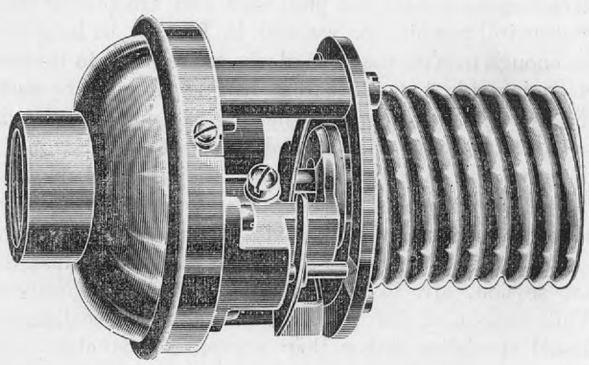

FIG. 2.—Holder for Series Lamp. Full Size.

that the lampholder becomes hot, and free ventilation being afforded, the fibre will probably be kept dry ; the insulation, so long as this condition is maintained, will be very fair. When the lamp is in the holder it will be seen that the pin is pressed down so that the phosphor spring is kept at a distance, and the current passes through the lamp instead of being short-circuited across. The other end of this spring will be seen to carry a short pin, which it causes to be pressed downwards on to the near side of the negative terminal, and between these is placed the fuse paper which, the moment the lamp ceases to act from any cause whatever, receives the full volts of the circuit, and is instantly pierced so that the current continues to flow without interruption.

In factories where arc lighting is used, these lamps would be useful for offices, and where street-lighting is carried out with a set of mains distinct from those of the general supply, these glow lamps might with advantage be employed.

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LEGAL INTELLIGENCE.

Hopkinson v. The St. James's and Pall Mall Electric Lighting Company (Limited).

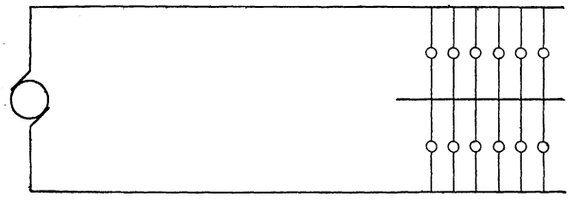
THURSDAY, NOVEMBER 3RD.

On the hearing of this case being resumed, Sir H. DAVEY made an application to introduce further evidence not mentioned in the particulars of objection. This related to several alternating current machines constructed by Messrs. Siemens. These machines were wound with independent circuits expressly for the purpose of such circuits being used in series in connection with three main conductors and lamps arranged in the same way as described in Fig. 5 of the plaintiff's specification (*see The Electrician*, November 4th, p. 7). One of these had been used by a person named Andrews, who was formerly in the employ of Siemens, and afterwards in the employ of the National Electrical Company of Glasgow, and the machine was used by the National Electrical Company of Glasgow for some considerable time.

Sir RICHARD WEBSTER opposed the application, and after some discussion,

Mr. JUSTICE ROMER decided to allow cross-examination to be taken without prejudice.

Dr. JOHN HOPKINSON, examined by Sir Richard Webster, said that he had devoted his attention for many years to the study of electric lighting, and took seriously to that class of work about 1878 or 1879. It was almost a part of his everyday business to keep himself as far as possible *au fait* with what was going on. Up to the end of 1879 or the beginning of 1880 electric lighting was always carried out by means of arc lights The arc lights were either single lights or else coupled in series. There was one exception, that was the Wedermann lamp and lamps of the same class, in which the carbons were kept actually in contact. When more lamps were put in, the potential would require to be raised in proportion to the number of lamps. With a number of incandescent lamps the current was distributed between them, and the object to be attained was to get the pressure the same at the beginning of each. By the aid of a diagram the witness then explained the matter to the Court. As a matter of fact some of the lamps being farther away from the generating station than others altered the pressure to a certain extent. A device to get round this difficulty was to take a separate conductor from the generating station, and allow that conductor

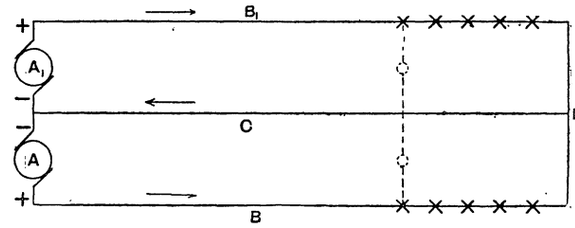


J. H. 2.

to feed in at different parts of the circuit. It was that variation of potential which occurred at the lamps at a distance from the generating station that led witness to devise his indicator referred to in the first claim. There was an advantage in using high voltage because one was able to transmit a given amount of power with smaller conductors. It was very early the object of effort to discover how to reduce the size of the conductors. Copper was a serious item in electric distribution. It ran already into many thousands of pounds in London alone. Practically speaking, glow lamps could not be made for more than a certain voltage. Looking at diagram marked J. H. 2 (*see* Figure), witness said that it represented one of the devices to enable less copper to be used, and at the same time to get a high voltage. The purpose of the third wire was to get all the lamps independent of each other as far as possible. The objection to the J. H., 2, system was that supposing they turned out one of the lights of the first group they then had too much current on one side and too little on the other. [A working model, illustrating the matter, was then put in and worked by Mr. Belfield, of the Westinghouse Company.] To make the system in question work, it was absolutely necessary to maintain absolute equality of the two sides; nevertheless, it was very largely tried. The model having been altered to represent the three-wire system, witness said that in that case the existing third wire was brought back from between the series of lamps to between the two machines. Two dynamos were substituted for one, and were connected in series. [The whole system was then explained at great length by aid of diagrams and hydrostatic analogues.] Witness was not aware of any user of the three-wire system prior to the date of his specification, though three wires had been used in connection with duplex telegraphy, which had no bearing on witness's invention. Three wires had also been used in connection with a common return in electric lighting. [A diagram marked J. H. 6 (*see* Figure), was then handed in, and the witness was examined in reference to it.] The dynamos A and A_1 were plainly not in series. There was by that arrangement no saving in copper, since the middle conductor C was merely a common return to the two outer conductors B and B_1 and had, therefore, properly to be double the size of either of them. There was also the objection that the machines were liable to reversal. Examined next in reference to the second claim of his patent, witness said it was essential to his system that the two dynamos should be placed in series. The defendants carried out the three-wire system precisely as above described. He had not, however, seen anything of the defendants infringing his first claim. [Witness next described to the Court the various devices, including his own, for ascertaining at a generating station the exact pressure at a distant point on the system.] The aim of his invention was to dispense with the pilot wires, and from an examination of the condition of a conductor at the station itself, to inform the engineers what was happening at a distant point. The drawing and the letterpress would enable a competent workman to construct this improved voltmeter. The witness stated that he had carefully examined the six anticipations which were enumerated in paragraph 6 of the particulars of objections, and was of opinion that none of the apparatus would do unless modified to a certain extent, and the application was absolutely and completely distinct.

Cross-examined by Sir HORACE DAVEY,

WITNESS stated that the three-wire arrangement was for the purpose of enabling two lamps to be used in series on a parallel system, so that every lamp could be turned out independently of every other. The system was applicable to arc lighting in the sense that one could use it, and did now use arc lamps in parallel upon the system. Arc lamps were really used as an accident to incandescent systems, though no doubt a saving of copper would be obtained.



J. H. 6.

Sir HORACE DAVEY: Now will you tell me anywhere in your specification in which you have pointed out or stated, or in any manner told the public that your system is to be used with incandescent lamps only? I do not find any or else I would put them to you.—I do not know whether it does or does not, really.

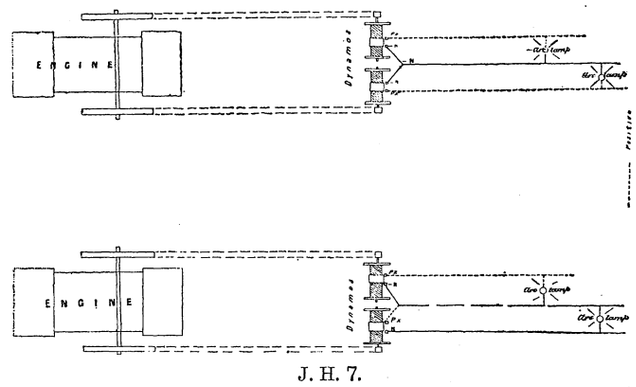
Sir HORACE DAVEY: If my learned friend can refer to any passage in which incandescent lamps are referred to I shall be glad.

Sir RICHARD WEBSTER: As you ask me to do so, I will refer you to page 5, line 20; but there are several other passages.

WITNESS: Yes, there it is: "When special circuits are required for specific purposes, or for charging secondary batteries, or for arc lighting, in addition to the ordinary incandescent lighting."

Sir HORACE DAVEY: But that relates to the first part of your invention. I now take it that from the beginning to the end of the description of the three-wire system in this specification there is no mention of incandescent lamps.

The Witness was next examined with regard to the system by which two circuits are used with a common return. He admitted that if the polarity of dynamo A in J. H. 6, were reversed and two lamps placed as shown by the dotted lines, these lamps would be in parallel on the united circuit, and if similar pairs of lamps were similarly arranged elsewhere on the circuit, the arrangement would be tantamount to the three-wire method. If, however, the lamps so placed were arc lamps, there would be no particular advantage gained, and, indeed, as compared with the ordinary series system of arc lighting the amount of copper used would be large. Moreover, he very much doubted if in 1882 there were arc lamps which would burn economically in parallel; his impression was that such lamps were a recent improvement.



J. H. 7.

Mr. JUSTICE ROMER: Let me ask a question so that I may understand. Suppose your system was applied to arc lighting. What do you say; would it be useful for that? Do you say it would not be useful?—I say it would not be useful in comparison with other ways of doing the same work. It would be useful in comparison with a system in which you have the whole of the arc lights arranged in parallel, but that was not the usual way of arranging arc lights at that time. The almost universal custom was when more than one was used to arrange them in series.

Witness was next examined with regard to the installation put up by Mr. Crompton's firm, and worked for many weeks, for the purpose of lighting the Alexandra Palace in 1880 and 1881 (*see* diagram J. H. 7, of the connection of this installation).

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After explaining the meaning of the diagram to the Court, witness stated that supposing that it was proved to the satisfaction of the Court that that was what was done for the purpose of lighting the Alexandra Palace in the winter of 1880 and 1881 it would not be an anticipation of his three-wire system. It would not be within the claim at all. Because there were here no lamps in parallel and the dynamo was unsuited for working lamps in parallel at all. The Alexandra Palace network, moreover, was not a system of distribution, *i.e.*, a system in which you supplied a current to a diversity of consumers. It was perhaps a system of supply to various points.

Sir HORACE DAVEY: Is it or is it not an essential part of your patent that there should be feeders separate from the supply wires?—No, but it is essential that the system should be such that feeders would be applicable to it.

Witness was then examined at length upon his specification, and stated that it was not necessary to have the third wire of the same dimensions as the two leads, though it would be equally a third wire if it were the same dimensions; but they would not then realise the full advantages of the invention.

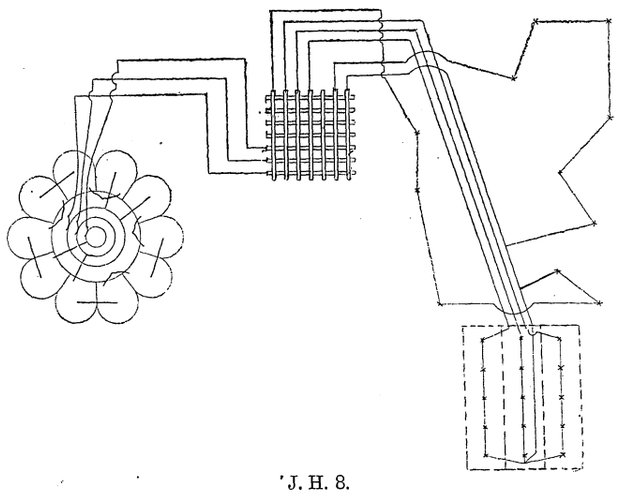
At this point Sir HORACE DAVEY addressed his lordship with regard to an affidavit of Mr. Curtis Hayward, solicitor to the defendants, with regard to the introduction of fresh evidence of anticipation.

Sir RICHARD WEBSTER submitted that the affidavit was wholly insufficient for the admission of the evidence, at any rate in that stage.

In conclusion it was decided that Sir Richard Webster should be given particulars of the objections.

Dr. JOHN HOPKINSON recalled and further cross-examined by Sir HORACE DAVEY at great length with regard to the equivalence of a single arc lamp to several incandescent lamps and the utility of the common return in an installation such as that at the Alexandra Palace.

Sir HORACE DAVEY: Supposing I had two arc lamps in series on each part of each division, and put out one, then would not it operate?—What would happen then would be that you would get a greater current on the side on which you had one lamp, and you would get a greater current passing back again down the middle conductor, but again would have a worse arrangement than if that middle conductor were not in use because you would have the lamp with such an excess of pressure upon it that it would burn exceedingly bad.



J. H. 8.

My witnesses do not agree with you there; they think it would be highly beneficial.—Well, I am sorry.

There is nothing for my learned friend to laugh at. I am instructed by gentlemen of position, who will be called before your lordship, who do not agree with Dr. Hopkinson. It is not a crime not to agree with Dr. Hopkinson. Now I will ask you this: It is desirable, I think you told my learned friend, to increase the electrical force in your mains?—Yes, on account of being able thereby to diminish the size of the conductors.

In point of economy?—Yes.

And by the use of this third wire system with arc lights you do get that advantage?—You get no advantage as regards economy in comparison with burning two lamps in series without a middle wire at all.

Will you point out any other place in the specification where you confine your third wire system to lamps or electricity consuming appliances arranged or parallel?—Yes, you put me on the whole specification.

Show me where it tells the public so?—To begin with you have a fixed potential in the very first two lines of the specification.

But that is the regulator?—Undoubtedly, it is a part of the patent.

Is there any mention of the parallel arrangement there?—No, but it is absolutely implied by the fact that you have to keep a constant pressure.

It is implied by the fact that you have to keep a constant pressure and that is all you would say.—I say it is absolutely implied and will not apply to anything else, and was never intended to apply to anything else. I say the words I there use imply a parallel system and they are not applicable to a series.

Do you suggest to me that you cannot use lamps in series on a fixed voltage system?—No, nobody ever would use them so. The two systems are broadly distinct and the words used here all the way through this specification are applicable alone to a parallel system and are not applicable to a series system.

There is no direction in your specification that when alternating currents are used in this way the dynamos are to be rigidly connected, or to have a common axis?—No, nothing whatever.

Did you ever have any experience prior to the date of this specification of any person having worked two or more alternating dynamos in series?—I do not know that I have.

Can you refer me to any text-book or paper on the subject that I can refer to showing that it was common knowledge that alternating dynamos should be coupled rigidly?—I do not know that I can; but I do know that when there were two alternating current dynamos used for the purpose of lighthouse illumination in order to give you a double current they were rigidly connected.

And your patent does not contain any direction for the use of mechanical gearing where two alternating dynamos are to be coupled in series?—No, it does not. I never dreamt of putting it in.

Supposing you have two alternating dynamos coupled on the same common axis, that is, in fact, the same thing as one dynamo double wound.—Yes, it comes to the same thing.

The Inchicore system was made by Messrs. Siemens, was it not; and in that system you have one dynamo fitted with two coils, and that would be the same thing as two dynamos arranged in series? Assuming this to be a correct diagram (*see* accompanying figure, diagram J. H. 8) of the Inchicore machine, do you not find in this machine a third wire system similar to yours?—You find a third wire going up to the switchboard, and then on the switchboard you have not indicated what the connections are to be.

Does not that outside wire going from the switchboard perform the office performed by your third wire in your specification?—No, not strictly speaking.

It would operate as a means for carrying off excess or supplying deficiency?—Yes, exactly the same as before—that is to say, in my view, at all events, it would act injuriously. There is another advantage which is secured by the presence of that wire, and that is, that you can burn five lamps, and leave the other five lamps out without going round to turn them off.

Assuming that in the opinion of the Court your specification, according to its true construction, is applicable to arc lights, and applicable to lamps arranged in series, is there any difference between this diagram, supposing it to be a true diagram of the Inchicore installation and your specification?—Assuming that my specification applies to this arrangement in which any utility is totally different from that which I intended, that would be so.

WITNESS was next cross-examined as to whether the mutual induction of the two coils of his regulator-galvanometer and the induced Foucault currents in the core would not when used on an alternating circuit interfere with its working. Witness thought practically not, but stated that he had not tried the matter experimentally. As a matter of fact, the Westinghouse Company used it themselves, though not pure and simple. He was not aware of any at work without improvements. He was not, indeed, aware of any place in this country where it ever had been put into operation. The essential feature of his regulator was the employment of a differentially wound indicating or regulating apparatus, so connected to the conducting wires from a generator of electricity to a distant place as to indicate when the difference of potential between the two conductors leading to such distant place deviated from an assigned value at that distant place, or to regulate the electricity producing machinery in such wise as to maintain a constant difference of potential at a distance from the place of supply, or generation of the current. The existence of series and shunt coils in one apparatus was already well known for the purpose of regulation. Abdank had proposed the combination of those two coils for a totally different purpose. If they used Abdank's instrument as he intended it to be used it would not answer the witness's purpose. If they used the witness's instrument in the way Abdank intended it to be used it would not answer the witness's purpose. The regulator certainly would not require improvements to work either with continuous or alternating currents, but for alternating currents it was convenient to make some improvements in it.

After re-examination by Sir RICHARD WEBSTER, the Court adjourned until Friday.

FRIDAY, NOVEMBER 4TH.

On the Court resuming the hearing of this action, Dr. JOHN HOPKINSON was recalled and further re-examined by Sir RICHARD WEBSTER.

WITNESS stated that, speaking of his specification as directed to a workman, it would not lead the workman to establish a system of arc lighting without incandescent lights. Arc lamps might be used in parallel as an incident, but it was very difficult to use them on a parallel system. As described to an electrician, there was in his invention a distribution of the current amongst different consumers. In 1882 the regulators of arc lights were not sufficiently good to enable them to run in parallel in a really satisfactory way. Until very recently a very considerable resistance had to be added to each arc light in order to keep it steady; but the regulators of late had improved so much that the resistance might be reduced to a comparatively small amount, even to-day no one would for choice run arc lamps in parallel. If one only required to have arc lighting one would not get the advantages which were mentioned in his specification, and even to-day when a large number of arcs were required, people always put down special plant for running arc lights in series. It would be absolutely clear to anybody that every one of the lamps in Fig. 5 of the specification was intended to indicate an incandescent light. The bulb and the continuous filaments were shown in every case. In diagram J. H. 7, assuming that both arc lights were burning there was no advantage in the lower sketch in the middle wire. There was no difference in the wiring between J. H. 8 (Inchicore) and J. H. 7 (Alexandra Palace), except that in Inchicore there were five lamps in series as distinct from one lamp in J. H. 7. The middle wire in J. H. 7, was only of use if one wished to burn only half the lamps.

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One of the merits of his invention was the great saving in copper. The use of the middle wire in J. H. 7, saved no copper at all, unless they took it as being equivalent to putting in two circuits instead of one. As to feeding mains on a simple arc system, he did not see how they could get them in. The title of the patent was "Improvements in distributing and measuring electricity, and in apparatus to be employed for that purpose." Nobody would describe an arc system as a system of distributing electricity.

LORD KELVIN was then sworn, and examined by Mr. ASTON: Witness stated that the title of the specification "Improvements in distributing and measuring electricity and in apparatus therefor," would convey to him the meaning "of causing to diverge into different groups the electrical energy supplied from a central station by mains." At the time of the inquiry before a large Committee on electric lighting, in 1879, it was shown that there was then a great want for what was called the distribution of electricity. The arc light was the only kind of electric lighting that was known at the time, and many questions were to put to various witnesses as to discoveries that could lead to the distribution of electricity. It was rumoured that Edison had such a discovery, but to the best of his recollection nothing definite regarding it was put before the Committee. The text of the specification, coupled with the drawings, described the three-wire system with perfect clearness and without any ambiguity of any kind, As regards the regulator, witness was of opinion that the directions with regard to its use with alternate currents were quite sufficient. In his opinion the three-wire system as described by Dr. Hopkinson in his specification was certainly new in July, 1882, and very useful indeed. It really made the difference between electric lighting being possible on the low-pressure alternate-current system, and almost impossible on account of the expense for copper. Mr. Abdank's invention and specification did not disclose anything that could lead towards the achievement of the object of the first part of Dr. Hopkinson's invention.

Cross-examined by Mr. FINLAY, Q.C.,

Witness stated that the multiple-bridge system of course was not part of the invention. The merit of the invention was the application of a third wire to a point intermediate between the positive and negative extremes of two dynamos in series.

Mr. FINLAY: Is not what you regard as the merit of this invention, the application of a third wire, connected in the same way as in those two diagrams, the Inchicore and the Alexandra Palace, to a system of multiple arc lights?—It could not have been of any practical use in a system of multiple arc lights, because multiple arc lights would naturally be put in series.

Is it not substantially the three-wire system as in this patent?—It is the three-wire system applied to two arc lamps.

Let me suggest what is put to me as one advantage of the third wire as applied to arc lamps. If you had two arc lamps in series in the way delineated there, not being provided with shunt regulators, would not the application of the third wire enable those two arc lamps to be burned in series when they could not have been burned in series without it?—Yes, I think it would.

That is to say, that the application of the third wire in that way would dispense with the necessity of the shunt regulator in the arc lamp?—It would dispense with the necessity for a regulator by which the circuit might be broken through an arc lamp.

In continuation of his cross-examination, witness stated that the use of the third wire in application to such a system with two arc lamps in series might affect a considerable saving if the distance were considerable, but the saving would be less appreciable with more lamps on. The third wire would only be an encumbrance for such a case as 10 arcs in series. Gülcher had a large dynamo that was intended to run in parallel, and if he had a lamp fitted for it it was probable he had an appliance by which they could be got to run parallel, but nobody in their senses would dream of using such appliances in connection with arc lamps either then or now, unless a number of arc lamps had to be placed on a circuit already provided for incandescent lamps. As to the Crystal Palace parallel circuits, unless the lamp were very close to the dynamo they would be very uneconomically arranged. He did not wish to say anything against the machine, only he must say nobody in their senses would dream of arranging a large distant circuit of arc lamps on that system.

Re-examined by Mr. MOULTON: Supposing that you take the system shown in Fig. 5 of the specification, and supposing instead of that incandescent lamp a couple of arc lamps were put in series, would that system be the system seen in Inchicore or in the Alexandra Palace?—No, I think not.

Would it still be a system of parallel bridge?—It would be still a system of parallel bridge.

Further cross-examination by Mr. FINLAY: If you are working on a system of alternating currents, would not the effect of that arrangement with alternating currents be this, that the current in the thin wire of the regulator would set up in the thick wire by mutual induction a considerable current?—Quite an infinitesimal current relatively to the whole current of the thick wire; but infinitesimal, or not infinitesimal, it would be allowed for when the adjustment is made by the experimental method which, in line 10, page 5 of Dr. Hopkinson's specification, is said to be the more practicable method. The experimental mode of adjustment would meet all the mutual indirections to which reference has been made.

Mr. MOULTON: You have had very great experience in galvanometers, differential and otherwise, have you not?—Yes.

In your opinion, are the directions sufficient to guide a workman, whether he is making it for an alternating system or a direct system?—Yes.

The next witness called was Mr. REGINALD BELFIELD, of the Westinghouse Electric Company, who was examined by Mr. ASTON.

Will you look at the diagram which has been put in marked J. H., 7, do you find there an employment of the three-wire system described in the patentee's specification?—No, I do not.

Why not?—Because there are no lamps arranged in parallel there. Everything is in series.

Witness concurred with Dr. Hopkinson and Lord Kelvin in regard to the inutility of the third wire in the Alexandra Palace installation, and on other points. He agreed with the statement made by Lord Kelvin that the directions given in the specification, in the general terms in which they were given, were sufficient with regard to the use of alternating currents. He saw no application of the three-wire system at the Crystal Palace Exhibition in 1882.

Cross-examined by Sir HORACE DAVEY.

WITNESS stated that the double-coil armature of the Inchicore dynamo differed from the pair of dynamos referred to in the specification, because in the pair of dynamos referred to in the specification each dynamo could be separately regulated, and one could therefore preserve a constant difference of potential at the lamps.

Sir HORACE DAVEY: If I made a draught upon your imagination and asked you to imagine an installation in which there were six houses lighted, or a dozen houses lighted—six in each division, as in Fig. 5—suppose all the six houses in one division put out, and suppose five of the houses in the other division are not burning. Then the current would pass through only the lamps of the house in which the light was left burning, would not it?—Yes.

And after passing through that it would all go down the third wire?—You would simply have a two-wire system then.

Mr. JUSTICE ROMER: Just answer the question. You see you are here to give assistance to the Court. You must not be too much of a partisan.

Sir HORACE DAVEY: The Westinghouse Company are proprietors of this patent?—Yes, I believe so.

I am not making any complaint of Dr. Hopkinson being plaintiff; I am very glad to see Dr. Hopkinson at any time, but all the beneficial interest in this patent is vested in the Westinghouse Company, in which you hold the position of head electrician. Now this state of things would be exactly what you have described with reference to the arc lamps when one arc lamp is left burning in one division, and all the other arc lamps in the other division are put out, would not it?—Yes.

Can you tell me any instance in England where the regulator has been used?—Yes, at Sardinia-street, Lincoln's Inn-fields.

Is it used exactly as it is described in the specification, or with additions?—It is used in a modified form. A transformer has been put in to reduce the voltage to allow it to be worked conveniently, and instead of the two coils being wound on the indicating device, it is there wound separately on a smaller transformer and the indicating device is separate.

Did you make those additions?—No, Mr. Shallenberger, the Chief Electrician of the Westinghouse Company in America, made those additions, and I experimented with them and found them successful.

In every place where it has been put up in any of the States it has been with those additions?—Yes.

Mr. Schallenberger, I think, took out a patent for his additions that you have mentioned, did not he?—Yes. An English patent.

I have been told—I do not know whether that is correct or not—that dividing the iron core would get rid of the Foucault currents but not get rid of the induced currents?—All I can say is that as far as my experiments went we never had any difficulty with that at all.

I think this is the first action you have brought on the third-wire system?—It is.

But we are not the only persons who use the third wire without paying royalty?—Well, no, I think there are other people who are using it. I think that you are about the first we have heard of who are doing it and who are not paying royalty.

Re-examined by Mr. MOULTON, witness stated at the date of the patent transformers were not used as a means of distribution. It would not be convenient to use a thousand volts in a differential instrument.

Mr. JUSTICE ROMER: In other words, the modifications or additions you speak of were only to meet some special circumstances?—To meet special circumstances.

Continuing, witness said that he did not consider in the case of distribution by parallel arc the case of all out on one side and all alight on the other worthy of consideration.

Sir FREDERICK BRAMWELL was the next witness called, and was examined by Mr. HOPKINSON, Q.C. Witness stated that the suggested anticipations in the case did not solve the problem of cheap electrical distribution. When they had a series system, the third wire was no use as long as the whole concern was working. In his opinion the regulator was a useful invention, and could be adapted to an alternating machine.

Cross-examined by Sir HORACE DAVEY: With all your great acquirements, Sir Frederick, I take it that you are not yet an electrical engineer?—Well, I thought I was.

Is it within your knowledge that in South Kensington the arc lights in large number are arranged in parallel on the system?—Yes, I do not think in large number, but it is within my knowledge that arc lights are arranged in parallel on the incandescent lighting system—on the three-wire system.

After re-examination by Mr. MOULTON, the learned JUDGE intimated that he would at that stage like to hear the argument of plaintiff's counsel on the question of construction of the specification.

Sir RICHARD WEBSTER: A suggestion has been made, which took the plaintiff's advisers by surprise, that the specification can be construed as enabling a person to make a system of arc lighting, and to include in the claim a claim for the system when applied to arc lights in series. We had no reason whatever to anticipate such a point being raised for the defendants. Now, we contend that upon the true construction of this specification it would be unfair to the plaintiff to construe it as pointing to arc lighting alone, or including in the claim a claim to using his system alone with lamps in series.

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Mr. JUSTICE ROMER : The point is—does it cover, that is include, in the claim a case in which there are nothing but arc lights.

Sir RICHARD WEBSTER : If it means that an arc lamp may be substituted for an incandescent one, then we do not dispute the proposition. We contend that the only point is whether it covers a claim to series lighting, whether by arc lamps or any other which are not arranged in a multiple parallel bridge. The distinction is not one between arc and incandescent lamps, but between an arrangement in parallel or in series. We protest against the specification being construed so as to include "series," as distinguished from "parallel." We must go back and read the specification as it would be read in 1882 with the knowledge men possessed at that date. Remember what the evidence on this point is—that series lighting by arc lamps was well known. It is not suggested by Sir Horace Davey that anyone would speak in 1882 of an arc light system being a system of "distribution." That term meant that the current was "distributed" in being led from one conductor to another. To determine the nature of the invention, we must look at the provisional specification. Its title reads as follows:—"Improvements in distributing and measuring electricity, and in apparatus to be employed for those purposes." It must be both distributed and measured. The evidence is to the effect that no competent electrician would have spoken in 1882 of an arc series as being a system of "distribution." The specification continues—"My improvements principally relate to maintaining the electromotive force on a system of conductors for an electric supply at a fixed potential." Here the patentee tells the public that his improvements relate to maintaining a "fixed potential," one does not desire and cannot have a fixed potential with lights arranged in series.

Sir HORACE DAVEY : You cannot use the provisional specification for construing the complete.

Sir RICHARD WEBSTER : Yes ; in *Bailey* v. *Robertson* it was decided by the House of Lords that one must look at the provisional specification to ascertain the patentee's intention. I never sought to use it for interpreting the complete. But I am entitled to say this : If the provisional has one ambit, and the complete a wider one, the patent may be good for the narrower ambit. It was so decided in *Bailey* v. *Robertson*, and that proposition has been good law ever since. For 50 years we have been told by the House of Lords to refer to the provisional specification for the nature of the invention. But as Sir Horace objects I shall go to the complete specification, reserving my right to refer to the provisional in reply. I will refer to the same language in the complete. But I submit that when the other side try to say that the complete means something else, then you are bound to refer to the provisional. No electrician can say he would read "conductors for an electric supply at a fixed potential" as referring to arc lighting. In a series system of arc lighting there is no fixed potential, in a parallel system of incandescent lighting, there is a fixed potential. But to continue : "When electricity is delivered by means of a pair of conductors to a distance from the station where the electricity is generated, there is a fall of potential due to the resistance of such conductors greater as the current is greater, and if it be desired to maintain the potential constant at the delivery end, it is necessary to increase the potential at the supply end, as the current increases, in a suitable manner." These remarks cannot possibly apply in arc lighting. In the multiple bridge system the more parallel bridges there are the larger the current required at the same potential, whereas in arc lighting the contrary is the case, the same current is required but a higher potential when more lamps are added on. Further down in the specification we read that the engine is to be regulated "for the purpose of keeping the potential on service main conductors constant." Now, no fair-minded electrician in 1882 could for a moment suppose that this expression referred to arc lighting. Nay, we go further. There is no book which contains any statement to support such a theory as that contended for by the defendants; their particulars of objection contain no reference to this matter. Now, however, they avail themselves of the fact that owing to recent improvements, long since 1882, arc lamps can be put on a parallel system. In describing how the cost of conductors is to be saved, the patentee says he places the two systems of "lamps or other appliances consuming electricity of approximately equal capacity also in series." Here he means that the quantity or volume of current required by the lamps on one side of the middle wire should be approximately equal to that required by those on the other side. The writer continues : "A main conductor is taken from each extreme pole of the two dynamos, and a smaller conductor from between the two dynamos to points between the two systems of lamps." He here indicates that it is to be joined to various points, more than one, and therefore cannot cover the case of a simple series of arc lights. Omitting the description of the voltmeter, further down we come to this passage : "For each machine I provide a pair of feeders of a size appropriate to the current they are to carry, but independent of the distance they have to go. Each pair of feeders goes to, and is connected to some part or other of the system of distributing mains, and by the use of my invention I am able to keep the difference of potential constant at, or near, the point where the feeders join the distributing mains." We do not hesitate to say that in 1882 the use of "feeder" conductors to arc lighting systems was unheard of, and, indeed, was an absurdity. Why are they used now ? To take energy without draft to where it is required to be used. Applying to that passage ordinary electrical knowledge (eliminating from consideration the improved arc lamp, which can be substituted for an incandescent one in a multiple parallel bridge), we say it cannot possibly refer to anything but the multiple parallel bridge. But that is not all. "By using a sufficient number of feeders I am able to keep the potential throughout the distributing mains very nearly constant, however the consumption may vary, without requiring conductors of excessive size"—a passage which is all absurdity if applied to arc lights. No one would even think of "feeding" a "series" system. There is only one reference to arc lighting in the specification, and that is where the patentee refers to Figs. 3 and 4, and writes : "When special circuits are required for specific purposes, as for charging secondary batteries, or for arc lighting in addition to the ordinary incandescent lighting." Again, "The intermediate conductor may be of much smaller dimensions than either of the other two, as it has only to carry the difference of current consumed by the two divisions of consumers." There can be no "difference of current" in the case of arc lights arranged in series. The three-wire system is referred to as being shown diagrammatically in Fig. 5. I hope for the sake of his reputation that there is no electrician in Court who would say that Fig. 5 could possibly refer to arc lighting. Every lamp in that diagram is connected only with two of the three wires. The only possible way of making it include arc lighting is to take out an incandescent lamp and put an arc lamp in its place. That, however, would be within the meaning of the patentee. Anyone who puts an honest construction on this specification must say it applies only to the multiple parallel bridge. The improvements which are disclaimed also support our view. The meter is quite immaterial if we are dealing with arc lighting, also the switch. In fact, if honestly construed, there is not a line in the whole specification to support the defendants' contention. The fact that at the present date there is an improved arc lamp which may be substituted in the multiple porallel bridge for an incandescent one has, of course, nothing to say to the point now under discussion.

Sir HORACE DAVEY, Q.C., then opened the case for the defendants. As to this question of construction of the specification, the plaintiff's counsel say they were taken completely by surprise. That is a mere rhetorical argument. Sir Richard himself read the particulars of objections, and his clients have seen the installation at Inchicore, hence they must have known what the defendants intended to say, and will say, is the true construction of the specification. Whatever Dr. Hopkinson may say, or whatever may be the most useful mode of applying this invention, or whatever meaning he intended to attach to this specification, there will not be found a single phrase or word in the whole of it pointing to its being confined to incandescent lighting or the parallel system. On the other hand, it is apparent from the language the patentee has used that he intended to include within his net "all lamps or other appliances consuming electricity." There is not the slightest hint of its being confined to lamps of a particular character ; on the contrary, we are told it is applicable to any system or appliances which consume electricity, including within that description, of course, "any lamps." We submit that the language of the specification is such as would enable him to sweep into the ambit of his patent the three-wire system when used in connection with arc lighting as well as the incandescent multiple bridge. What would have been easier than to say what the patentee now alleges he meant to say. No doubt he intended to include all applications within his patent, although in the case of the multiple arc of incandescent lamps there is more benefit to be got from his invention than in others. Now assuming, for the sake of argument, that we prove that the defendants in fact used the three-wire system with arc lamps and with arcs in series, what was there to prevent them from applying a well-known mode to another system ? Sir Frederick Bramwell said in the box that they would have to make certain material alterations, but they would have to do that in adopting the incandescent system. How could the patentee prevent them from doing that which they could, apart from his patent, have done before ? They have it for arc lamps and use it, they then change to multiple parallel bridge, they alter their conductors without the plaintiff's aid, they already have the dynamos, conductors and three wires. If my friend's contention is right as to construction of specification, then the objection is really want of subject-matter. The plaintiff's patent would prevent the defendants from changing their mode of lighting as they might otherwise do, and all the world knew how to do. The plaintiff, in fact, says : "I have taken out a patent, you cannot therefore make that change!" which is after all only telling the defendants the most useful way of employing the three-wire system which they already had. Now we shall criticise the language of the complete specification a little more closely, when it will be seen that, from inadvertence no doubt, the patentee now gives it a meaning that it will not bear. One is surprised to hear from an ex-Attorney General that one could use a provisional specification, when there is no question of nonconformity, to aid the Court in construing the complete.

Mr. JUSTICE ROMER : He meant that when you are in doubt as to the meaning of the complete you are entitled to look at both together, to ascertain the real meaning of the complete and narrow it. He never said this could be done when both were clear.

Sir HORACE DAVEY: The provisional specification describes the nature of the invention and the complete the way of carrying it out. Now that I have read the provisional more carefully, I do not think it carries it any further. There is no difference between the two. Plaintiff's counsel suggests that "distribution" has a technical meaning confined to the multiple parallel bridge. It is a well known word in the English language, and the plaintiff used it just as he pleased. In the claim he makes it synonymous with electrical supply, he advisedly used larger language in order to draw as much fish as possible into his net. The specification commences with the passage already read by my friend, which relates to "maintaining the electromotive force. . . at a fixed potential," and to "reducing the cost." Now it may be that there are two distinct inventions, one for regulating or indicating the potential, or difference of potential at distant points, and the other for reducing the cost of conductors consistently with efficiency and safety. This is an odd argument. You only want to ascertain that the potential at the lamps is equal in the case of the parallel arrangement (conceding that for the moment), *ergo*, says my friend, the first part of the invention will only apply to the parallel arrangement, *ergo* the second part, which is equally applicable, is applicable now only to the parallel arrangement. That is my paraphrase of his argument. We deny that in 1882 the instrument described for ascertaining the potential would only be useful for the parallel system, and that the

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parallel system *only* can be meant. A person may mention an instrument for one purpose, yet it may be useful for another, namely, to measure the potential at a distant lamp in an arc series also. If anyone so employed it it would be covered by the claim. The patentee makes a claim for the regulator itself, and not merely for the use of it. The term "conductors for electricity" cannot, therefore, be cut down to refer to one class only. My friend says that the term "such conductors" must mean only those with a fixed potential. That is not the context, and it may be read the other way. There is nothing which confines that expression to electric supply in a parallel bridge. The words disclaimed refer to an arrangement for disconnecting the dynamos from the conductors. No one could pretend that it referred only to a parallel system, for it is equally applicable to every conductor and dynamo. The patentee describes an instrument, which seems a very efficient one for measuring quantity of current in any system of conductors. That is the very thing that is wanted in a series system. Next the differential galvanometer which he describes is the first invention; the two are perfectly distinct. The regulator for measuring potential may be usefully employed for other systems as well, although they say it is only useful now for a parallel system. What is claimed, however, is the instrument itself, apart from its application to any system. Now to consider the second invention. Edison's lamp was invented in 1879, and Swan's in 1880. Two years afterwards their value was appreciated, and incandescent lighting became a practical success, so that when this specification was written, men's minds were only beginning to be directed to the subject of incandescent lighting. The best known, and till then the only system, was that of arc lighting. If the patentee was going to tell the world this, "Incandescent lighting is only now a success, I am now going to give you a means of lighting by incandescent lighting in parallel or multiple arc, which will apply Edison's invention to a practical and particular use," he carefully abstains from confining it to what it is now alleged to be confined to, but speaks of it in connection with "other appliances." He goes on to say, "For the purpose of economising the cost of main conductors," not in a parallel system of incandescent lighting, but "main conductors," used in its largest possible sense. And then continues, "I place two dynamo machines in series, and I place two systems of lamps," not "two parallel systems," but "two systems of lamps," and so sweeps in every lamp, not to speak of "other appliances," which are to be placed "also in series." We say this specification is not confined to the parallel system. If we cannot contend that then we say it is bad on the ground of ambiguity. All we are told is that the lamps are "also in series." That would include all the rungs of the ladder. What is there to confine it to one rung only? Again, "A main conductor is taken from each extreme pole . . . and a smaller conductor from between the two dynamos . . . serving to bring back to the central station any electricity required for one system of lamps in excess of that required for the other." My witnesses will say that this passage is equally applicable to one system as well as to the other.

At this point the Court adjourned until Saturday.

SATURDAY, NOVEMBER 5TH.

Sir HORACE DAVEY: When your lordship rose yesterday I was commenting on the language of the specification, because, after all, that is what we have to look at—the meaning of the patentee as expressed in the specification. I had just pointed out that the patent is not confined to two systems of incandescent lamps, or two systems of lamps, but applied to other appliances such as for example electro-motors. I had pointed out that the patentee, although he mentions that the lamps are to be in series, does not mention that they are to be a part of a parallel arrangement. Suppose electro-motors were placed in series, and it is required to do a particular amount of work or "load," let one motor be 2 H.P. and the other 1 H.P., the third wire would conduct the extra current. Such a case as that comes clearly within this passage of the specification, it is not at all confined to incandescent lighting. The real truth is, which we concede, that the patentee had chiefly in his mind the case of incandescent lighting; but like many patentees—in fact, like most—he has endeavoured to make his claim in such large terms as would comprise arrangements other than those he had in his mind. When one comes to attack a patent, the patentee on his defence seeks to put a narrow construction on his specification. If it were a case of infringement and a person used two electro-moters in series, such as I have described, would not Dr. Hopkinson say that it was an infringement of his patent? That question of infringement would not be arguable, for you would have in the words of the specification "two systems of lamps or *other appliances* consuming electricity of approximately equal capacity also in series." The specification continues: "More than two dynamos may be placed in series, and more than one intermediate smaller conductor may be used on the same principle as above described." With this passage this part of the case ends. So far as the general description goes and the "nature of the invention" there it ends, the part corresponding to the provisional. We submit that, so far, there is no reference whatever to its being confined to the parallel system alone. The next portion was struck out on amendment. We must now construe the specification as it stands. The patentee next goes on to describe his invention by reference to the drawings. He shows that his object is to keep adjusted the factor E−CR, so that the pressure at the houses be kept constant. The next paragraph describes the construction of the indicator or regulator, and the following one is important, for he says there "the application of this instrument to an *extended system* of electrical supply with a network of distributing mains is important." Lord Kelvin, in his evidence, seemed to infer that the word "distribution" had a technical meaning, and was to be confined to the case of incandescent lighting in parallel arc. We do not at all agree with that view. The word "distributing" was perfectly well-known to refer to simply bringing it to customers and consumers. To take a homely illustration—the milkman "distributes" milk in his morning rounds. He goes his rounds "in series." I am told that numerous examples can be shown in text-books of "distribution" being used in the wider, that is the popular, sense of bringing the supply to places where it is to be consumed. But it is not necessary to dwell further on this, for the patentee thought the narrower construction might be put on his specification by some people, so in his claim he takes care to avoid such a result. He there says, "electrical distribution *or supply*." No one suggests that the word "supply" is not wide enough. In fact Dr. Hopkinson, in his evidence, agrees with me that the word "supply" had no technical meaning. Next follows the description of the regulator, and as to its application the public are told, "When special circuits are required for specific purposes, as for charging secondary batteries, or for arc lighting in addition to the ordinary incandescent lighting, such special circuits may be prevented from disturbing other circuits," &c., that is to say, that when a particular use is to be made of this regulator it may be adopted or adjusted to meet the circumstances of that particular case. This passage relates exclusively to the regulator. It is idle to suggest that a passage relating exclusively to the first invention has any bearing whatever on the construction of words describing the second invention. Moreover, it shows that the patentee had in his mind the difference between incandescent and arc lighting, and the different conditions of each. If he has not, when describing his second invention, described it with reference to one or other system, there is cogent evidence that he wanted his claim to be as wide as possible. The patentee next goes on to describe with reference to the drawings of his second invention. We do not say that Fig. 5 does not represent a parallel arrangement. But he must in a diagram take an instance, either parallel alone, or series alone, or a combination of both. One cannot make a picture of a "general" case. It was the parallel arrangement that the patentee had chiefly in view, and therefore he showed it in the diagram. The question is whether the *words* of his description are not such as go beyond and include other cases besides the arrangement in the illustration.

Mr. JUSTICE ROMER: The question really is, Is the specification, according to its true construction, confined to the parallel system or not?

Sir HORACE DAVEY: If the patentee meant so to confine it, why should he not say so? Nothing would have been easier. For the purposes of illustration he gave the case of houses because that application of his system was clearly in his mind. Again, he says the intermediate conductor "may be," not *must* be, of smaller dimensions. We shall prove in our anticipation that it was, in fact, smaller, but the patentee merely shows he had a preference.

Mr. JUSTICE ROMER: They say that the middle wire only carries the difference of current, which is the main feature, and that in a series arrangement there is no difference of current to be carried. Enlighten me on that point.

Sir HORACE DAVEY: To that question I have three answers:—(1) Exactly the same observation applies to incandescent lighting. It is quite possible that all the lights be put out in one division. That may not be likely in a large system, but where it is applied to a small system it is quite possible. (2) It is not true with arc lights. The same thing occurs exactly as with the other system. (3) Arc lamps do not burn uniformly. The carbons tend to move apart, resistance varies, so that there will always be a small current in the centre wire. But for the purpose of construing this specification, I am not bound by the instance of arc lighting. Take any other electrical consuming appliances, say, electro-moters, one a 2 H.P., another 1 H.P., without the third wire the whole would go through both. The balance goes down the centre wire. No one will say that in the case of two motors this invention will not be very advantageous indeed. If it were so used would not the plaintiff at once say, "That is within my patent?" There would be no defence to such a case. He would point out that he confined his invention to all electrical consuming appliances—that Fig. 5 was only an illustration of its use with one such appliance. Indeed, heaters and cookers might take the place of motors. Such were known in 1882. There is no limit to the purposes for which electricity may not be used—lifts, &c. Can it be said that because it is most useful in one system of electric lighting that, *ergo*, it is confined to that system—the parallel system? The comic part of this argument is that my friends are taking pains to show it is not useful for a particular purpose, while we show it is. If arc lighting be held to be included, what is the result to plaintiff's case? The reply is too obvious to mention. They cannot show its want of utility in order to narrow its meaning. Now to consider the claim. With "electrical distribution or supply" I have already dealt. The plaintiff's counsel now read the rest of the claim in a forced and erroneous manner. It may be convenient for the patentee to attempt to narrow its meaning now, but the narrow construction is not one that can be fairly put, nor which the patentee would put himself were he wishing to restrain other infringers. Now as to the rest of our case. I shall prove that in the winter of 1880-1 Mr. Crompton's firm had instructions to light the Alexandra Palace. Wishing to economise copper, they proposed to use two dynamos for two arc lights with a common return conductor. They found on working their arrangement that one dynamo "reversed" the other, so that they became in series instead of in parallel. Mr. Crompton then let them so act, and they worked very well. It was so worked for some months and then taken down. There were only two arc lamps. This invention was in that way hit upon by accident; it worked exceedingly well and gave considerable advantages in the way of economy. In the Inchicore anticipation a single dynamo with two coils on a single armature is used. This the patentee admits to be the same thing as two dynamos. [Mr. ASTON: Could *be made* the same thing.] It is the same as two dynamos coupled in series by rigid connection which is necessary in the case of an alternating dynamo. This machine was put up at Inchicore in March, 1882. It has been at work ever since and is used for arc lights in parallel. This case would clearly be an anticipation, if my construction of the specification is the correct one.

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In the particulars of objection we state that other similar machines were made and sold by Messrs. Siemens. One instance we will prove where the machine was used on board s.s. "City of Berlin." Within the last few days we have received intimation of another case of anticipation. The National Electric Lighting Company of Glasgow's Manager, Mr. J. Andrews, was duly furnished by Messrs. Siemens with a machine of the same character as the Inchicore one. The Company altered it in their own works, and instead of using it with arc lamps in series they used it in parallel with incandescent lamps. This is the anticipation already mentioned to the Court in connection with the amendment of the particulars of objection. It was so used for about 11 months before March, 1882. The Company not being very successful, was wound-up; the user of their machine was open to members of the public. We submit that if we prove Alexandra Palace and Inchicore cases we have proved enough. The new anticipation, if we go into it, covers the whole ground. But suppose that our construction of the specification is wrong and that my friends are right in saying that it is to be confined to incandescent lighting in parallel, then the question arises, Is that invention subject-matter for a patent? The plaintiff may have made a very useful discovery with regard to the advantages of its use with the parallel bridge, but not every discovery is a patentable invention. In the recent case of *Lane Fox* v. *The Kensington and Knightsbridge Company*, Lord Justice Kay in the Court of Appeal used the same argument, and pointed out that Mr. Lane Fox merely told people how to use one well-known thing in connection with another well-known thing. Here the three-wire system was well known. It was used with arc lamps. The parallel system was well known also, and the plaintiff only proposed to use these well-known things without change in connection with each other. We have the three-wire system known, know also how to change from arcs in series to incandescent lights in parallel—no change required in the three-wire system. We merely exercise our right of substituting incandescent lights in parallel for arcs in series. Then Dr. Hopkinson points out we shall gain a certain advantage. Is that invention? Is that subject-matter? He has nothing to tell us as to changing the three-wire system. I will *suppose* that Dr. Hopkinson knew (what we believe he did not know) that the three-wire system had been employed at Inchicore and the Alexandra Palace, and suppose, consequently, he said in his specification, "I am aware that the three-wire system has been used in such and such cases. Now, my invention consists," &c. Could any one suggest that it would be subject matter? Hence if the narrower construction be the correct one we say there was nothing left for Dr. Hopkinson to invent, and that his invention is not subject matter. On the other part of the case, as I have the book here, I may refer to *Harwood* v. *Great Northern Railway* (11, House of Lords cases, page 681), it is laid down that the proper test in such a case is to consider whether the anticipation set up would have been an infringement had it been done subsequently and not prior to the plaintiff's patent. There can be no doubt but that it would be an infringement for anyone to apply his system to arc lights or electro-motors. There remains one other matter. We also say that in addition to the points already mentioned the patent is void, on the grounds of (1) want of utility and (2) insufficiency of specification. I refer to the application of the invention with regard to alternating currents. The specification reads :—"The foregoing description of instruments relates more particularly to continuous currents, but it is obvious that the arrangements (Figs. 1, 2, and 5) are also applicable to alternate currents; but in that case the iron in the electro-magnetic apparatus must be so divided that local-induced currents are prevented." Now, if the patentee says in his specification that his invention is useful in cases A and B, and it fails in B, the patent is bad. The cases of *Reg. v. Cutter* and *Simpson* v. *Holliday* are in point. Foucault currents can be got rid of by dividing the core; I do not refer to them, but speak of the induced currents arising from the magnetic core, wound as the patentee describes, acting as a "transformer," and inducing currents in the adjacent wires. The existence of such currents is not denied by any of the scientific witnesses. Dr. Hopkinson and Lord Kelvin said it would not affect the working of the apparatus. Sir F. Bramwell said that these currents would be allowed for in adjusting the wires. Neither of those witnesses nor Mr. Belfield had ever tried it; they had no actual experience, their evidence is merely theory and opinion based on general experience and knowledge. Mr. Belfield said it had been used with additions. Our people have examined it. Mr. Belfield told us these additions had nothing to do with the removal of induced currents. He said that when one had a very high pressure, and reduced it by well-known means to a pressure which was practically safe to use, such an operation had nothing to do with these induced currents. My witnesses were surprised at that evidence. They think that these induced currents would have such an effect on the current as to interfere with the working of the system—that is their opinion. But we have seen their instrument. We found it was not used, and is now discarded. They use some other means. So it turns out that the instance proved is no instance of successful use at all. We know now it will not work. Why that is is not the question. If it is of such great value as one would conclude from the model, is it not most extraordinary that no one should think it worth while to employ it? If they say, as they are entitled to, it will work with a modification, then I say that amounts to insufficieney of specification. The patentee has omitted to give certain directions which will make it work with alternating currents. The same point arises in the application of the three-wire system to alternating currents. It is difficult to get two alternating dynamos to work together; a slight difference of speed would put them out; they must be absolutely in unison. In practice this difficulty is met with by using one dynamo having two coils on the one armature instead of two dynamos. Instead of the two coils on one armature the two dynamos may be coupled by a rigid connection, as, for instance, using a common axis. But the specification contains no directions as to the overcoming of this difficulty. The plaintiff meets this objection in an ingenious manner. He says that in 1882 it was not known that alternating dynamos in series could be coupled otherwise than rigidly, that it was a subsequent discovery. But Wilde told the public that in 1869, hence it was common knowledge in 1882, and express directions were necessary for rigid connection. As the patentee has described a machine to work with both kinds of couplings which will work with one only his patent is bad. The only answer the patentee attempts to make is that in spite of Wilde's publication the electrical workman would only know of rigid connection for alternating dynamos in series. I have endeavoured to lay before the Court the outline of our case. Our scientific witnesses will correct any inaccuracies in the mode of expression.

Mr. WILLIAM LEWIS CRESSWELL was then called and examined by Mr. FINLAY. Witness stated that he was foreman of the Hydraulic and Electric Lighting department at the Great South Western Railway Company's Station at Inchicore. He remembered a machine coming from Messrs. Siemens in March, 1882. The machine had remained in the same condition, and had been used in the same way ever since.

Mr. EDWARD LAUCKERT, called and examined by Mr. FINLAY, stated that he had been the works manager of Messrs. Siemens Bros.' electric lighting department since the beginning of 1880, and it was under his directions that the machine supplied to the Great South Western Railway at Inchicore was wound. There were ten bobbins, all wound in the same direction. The whole machine was connected in series. In the centre of it a wire was taken to a return, so that the machine was connected on the three-wire system. It had three collector rings. The diagram J. H., 8, represented the working of the machine. In a machine so wound the third wire only conveyed the difference in current between the two circuits, but if only one circuit was burning then it conveyed the whole current of that circuit. He had given directions for winding another similar machine which was supplied to the National Electric Company of Glasgow. He gave the directions for winding that machine on January 18, 1882, and for the first one on January 4, 1882. The Inchicore dynamo was sent away on January 24th, and the Glasgow machine was sent away from Woolwich on March 1st. He estimated that by working the Inchicore dynamo, which gave a total useful work of about 3,960 watts, on the third-wire system there was a clear saving of 414 watts.

Cross-examined by Mr. MOULTON, witness stated that he did not go to Inchicore. All that he had to do with was the making of the machine and directing them to put it up. What he meant by the watts gained was that if he had to work two sets of five-lamps in the ordinary way he would have four wires, whilst in this way of working he need only have three wires.

Mr. JOHN NEBEL, examined by Mr. ROGER WALLACE, stated that he had been in the employ of Messrs. Siemens Brothers since 1874. He agreed with the evidence given by Mr. Lauckert.

Cross-examined by Mr. ASHTON, witness stated that he did not know that Messrs. Siemens in Germany were licensees under Dr. Hopkinson's patent. He could not say whether an application was made by Dr. Siemens to patent the third-wire system in this country.

Mr. WILLIAM SCHARINA, examined by Mr. FINLAY, stated that he had been in the employment of Messrs. Siemens for a good many years. He was employed by them to see to the starting of the machine at Inchicore. It was set up as per diagram J. H. 8.

Mr. THOMAS BONSALL CROMPTON NUTTALL, examined by Mr. ROGER WALLACE, stated he took the measurements on which the calculation was based by Mr. Lauckert.

Mr. EDWARD LAUCKERT recalled, and further cross-examined by Mr. MOULTON, said that his calculation would have been substantially the same if whenever he turned the ten lamps on he broke connection with the third wire.

Mr. WILLIAM HENRY ILLINGSWORTH, examined by Mr. FINLAY, stated that in the year 1880 he was in the employment of Messrs. Crompton and Co. The installation at the Alexandra Palace was used in the summer time in lighting the grounds and after that for lighting the Palace itself during the winter. The plant consisted of H. A. wound dynamos, a Marshall's portable engine, and Crompton arc lamps, series wound. The output of the dynamos was about 50 volts and a little more than 20 amperes. He was in charge of the plant. The dynamos were arranged to run two in parallel with a common return. According to J. H. 7, they were using two insulated conductors and a bare copper wire in the centre. On starting he found at once that one of the machines had reversed, so that the machines were running in series. He continued to run them in that way for the whole time that they were lighting the central hall. This would be December, 1880, and January, 1881. There were only two arc lamps in the circuit in question. The size of the insulated wires was 7/16, their length was something like 315 yards, and the common return was No. 8 bare copper wire.

The Court then adjourned until Monday.

MONDAY, NOVEMBER 7TH.

On the resumption of the hearing of this action, Mr. ROOKES EVELYN BELL CROMPTON was called, and examined by Sir HORACE DAVEY. Witness stated that he put up an installation for the purpose of lighting the Alexandra Palace in 1880 largely with his own hands. In those days they were all working themselves. [Witness then minutely described this installation.] The type of lamp used had the trade name of "E." It was the latest type of lamp he made previous to the use of differential coils. These lamps would not burn at all on an ordinary two-wire circuit in series. They invariably went out each time the lamp had to be fed. They worked quite satisfactorily with the three-wire arrangement. The third wire enabled the difference of the currents of two lamps to be dealt with by the dynamos exactly in the same way that the difference between currents on the two parts of the three-wire system were now dealt with by the dynamos. There was a current passing either one way or the other up or down the third wire. He had the actual advantage of using three wires instead of four, and he could have reduced the size of his leads. In the year 1880 it was not unknown to use arc lamps in parallel.

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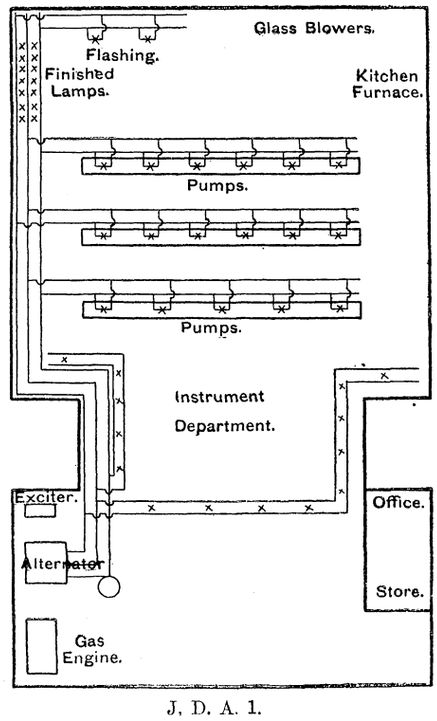
Cross-examined by Mr. MOULTON, witness stated that leaving out Andre and Werdermann, he knew of no public user of lamps in parallel in England before July, 1882. Witness was perfectly confident his lamps were not provided with a shunt coil for regulating. His firm had erected 2,000 odd incandescent lamps by the time Dr. Hopkinson's provisional patent was taken out, and nearly half of those were in one large installation at the Birmingham Town Hall on a five-wire system. The wires did not come back to the dynamo. On the occasion of the reading of a Paper by Mr. Preece at the Society of Arts, on March 7, 1884, he did not remember Mr. Preece saying, "A marvellous improvement has been made by Dr. John Hopkinson and by Mr. Edison, independently of each other, by which the weight of copper necessary for central station working has been diminished 60 per cent., and this is due to the use of two dynamos connected in series, and a third or compensating conductor placed between them as shown in the accompanying diagram, *see* next page." He spoke on that occasion, but did not remember saying anything about that not being an invention or his having discovered it two years before. He had mentioned to Dr. Hopkinson himself that he had done something of the kind at the Alexandra Palace, which witness thought would invalidate his patent. Probably in 1883. He did not remember saying anything at the discussion at the Institution of Civil Engineers in November, 1884, on a Paper by Prof. Andrew Jamieson, to the effect that he had anticipated Dr. Hopkinson. He never accepted Dr. Hopkinson's patent as a satisfactory solution of the difficulty.

Mr. JOHN SMITH RAYWORTH, examined by Mr. FINLAY, stated that while acting as agent for Messrs. Siemens at Manchester he fitted up the steamship "City of Berlin" with electric lighting apparatus. This was in November, 1879. The machine was a Siemens alternator, and it had a separate exciter. It was wound in two circuits in series, with three collecting rings. It was the same sort of arrangement as the Inchicore arrangement. Siemens' differential arc lamps were used. There were eight; four on two circuits. The third wire acted in the first instance simply as a divider of the two circuits, so that they were able either to burn the steerage lamps or the saloon lamps, or both, as desired. Then it acted as a protector of one circuit from the inequalities of the other. Reading the specification by the light of the knowledge he possessed in 1882, the reference there made to alternators would not have conveyed to his mind the idea that the two dynamos had to be rigidly coupled together.

Mr. JOSEPH DAVENPORT ANDREWS, examined by Mr. FINLAY, stated that he was formerly in the employment of Messrs. Siemens. He subsequently went to the National Electrical Company in Glasgow, and ordered an alternator wound in the way described. It was used with incandescent lamps, partly for lighting the workshop and partly for manufacturing purposes of incandescent lamps; the machine was bought for the purpose of manufacturing incandescent lamps. The connections were as in the diagram marked J. D. A. 1.



J. D. A. 1.

Mr. ASTON: I have followed this with great care, as your lordship will imagine, and I am justified in saying that the evidence does take us by surprise, for we did not expect it.

Mr. JUSTICE ROMER: I will accede to your application. Are you going to apply for an adjournment?

Mr. ASTON: My application is that we should adjourn to consider what our position is.

After some little discussion the Court adjourned, subject to any application in the meantime, with notice on either side, until Monday next, the 14th inst.

Pepperill v. The City and South London Railway Company.

On Thursday last week, in this action, the plaintiff appealed to the Master of the Rolls and Lords Justices Lopes and Kay from a judgment of Mr. Justice Wills, who heard the case in May last. The cause for action, and other particulars, will be found in *The Electrician* of May 27th, p. 102. The Master of the Rolls upheld Justice Wills's judgment, and dismissed the appeal.

Donovan v. Laing, Wharton, and Down.

This was an action before Mr. Baron Pollock and a special jury to recover damages for personal injuries caused by the alleged negligence of the defendants' servants. The defendants denied the alleged negligence, and asserted that there had been contributory negligence on plaintiff's part. Mr. Cock, Q.C., and Mr. Lynden Bell appeared for the plaintiff; and Mr. Lawson Walton, Q.C., and Mr. Rawlinson for the defendant. The jury returned a verdict for the plaintiff for £500 damages; but judgment was not entered, as points of law in regard to defendants' liability have to be argued.

Re the International Electrical Syndicate (Limited).

In the Queen's Bench Division, on Wednesday last, a petition for the winding up of the above Syndicate came before Mr. Justice Vaughan Williams.

Mr. FILLAN said he understood the petition was unopposed. The nominal capital of the Company was £12,000, and the amount paid up was £10,000. The application was by a shareholder, who had a holding of £500 paid up. The object of the formation of the Company was to buy some patents for electrical motors, and to work them in England. The Company was incorporated in April, 1891, and since then nothing had been done. He therefore applied under the 79th Section of the Act for a winding up. The registered office of the Company had been closed altogether; in fact, it had never been opened at all.

The order for winding up was granted.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 28, 1892.

The American Street Railway Association.—The eleventh annual convention of the American Street Railway Association, which was held in Cleveland, Ohio, on October 19th, 20th and 21st, was the largest, and in some respects the most important of any in the history of the Association. The attendance reached nearly 600. A number of important Papers were presented by various street railway men and discussed at considerable length. It was noticeable that a large proportion of the Papers were upon electric roads. While the Papers themselves contained matter of importance, it is to be regretted that the discussions were not more general and more complete, as this is often the most valuable feature of such a meeting. The exhibition of street railway apparatus was the largest and most interesting collection that has ever been brought together in this country. The display of the General Electric Company surpassed all former ones of the Edison or Thomson-Houston Companies, and the Short Electric Railway Company, and the Westinghouse Company also made very elaborate exhibits, while a large number of other firms were represented to a greater or less extent. The formation of a Supply Dealers' Association in connection with the American Street Railway Association was considered, but the Executive Committee decided that there was no necessity for such an Association at the present time. The supply dealers themselves, however, were not satisfied with this decision, and held a special meeting at which a Committee was appointed to confer further on the subject with the Executive Committee of the Street Railway Association.

The New Westinghouse Lamp.—At the time of the decision of the United States Circuit Courts of Appeals in favour of the Edison General Electric Company the Westinghouse Company announced that it was prepared to place upon the market a new form of incandescent lamp which did not infringe in any way upon the Edison patent. At that time no definite information could be obtained in regard to the construction of this lamp, but now the matter has been made public, although the lamp itself has not made its appearance. The lamp is of the keyless type, and the base is of glass instead of brass. No platinum is used for the leading-in wires, its place being taken by an alloy, which is claimed to be a satisfactory substitute and to

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have a proper coefficient of expansion. The lamp is a separable one, that is, the filament can be removed and the bulb used over again. This is accomplished by attaching the burner to the ground-glass stopper, which is duly inserted in the bulb, and the air is then exhausted. The lamp is sealed by a base, and when it is necessary to remove the filament the lamp is placed in hot water, which softens this sealing compound and permits the removal of the stopper, which, when refitted with a new filament, can be replaced and again exhausted. The connection with the socket is made directly through the leading-in wires, the base is of porcelain, of very simple construction. The binding posts are connected to two spring clips, with which contact is made by turning the lamps so that the wires are at right angles with these clips, which are thus forced apart, one wire pressing against each. A quarter turn of the lamp places the wires parallel and between the clips, which then spring back to their normal position, and the light is thus extinguished. The shell of the socket is nickel-plated, and the lamp is simply pushed into it, it being retained by the springs on the side. It is claimed that these lamps can be sold as low as 30 cents each.

CORRESPONDENCE.

SUNSPOTS AND MAGNETIC STORMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: M. Ricco's investigation of the time relation between sunspots and magnetic storms is very interesting. It is rather unscientific to assume a new ether to explain every new phenomenon, and there are very serious difficulties in the way of believing that the very long ether waves, thousands of miles long, which would act on the magnetometers used in magnetic observatories, could be emitted as a beam from the sun and not be spread over a very large angle by diffraction long before they reached the earth. Except for this there does not seem any great difficulty in assuming that the beam is not emitted perpendicularly to the solar surface. If it came up the sunspot like a beam out of a lighthouse all that need be assumed is that the line of the sunspot is not perpendicular to the solar surface, and that it points backwards as regards the solar rotation, a not impossible assumption. However, the difficulties of diffraction already mentioned make it very improbable that it is a direct action of an electro-magnetic wave started by the sunspot. It is just possible that, as Prof. Perry suggests to me, a very rapidly vibrating electro-magnetic beam, so rapidly vibrating that its short waves would not spread much by diffraction, could unsettle the magnetic equilibrium of the earth, in the same sort of way that striking a match may light a fire, or a burning glass light paper; but there does not seem much evidence that the magnetic equilibrium of the earth can be so upset.

What seems a better hypothesis is that a sunspot is a source from which some emanation like a comet's tail is projected from the sun. It is known that comets' tail are explicable on the hypothesis that the sun is powerfully electrified, and repels similarly electrified molecules with a force of some moderate number of times the gravitation of the molecules to the sun. With intense chemical actions taking place in the sun, it seems not improbable that chemical atoms highly charged may be produced and repelled like comets' tails from the solar surface. In fact, several of the phenomena of the corona have long been attributed to such a condition. Is it possible, then, that matter starting from the sun with the explosive velocities we know possible there, and subject to an acceleration of several times solar gravitation, could reach the earth in a couple of days? In the first place, it is to be remarked that inasmuch as this action hits the earth, even though the sunspot is not apparently in the plane of the ecliptic, it must diverge in a cone of 15deg. or 20deg. aperture from the spot, and that the forward edge of the cone would reach the earth when the sunspot was 20deg. from the central meridian, only for the delay M. Ricco attributes to the time taken to reach the earth. This consideration increases the delay to about four days, and reduces the average velocity to about 300 miles per second, which does not seem at all excessive. Now, as to the quantity of matter that need exist in this cometary beam, in order to act as an electric current on the earth. We may assume each atom to have the usual atomic charge, and it appears from an obvious calculation Dr. Lodge and I worked out in the train the other day, that a few cubic metres of hydrogen at atmospheric pressure and temperature spread over a volume a thousand miles cube would represent a current of some thousands of amperes, which seems amply sufficient to disturb magnetometers very seriously. Considering the connection between sunspots, magnetic storms, and some coronal phenomena, this comets' tails hypothesis seems much more probable than a direct electro-magnetic wave propagation.—Yours, &c.,

GEO. FRAS. FITZGERALD.

Trinity College, Dublin, November 7, 1892.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The Institution of Electrical Engineers is the principal corporate representative of an important and increasing profession; in its early days, and especially when it existed as the Society of Telegraph Engineers, it was the principal exponent of the scientific aspect of electrical progress, and attracted a large number of gentlemen only indirectly connected with practical engineering. Under those conditions it was appropriate that the Council should have been composed to some considerable extent of professors and similar representatives of purely scientific effort. The Council, which has the responsibility of nominating its own members, has always given due, if not excessive, prominence to this idea, with the result that at the present time, notwithstanding that the membership now includes a very large number (in fact a considerable majority) of electrical engineers actually engaged on important works, that body consists of:—10 actual or nominal professors; 4 physicists; 11 present or past representatives of Government departments, including naval and military officers; 7 electricians and electrical engineers, in all 32; or omitting the vice and past presidents it consists of: 5 actual or nominal professors; 7 present or past representatives of Government Departments, including naval and military officers; 3 electricians and electrical engineers, in all 15.

From a consideration of the above list, which the most vivid imagination would have difficulty in recognising as representative of the present membership of the Institution of Electrical Engineers, we turn with relief to the Institution of *Civil* Engineers, an association which has earned the respect not only of this but of all civilised countries, and whose principles and procedure may with advantage be imitated by other societies aiming at similar objects. Their Council is composed almost exclusively of engineers in actual practice, it contains only six representatives of Government Departments and no professors. It must not be considered from the above remarks that any professor who sits on the Council of the Institution of Electrical Engineers is not in every respect an ornament to that Council, and that his presence there does not give satisfaction to the whole body of members and associates, for we fully believe that the contrary is the fact. In approaching this question we wish to deal exclusively with numbers, and we have neither intention nor desire to approach the subject from the point of view of the personal or contingent qualifications of individuals, for notwithstanding that we, in company with other members, entertain a high personal regard for each and every member of Council, we feel that it is imperative in the interest of the Institution that that body should be truly representative, no class or interest predominating over others.

We have accidentally commenced with the professorial element, but there can be no doubt also that the various departments of Her Majesty's Government have at the present time a representation much in excess of their share in general electrical work, and that some of the seats held by both the above-mentioned classes might with advantage be distributed amongst other branches of the profession.

We know that our views as expressed above are shared by a large and influential section of the Institution, and we believe

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also by some members of Council, who would have given effect to them had they been supported by any general expression of opinion. We do not advocate, as politic or possible, the making of any immediate radical change in the constitution of the Council; but we do advocate a gradual modification of it, by the nomination on the part of the Council of new members, actively employed in constructive work to replace others retiring in rotation, until a more equal balance be attained. As the date of the annual election is approaching we have taken the liberty of bringing this subject forward through the medium of the Press, in order that an opportunity may be afforded to members of the Institution of expressing their opinion on a subject which we are assured is attracting serious and increasing attention.—Yours, &c.,

R. S. Erskine,
E. Manville,
London, November 7, 1892. Alfred E. Mavor,
John Raworth,
A. A. C. Swinton.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

Tenders Invited.—The Corporation of Blackpool invite tenders for the installation of wires, switches, &c., for the electric lighting of the new police-station buildings. Plans, specifications, and forms of tender may be obtained from Mr. J. Wolstenholme, borough engineer, by whom tenders must be received not later than the 25th inst. Further particulars appear in our advertisement columns.

——— The Bristol Urban Sanitary Authority require tenders for the supply, delivery and erection of underground feeders, mains, arc light circuits, junction and house boxes, arc lamps, posts, and suspension gear. Some particulars will be found elsewhere, but full particulars can be obtained of Mr. D. Travers Burgess, town clerk, 51, Prince-street, Bristol, and tenders must be in by Thursday, December 1st.

——— The Asylums Committee of the London County Council require for the installation of the electric light at the London County Lunatic Asylum at Claybury (Woodford), Essex. Further particulars are given in our advertising columns, and full information can be obtained of the Clerk to the Committee, 21, Whitehall Place, S.W., after Monday next. Tenders must be in not later than noon on December 6th.

——— The Controller of Stores of the General Post Office invites tenders for the purchase of various stores, including india-rubber, gutta-percha, and old metal. Forms of tender may be obtained from the Controller, Telegraph-street, E.C., and tenders must be in by noon on Tuesday next, the 15th inst.

——— The Corporation of Derby invite tenders for the builders' work in the engine and boiler-house, &c., and accessories, at the central station. Tenders to be in by Monday next, the 14th inst.

——— The Director of Army Contracts invites tenders for the purchase of about 460 tons of old metal of various kinds, including copper, nickel, brass, &c. Particulars can be obtained of the Director-General of Ordnance Factories, Royal Arsenal, Woolwich, and tenders have to be in at the War Office, Pall Mall, S.W., by Friday, the 18th inst.

Sale by Auction.—Messrs. Wheatley Kirk, Price and Goulty announce in our advertisement columns that they are instructed to sell by public auction, at an early date, the entire contents of the works of Messrs. A. B. Gill and Co. at Gilmore-road, Lee, comprising electrical and engineering plant, tools, stock, fittings, stores, &c.

Dissolutions of Partnership.—Messrs. J. H. Geisenheimer and E. A. Lessing, carrying on business as electrical engineers at 10, Glasshouse street, London, W., under the title of Watson, Geisenheimer and Co., have dissolved partnership, and the business will be carried on in future by Mr. E. A. Lessing, who will pay and receive all moneys owing by and due to the late firm.

——— In reference to the Trade Note appearing in our last issue we are asked by Mr. Roger Dawson, of the late firm of Rashleigh Phipps and Dawson, to state that he has purchased Mr. Rashleigh Phipps's share in the business as from October 14th last, and that the business will be carried on at 53, Berners-street, as hitherto, under the style of Roger Dawson, as will also the works at Stanhope-street, N.W., and the branch establishment at Bournemouth. Mr. Roger Dawson will receive and discharge all debts due to and from the old firm.

Removal Notice.—The Phonopore Company (Limited) has definitely removed its offices from Bloomfield House, E.C., to Faraday House, Charing Cross, W.C.

Patents, Designs, and Trade Marks' Acts.—Notice is given in our advertising columns that Signor Michelangelo Cattori, of Rome, has applied for leave to further amend his letters patent, No. 14,234 of 1891, for improvements in, and relating to electric railways.

Blackpool Electric Tramway Company (Limited).—At extraordinary general meetings, held on September 24th and October 15th, a special resolution was passed and confirmed that the Company be voluntarily wound up, and that Mr. John Oddie, of Halifax, be the liquidator.

Collier Audible Telephone Syndicate (Limited).—At extraordinary general meetings, held on October 1st and 17th, a special resolution was passed and confirmed that this Syndicate be voluntarily wound up, that Mr. Godefroi Drew Ingall be the liquidator, and that the liquidator be authorised to carry out the sale of the assets on the terms of the contracts made between the Syndicate, Mr. E. Hampson, and the Collier-Marr Telephone and Electrical Manufacturing Company (Limited).

Froude-Hurrell Torpedo Company, Limited (in Liquidation).—Notice is given in the *London Gazette* that Messrs. H. Jasper, W. Mackie, and H. C. Knight have been appointed a committee of inspection to act with the official receiver and liquidator.

Electrical Assets Purchase Company (Limited).—A meeting is to be held at Mr. W. R. T. Carr's, Monument House, Monument-yard, E.C., on the 28th inst., at 2 p.m., to receive the report of the winding-up.

Failure.—The failure is announced of Mr. Thomas Griffiths, managing director of Griffiths Pyrodene Fireproof Company (Limited), with gross liabilities of £17,148, of which £12,998 are expected to rank, and assets estimated at £2,605.

Ship Lighting.—Messrs. G. E. Bellis and Co. have recently supplied the electric lighting engines and accessories for the two new Cunard liners, the "Compania" and "Leuconia."

Messrs. Russell and Co.—As notified in our issue of the 28th ult., this firm have commenced business in London as electrical engineers and contractors. They propose to list and supply requisites for electrical work of all descriptions, and to contract for the supply, erection or equipment of any desired plant. A complete catalogue is in preparation.

Electrical Supplies and Fittings Company (Limited).—This Company are busy with the wiring and fitting of a number of West-end houses and business establishments, including an extension of the lighting in the school-room of St. Jude's Church, Kensington.

Messrs. King, Mendham and Co.—This firm send us a large illustrated sheet of electrical accessories manufactured by them. The sheet will be handy for reference, and is provided with tabs for hanging in the office or laboratory. In the centre of the sheet, on both sides, is some useful information.

Messrs. Crompton and Co. (Limited).—Extensive new plant has recently been laid down at this Company's works at Chelmsford, including a 240-H.P. boiler, supplied by Messrs. Penman and Co., of Glasgow. The new engines are by Messrs. Willans and Robinson (Limited).

Crompton-Howell Accumulators.—The Crompton-Howell Company have, we learn, recently secured an extensive order to supply accumulators to the New York Central Lighting Station.

The Oerlikon Machinenfabrik.—We have received from this well-known firm a well-illustrated and interesting pamphlet relating to their electric traction apparatus. Several views are given of electric lines laid down by the Oerlikon engineers, the lines, with the exception of that at Marseilles, running up mountains. The motors are of the multipolar, single-reduction type, with ring armatures, carrying conductors in deep slots.

United Electric Wire Company.—This Company issue a second edition of their price list of wires and cables. They call particular attention to some useful tables on pp. 4, 5, and 23, the latter of which is a Wire Price List and Ready Reckoner.

Messrs. J. H. Pickup and Co. (Limited).—We have received a catalogue from this firm giving particulars of the Pickup Electrical Fan, the Pickup Dynamo, and the Britannia Air Propeller. The list is fully illustrated.

Messrs. D. and G. Graham.—This firm have secured the contract for the electric lighting of the Central Hotel, Belfast. The installation is to consist of 576 16 c.p. lamps and several arcs; the two dynamos to be supplied have each to be capable of maintaining the whole number of lights.

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CHRISTMAS AND THE NEW YEAR.—Those of our readers who contemplate despatching letters, books, or parcels, abroad for Christmas and the New Year, will find the postal arrangements set out in a circular, No. 49, recently issued by the Post Office.

ASHFORD.—At the last meeting of the Local Board a communication from an electric lighting company, proffering to supply information in relation to the question of the public lighting of Ashford was referred to the Lighting Committee.

BANDON.—It is stated that a company will shortly be formulated with a view to provide the electric light for the town of Bandon.

BELFAST.—The concluding article (No. 22) on Electric Lighting, by the *Belfast Evening Telegraph's* Special Commissioner, appeared in the issue of that Journal for November 4th. The result of this series of articles has, we understand, been gratifying to the proprietors of that Journal, who are to be complimented upon the energy displayed in providing information on the subject of electric lighting generally at a time when the matter was occupying the attention of the Belfast public.——Mr. J. H. Greenhill delivered an interesting lecture on the practical application of electricity, on Wednesday last week, to the members of the Natural History and Philosophical Society. The lecturer brought to his aid a quantity of electrical apparatus—lamps, &c.—to illustrate his remarks. An interesting discussion followed the lecture, which was listened to with attention by a large audience. Probably in no town in the kingdom is the subject of electric lighting more keenly discussed than in Belfast, and Mr. Greenhill received an enthusiastic vote of thanks for his lecture at its termination.

CARNARVON.—An agitation is on foot in Carnarvon for the introduction of the electric light, serious complaints being made against the gas service. The price of gas is 4s. 6d. per thousand, and it is stated to be of most indifferent quality. The gas is under the control of the Corporation.

CHISWICK.—The special Electric Lighting Committee of this Board have met, and have recommended that body to take over the transfer of the Board of Trade Order.

DUBLIN.—Messrs. Curtis Bros., of Suffolk-street, Dublin, have several important installations in hand, amongst them being the providing of a handsome wrought-iron crescent out-door electric illumination for the Sun Insurance Office. This takes the form of a wrought-iron crescent over the entrance, in the centre of which is arranged a large sun, with six lights. This novelty is to be provided with an automatic cut-out, so that the light can be extinguished at any hour of the night automatically. The device is made from suggestions by the Sun Company's engineer.

DUNDEE.—At a meeting of the Dundee Chamber of Commerce on Friday last, on the appointment of the Gas Commissioners, a discussion arose on the electric lighting scheme which had been adopted. It was announced that the whole of the arrangement for lighting the central area had been completed. It was further announced that applications for 1,000 lights of 16 c.p. had been received, being about a fifth part of what they would be able ultimately to supply.

EALING.—The Electric Lighting Committee of the Local Board have presented a report, in which they recommend that "five or six electrical engineering firms" be invited to send in schemes for lighting the Uxbridge-road, from the boundary of Hanwell to the Ealing Common Station, and through the southern part of the district, from the Broadway to South Ealing Station. A discussion ensued as to the desirability of the Board's consulting an expert prior to inviting the firms referred to to send in their schemes, and the report was ultimately referred back to the Committee for reconsideration on this basis.

EAST MOLESEY.—At the last meeting of the Local Board a fresh plan for the lighting of the district by electricity had been submitted, and a Special Committee was appointed to consider the subject.

LEICESTER.—A series of free lectures is being held in the Art Gallery of the Leicester Museum, and the third of the series was given last Thursday by Mr E. E. Brooks, the subject being, "Forms of Electrical Discharge." The room was well filled, and the lecturer received a hearty vote of thanks at the conclusion.

LIVERPOOL.—The *Liverpool Daily Courier* of Monday last contained an interesting account of the Victoria Building, Liverpool University College. The electric light fittings and metal work have been supplied by Messrs. Hart, Son, Peard and Co., the general lighting arrangements having been conducted under the superintendence of Mr. A. L. Taylor.

MERTHYR.—It has been decided by the Board of Health to defer the consideration of the question of the electric lighting of the town for 12 months, in order that the Lighting Committee may visit various towns for the purpose of obtaining information.

PONTYPOOL.—In connection with the Pontypool Electric Light and Power Company a luncheon was given on Wednesday in last week to celebrate its formation. Mr. J. C. Howell was able to announce that support had been promised for the new venture to the extent of 1,200 lights.

WOKINGHAM.—A proposal having been made that the Town Council should purchase the Gas Works, it was proposed at the last meeting of the Council by Alderman Moorcock that they should apply for an Electric Lighting Order. A resolution was passed that a committee of five members be appointed to consider the general question of lighitng the town.

YARMOUTH.—A report has been received by the Yarmouth Town Council from Mr. W. H. Preece, in which he states that Yarmouth should be able to supply the electric light at 6d. per Board of Trade unit, and thus compete with gas which is 3s. 4d. in that district. In the course of his report Mr. Preece altogether repudiates the notion that the electric light is only a luxury for the rich, and states that, owing to the expiry of patents and other favourable conditions, electrical energy should be obtained by everybody. He recommended the Council to start with an installation of 4,500 lights of 8 candle-power at a cost of about £10,000. In reference to the site for the central station, he strongly recommended that at the north end of the South Denes, where water was abundant and coal was easily delivered. Ultimately, a resolution that the report should be dealt with by a committee consisting of the whole Council (to which Mr. Preece was invited) was agreed to.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

October 14, 1892.

18,399. R. WHITEHEAD and A. DOXEY. Sheffield. Combined telephone switch and ringing key.

18,452. J. GREEN and G. TURNER. Improvements in the manufacture of zinc rods for electrical bells and batteries.

October 15, 1892.

18,465. F. W. GOLBY. London. Improvements in electro-magnetic sounding apparatus. (P. Binsfield and H. von Gleissenberg, Germany.)

18,505. C. CASALONGA. London. Improvements in, or relating to, the supply of electricity to aërial machines.

18,516. E. N. A. PICARD and J. A. TANIÈRE. Improvements in, and relating to, the electro-deposition of metals.

18,520. R. K. BOYLE. London. Improved telephone transmitter and receiver.

October 17, 1892.

18,538. T. WALLACE. London. A new construction of underground conduit for electric conductors.

18,542. J. K. GRINDROD. Manchester. Improvements in certain brackets or supports for electric arc lamps, applicable also for supporting lamps of other kinds.

October 18, 1892.

18,602. S. D. SMITH and O. J. WELLS. London. Improvements in electrical appliances for canes and analagous articles.

18,655. H. SHAW. London. Improved buildings with means of access thereto to supply them with water, gas, also electric light, with electric and steam power, and means to abate smoke.

October 19, 1892.

18,681. S. W. BAYNES. Bradford. Improvements in underground conductors for the distribution of electricity.

18,695. C. A. BANNISTER. London. Bannister's new and improved electric railway, signal and point working system.

18,700. T. S. POOLE and WOODHOUSE AND RAWSON UNITED (LIMITED). London. Improvements in electrical ceiling roses.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

16,572. SAYERS. Dynamo-electric machines, &c.

16,934. LAKE (Kennedy and another). Secondary batteries.

16,938. LAKE (Kennedy and another). Secondary batteries.

17,220. DE FERRANTI. Commutating electric currents.

17,831. BANKS. Insulating, &c., compound.

18,256. FORD (Pottier). Electro-deposition of metal upon the surface of glass, &c.

1892.

4,523. RIES ELECTRIC SPECIALTY COMPANY AND OTHERS. Incandescent electric lamps, &c.

11,320. VOGT. Telephonic apparatus.

11,353. MULLARKY. Electric alarm clocks.

11,426. DYMOND. (Strowger and another). Electric switches, &c.

11,941. MILLER. Electricity meters.

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COMPANIES' MEETINGS & REPORTS.

Western and Brazilian Telegraph Company (Limited).

The 24th ordinary general meeting of this Company was held at Winchester House, Old Broad-street, yesterday, Mr. W. S. Andrews presiding.

In the absence of the Secretary (Mr. R. M. Cunningham),

The MANAGING DIRECTOR (Major Wood) read the notice convening the meeting and the minutes of the previous meeting, the latter being approved and signed by the Chairman as correct.

The report of the Directors and statement of accounts were, as usual taken as read.

The CHAIRMAN: Gentlemen, as is customary on these occasions, I propose to deal with the receipts in the first case. Of course as we had reason to anticipate so have we reason to realise to-day that, owing to the decreased state of the exchange in Brazil, the outcome of the half-year that we are going to deal with on this occasion will not be found to be so satisfactory as it was on previous occasions. It is quite true that in our case it is not so bad as it has proved to be in many others, because you must have seen from time to time in the newspaper reports of the public meetings of companies that it was shown that owing to this same cause there was no dividend at all. Yet it is far from gratifying for the members of this Board to come before you to-day with a reduced dividend. We have done our best, however, to combat the difficulties that we have had to face, and on the whole, although we regret to see this diminution of gross revenue, we do feel, after all said and done, that it is owing to a cause which we have had no power to control. Well, gentlemen, it is not alone that you have had to deal with a further reduction in the exchange in Brazil; but, as you may remember, there was also a reduction of tariff between this country and Brazil which has had a certain effect in the revenue of the last half-year. The gross revenue for the half-year is £84,021. 16s. 9d., compared with £104,962. 9s. 7d., showing a falling off of £20,940. 12s., no less than £15,539. 14s. 2d. of this owing to the item of exchange. Now, turning to the expenses, these amount to £39,140. 16s. 8d., against £38,638. 10s., showing an increase of £502. 6s. 8d. Now we usually analyse these things, and I will begin by analysing abstract "A." The total under this head is £17,253. 19s. 7d., against £18,765. 6s. 9d., and you see that there is a decrease there of £1,421 7s. 2d. There are, in fact, decreases under ten heads, amounting in all to £2,124. 10s. 8d., and increases under three, amounting in all to £703 3s. 6d., and out of the latter sum no less than £574. 15s. is owing to medical expenses, an unavoidable item on account of the extremely sickly season. You will, therefore, see that there is a very considerable expenditure under abstract "A." Under abstract "B" the result is pleasing in one way, although unsatisfactory in another. It is pleasing in that the ships ought to have shown, and would have shown, a decrease of £2,833 17s. 9d., of which £500, it is true, would have been owing to the "Norseman" having assisted in laying the loops, and to that proportion of her expenses being charged, therefore, to the loops; but there would have been still a reduction of £2,300, but, unfortunately, the "Norseman" was caught in a very heavy gale. She sprung a leak, the sea was extremely high, the vessel was almost—in fact, it was given up for lost. Major Wood reminds me she was really abandoned, that is to say, that the crew had left her, and returned on board the other ship close by. After some time, however, the weather calmed a bit, and she was joined by some of the crew, and was successfully towed to Monte Video, where she was landed in dock. Misfortunes never come singly. Just at this particular period, when that unfortunate vessel was put into dock to undergo repairs, two of our cables took the opportunity of breaking. Well, there was only one thing for us to do. Fortunately, the ship "Scotia," of the Telegraph Maintenance and Construction Co., was on the spot, and we hired her, and by that means we repaired the cables; but, of course, we had to pay the charge, which came to £4,260. At the same time the spending of this money kept the cables going, and prevented the loss of revenue. But for that unavoidable accident—which you will see was again a thing absolutely beyond our control—instead of there being a decrease of £2,832 there would be an increase of £1,487. But you will see again that, in this case as in the former instance, the expenses have been clearly looked after, and we should have had a saving but for that wretched accident. Now, under abstract "C" there is a small increase of £300 under seven heads, and a small reduction under two heads. The outcome of all this is that the receipts amount to £84,021. 16s. 9d., the expenses are £39,140. 16s. 8d., and the balance is £44,881. 0s. 1d. We brought forward for the preceding half-year £4,486. 18s. 2d., so that together these two sums amount to £49,367. 18s. 3d. These are reproductions of the figures in the balance-sheet. We have to deduct interest on debentures, £12,489. 10s. The debenture redemption fund amounts to £6,610. 10s., the reserve is £14,000, the proposed dividend will absorb £14,605. 13s., leaving to carry forward £1,662. 5s. 3d., and make altogether the sum of £49,367. 18s. 3d. Well, gentlemen, of course the enterprisers in Brazil—worked for the benefit of Brazil all round—cannot be very well satisfied with the present inadequate returns which they are getting, and which are most disappointing for the investments made. This is attributable especially to the cause I have named, but also to another. On this occasion, for the first time for a considerable period, we have to deal with a falling off of business. In other words, the times of excitement, which, a year ago, rejoiced our hearts considerably, because they led to the forwarding and receiving of more numerous telegrams, are now ceasing. There is commercial stagnation to a great extent—and so there has been—where there ought to be commercial activity, and, of course, we suffer accordingly. The only consolation is that it seems to be generally felt that an improvement is beginning. We hear from some gentlemen who know a great deal about Brazil and the Plate that that is so, and, therefore, the situation is not altogether so discouraging as the mere figures themselves would seem to point to, because we may hope, after all, that if there is not a good time now, there is at least a better coming. There is another thing which, gentlemen, you have felt the absence of—the sum of £7,000 odd, by way of dividend, which we usually receive from the Platino Telegraph Company, with which we exchange shares. On this occasion that £7,000 is entirely wanting, because that Company suffered very much more severely than we did—under circumstances which are too complicated for explanation—from the losses on exchange, and the consequence was that they could not pay any dividend at all. Then there is a little room for encouragement in the fact that the exchange, which at the corresponding period last year was 11½d., is now at 13d. to 14d. per milreis; and the revenues of the Platino Company up to the present time have, I am pleased to say, owing in the main to this fact, shown a considerable increase. Well, gentlemen, we must hope that that will continue, and that it may eventuate in our getting that money, or some of it, back again. It comes to us, of course, in the shape of a net receipt. It does not cost us anything to earn it. Since our last meeting we completed the last link of those loop cables that we had been laying down for a considerable time. This big operation, I am happy to say, was finished on June 7th, and since that date we have been receiving from the Brazilian Submarine Company that £6,000 per annum, in consideration of which the arrangement was made for laying these loops as predicative of the progress of both companies. The traffic has been kept together, I am happy to say, and although there have been breakages, still, on account of our arrangements for repairs, and one thing and another, they have not materially affected our revenue, and now that the loops are completed the loss will be very small indeed. On the other hand, we have not been able to do all this for nothing. The reserve fund which we possessed has been all invested—I will not say spent—in those loops, and as against a reserve fund producing a certain annual interest, you have an addition which pretty nearly doubles your plant, and entirely doubles it between Pernambuco and Monte Video, which is an earning portion of your line, and which at the same time serves the important purpose of enabling you to work, instead of giving up, one of your broken cables. So your reserve is all spent, and we carry over a small debt-balance of £2,000. I mention that to you because I thought that somebody might have a word to say about the amount that is put to reserve fund. Now you see that we could not help ourselves under the circumstances. The money has been actually spent, and it has been spent in a way of which you, gentlemen, I am pleased to say, have consistently and constantly approved. The Directors stated at the last meeting that if abroad commerce was active, and gave plenty of business, and if the exchange improved, the £50,000 of debentures, which the Company had power to issue, would not be dealt with. Now, circumstances had not been altogether so favourable as that; but, at all events, we had been enabled up to the present to scrape through, and these debentures are consequently still in hand. They have not been dealt with in any way. Of course a great deal depends upon the future. If revenues should be elastic, and we could make more money, then, I think, we could continue to move on and clear off the liabilities which will have to be met for the new ship more particularly, and for other things which have to be done for the security and advancement of your property. At the last meeting, too, we told you that a line had been acquired by a Company called the Central American Company, which was a neutral line at that time between Valparaiso and Buenos Ayres; and that in consequence of the acquirement of that line by the Central American Company it was used for the exclusive purpose of opposing us and taking away the revenue which before we had been enabled to compete for on the West Coast. We reported that in order to get this traffic back again and to repel the attack made on your property we had determined to form a Company to put up a line between Buenos Ayres and Valparaiso, under concessions which had been secured. Well, that project has been so far successful. We did form a Company, the Pacific and European Telegraph Company, and it and the Western and Brazilian Company, and the West Coast Company are all in agreement. The new Company, I am pleased to say, obtained the able assistance of Sir John Pender. The lines are in full course of erection, and will be completed in a few months. When that is accomplished there is no doubt that it will be beneficial to our revenue. I should say with respect to the issue of the debentures that we have been told that if the present improvement should not go on in Brazil and South America, the period for that measure will be within reasonable distance of becoming practicable. We have everything cut and dried, and we are only too axious to go on with it as soon as we are advised to do so by those who know better than we do. The new ship is practically ready to be launched. It is proposed that this should be done on Saturday week. You know the objects for which that vessel has been built—high speed, sufficient carrying capacity, and more economical working. The ship will be under 1,000 tons, whereas the "Norseman" is nearly 1,500, and the cost of the new one will be less than that of the "Norseman." We hope to be able at the next meeting to make a communication to you with respect to these vessels and their arrangements, which will be very satisfactory. As regards our present revenue, it is not unpleasant to remember that it embraces a period during the whole of which two of the opposing lines have been in active competition. Therefore, that shows not merely that we have, I might almost say, surmounted the loss on exchange, but also that entailed on us on account of those two opposing companies which have been actually at work. I cordially wish I could stop there; but all of you must have seen by the newspapers that another—

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"the cry is still they come"—that another cable has been laid by another competing company between Brazil and French Senegambia. Well, the old opposition with the French Company was more particularly with Brazil, and that with the Central Company was with the River Plate, This new Company is concerned, perhaps, more particularly with Brazil, but at the same time they are competing for the traffic that we get throughout our entire system. What may be the result of that it is impossible to say. We told you long ago that you could not maintain the inflated traffics, because they were quite exceptional. The line was opened on October 5th, so that it is too soon yet to say what may be the result of it. All that we can assure you of is this, that we shall continue to look after your traffic as closely as we have hitherto done. We do not mean to be beaten if we can help it, and we do not mean to lose more traffic than we can avoid. You have enabled the Board by your own sound sense to make a system which those gentlemen, I think, will find it rather difficult to fight with. They have rushed into the fight, it is not our doing. They have attacked us and we are simply defending ourselves. With our duplicated lines, with our experienced staff, and with the duplex apparatus which we have supplied, I may tell you that we have been getting messages from Brazil to London on an average in from 30 to 50 minutes. It will take something to beat that. Well, then, we know that we are accurate, and we think that, generally, we shall hold our own. I do not think, gentlemen, that there is any further observation that I can profitably make, and I do not wish to take up your time by saying anything unprofitable, and therefore I beg to move—

"That the report and accounts for the half-year ended June 30, 1892, be and the same are hereby approved and adopted; and that a dividend for the half-year at the rate of 2 per cent. per annum, free of income-tax, be and is hereby declared, payable on the 11th inst."

I will ask Mr. Coppen to second that.

Mr. JOHN COPPEN: Gentlemen, this being my first appearance on this side of the table, no doubt the Chairman thought it would be more becoming that I should say a few words on this occasion. I have great pleasure in seconding the adoption of this report. I must confess that I would have done it with a great deal more pleasure had we had a more successful half-year; but as the Chairman has explained, and I think very fully, and with the full concurrence of the whole Board, it has been from circumstances over which we had no control. We have had serious difficulties in this Company. It has, indeed, been a very anxious half-year, and the number of questions which have come before us have been of a nature which hitherto had not troubled us. During the six months that I have been on the Board I have learned a great deal of the intricacies connected with telegraphic business, and I can only say that in considering the questions brought before us we have worked in perfect harmony. I have found my colleagues most anxious to give me every information in their power. I have also found in Major Wood a most valuable manager. He has the whole business of the Company at his fingers' ends, and in speaking of Major Wood, I also desire to speak of our friend the secretary. I am quite sure that a more indefatigable officer no Company could possess. As to the opposition that the Chairman has alluded to, I am confident that if we continue to administer the affairs of this Company in the manner in which I have seen them administered during the last six months, and if we carefully watch our expenditure and keep things as low as we can—having always in view efficiency—I have not the least doubt as to the result. Bear in mind that, with a competing company, the first thing that we should take care of is that they do not beat us in the service. We get our messages in the quickest possible time that it can be done in from the Brazils, while at the same time we charge a very moderate price for the service. We are giving to that service our undivided attention, and if it is not sufficient to compete with any ordinary competitor I think that then we shall have to throw up the sponge and say that energy, perseverance, and skill are of little avail against competition. I am much pleased to second the adoption of this report, and I hope that to-day we shall meet with the sympathy of the shareholders rather than with adverse criticism about the circumstances which have brought about this reduced dividend, and which I can only say are circumstances over which we have no control.

Mr. LIDDON wished to point out that there was no allusion to the preferred shareholders, nor any amount recognised as being devoted to the purpose of dividend on those shares. He presumed that it would be paid in the usual way.

The CHAIRMAN said that the whole amount went to the preferred shareholders. He was sorry that there was nothing for the deferred.

Mr. PETO congratulated the Chairman on the clear and straightforward statement which he usually puts before the shareholders. By building up their large reserve fund they had been able to duplicate all their lines at the expense of revenue, and, consequently, he ventured to think that their position was better than it had ever been. As to the competition, one never knew in these days when it was going to break out. The Chairman was usually so cautious that he never looked as if he were over sanguine, but he (the speaker) was glad to hear Mr. Andrews speak so hopefully of the future.

A SHAREHOLDER thought that the stationery account was too high and seemed to be rising every half-year, and urged on Major Wood to carefully look after the item of salaries and wages, which seemed too large for such a business as theirs. He thought, also, that the outlay in connection with their ships was amenable to reduction.

The CHAIRMAN said that such questions naturally arose in the mind of any shareholder, and they were very proper questions. He invited the gentleman who had spoken to go to the office of the Company and see the amount of work that was dealt with. Millions of messages were received and dispatched, and each message took not one form, but in its progress from end to end used up several. The stationery was one of the means of earning their revenue. It was stationery not merely used in this country, but over the whole of South America wherever the Company had stations, and it was mainly employed in the message work and in the abstract business of maps and publications of the Company, and when they came to see the work done they would not be surprised at the cost. When they sent out stationery to South America, it was sent in bulk because that reduced the expenses. They sent enough to last twelve or eighteen months, according to circumstances, and in some cases they sent a supply sufficient to last for three years, because of the cost of carriage and other things that had to be done. The charge looked heavy at the time, but it was economy in the end. As to the ships, it was a question of revenue that they should secure the safety and speedy repair of the lines. They had been keeping their eyes on the expenditure in regard to their ships, and not only so, but they had been in consequence able to put their hands on the sovereigns, and keep them in the till, and keep them there for the benefit of the shareholders.

A SHAREHOLDER thought that the expenditure, and particularly miscellaneous expenses, might be given in greater detail.

The CHAIRMAN said that they did not give as many headings as they could. What the shareholders wanted would be a still further analysis, if practicable. As to the miscellaneous expenses, they included all kinds of little outlays, which it would be well nigh impossible to set out. Even if they could be particularised, it would not be worth while to do so.

The resolution was then put to the meeting, and carried unanimously.

Mr. PETO proposed, and Mr. LIDDON seconded, a vote of thanks to the Chairman, his colleagues, and the chief officers of the Company.

The vote was passed, and

The CHAIRMAN having briefly returned thanks, the proceedings terminated.

Aluminium Company (Limited).

The fifth ordinary general meeting of this Company was held on Monday at the Cannon-street Hotel, under the presidency of Mr. G. W. Balfour, M.P.

The CHAIRMAN referred to the difficulties and disappointments which had attended the past career of the Company. When the Company was started, he said, the price of aluminium was 60s. per lb., and they expected, by means of their new process, that the cost price would be 10s. per lb., and that they would be able to command the market of the world at something like 20s. per lb. At the present time, however, aluminium, instead of being 60s., was to be obtained at 2s. per lb. They were obliged, then, to confess that they could no longer hold the field against the electrical methods of manufacture, and to bid farewell to the expectations of large profits they had anticipated. They had succeeded in creating a new branch of industry. It was true the trading account still registered an adverse balance, though a comparatively small one; but during the half-year from January to June the works at Oldbury showed a profit of between £2,000 and £3,000, and this was earned in the face of large reductions in the selling price of sodium. They had at the present time orders actually on hand that would keep the whole of their plant in operation for upwards of three months. With regard to the issue of £12,000 new debentures, they would be secured as a first charge on the new process, and as a second charge on the assets of the Company generally. With respect to the writing down of their capital, the matter had been fully considered by the Directors, and in their last report they stated that it would be ultimately necessary to do this. The only question was when it should be written down, and by how much. The Directors advised the shareholders to defer it until the value of the new electro-chemical process, invented recently by Mr. Castner (Managing Director), and to which they attached great importance, could, to a certain extent, be ascertained.

The report was adopted.

West India and Panama Telegraph Company (Limited).

The following is the report of the Directors for the half-year ended 30th June last to be submitted to the thirty-first ordinary general meeting, to be held at Winchester House, on Tuesday, the 15th inst., at 12 o'clock:—

The amount to credit of revenue is £44,148. 17s. 7d., against £47,641. 16s. for the corresponding half-year of 1891, and the expenses have been £28,589. 6s. 4d., against £24,868. 16s. for the same period in 1891, leaving a balance of £15,559. 11s. 3d, which, with £2,122. 16s. 5d. brought from ast account, makes a total of £17,682. 7s. 8d., with which it is proposed to deal as follows:—

First Preference Shares—			
Dividend, six months to June 30th, 6s. per share..	£10,368	18	0
Second Preference Shares—			
Dividend, six months to June 30th, 6s. per share..	1,400	14	0
Ordinary Shares—			
6d. per share (free of income-tax)	2,208	0	6
Balance to current half-year's account	3,704	15	2
	£17,682	7	8

The traffic receipts for the six months show a decrease of £3,762. 3s. 11d. as compared with the corresponding period. This decrease is due to the reduction of tariff made in June last year.

The cost of repairs to cables amounted this half-year to £22,879. 0s. 10d., as compared with £11,936. 14s. 2d. for the corresponding period. Of this

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sum £8,528 has been charged against reserve. The increased expenditure is due to the number of interruptions and to the laying in of greater lengths of new cable to renew and strengthen the system. The most difficult repairing operation, included in the above expenditure, was that of the Jamaica-San Juan section, where the fracture was in a depth of 2,234 fathoms. Owing to this great depth of water the old cable broke frequently in the attempts made to lift it to the surface, and this necessitated an expenditure of 85 knots of new cable to bridge over the gap.

The Company's s.s. "Grappler" has been ordered to London to be surveyed, in accordance with Lloyd's requirements, and to be fitted with a new boiler. She will return to the West Indies with a cargo of 256 nautical miles of cable for stock.

It will be in the recollection of shareholders that it was announced at the general meeting held in May that the Board had to regret the loss of their valued colleague, Mr. Ford, whose death had occurred since the issue of the report then submitted. Sympathy with his family and appreciation of the value of his services to the Company were expressed at the meeting. The Board, from motives of economy, do not propose to fill up the vacancy.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322, *&c., &c.*]

BILLERICAY GAS COMPANY (LIMITED).—Capital £5,000, in £5 shares. This Company includes among its objects the business of supplying electric light, heat and power.

GLAUBER-FERRITE SYNDICATE (LIMITED).—Registered with a capital of £25,000, in £10 shares, to carry on the business of manufacturers of glauber-ferrite and of the plant, machinery and materials therefor, and to carry on the business of civil, mechanical, and electrical engineers.

LONDON MICA IMPORTERS (LIMITED).—This Company has been registered with a capital of £70,000, in £1 shares, to purchase and work mica mines, and to deal in mica generally.

NORTH AMERICAN CONSTRUCTION COMPANY (LIMITED).—A Company, under this title, has been registered, with a capital of £100,000, in £1 shares, to carry on (amongst other objects) electric light, telephone, telegraphic, and power supply works, &c.

STEPHANITE FLUX SYNDICATE (LIMITED).—This Company has been registered with a capital of £5,000, in £10 shares, to carry on the business of manufacturers of, and dealers in, an aluminium flux called "stephanite," and all aluminium and other alloys, and also the business of chemical manufacturers, metallurgists, &c.

W. WEEKS AND SON (LIMITED).—This Company has been registered with a capital of £25,000, in £5 shares, to carry on the business of mechanical and electrical engineers, iron and brass founders, &c., at the Perseverance Iron Works, Maidstone, Kent.

CROMPTON AND COMPANY (LIMITED).—The annual return of this Company, made up to August 12, 1892, has been filed. The nominal capital was at the time of making up £190,000, divided into 30,000 preference and 8,000 ordinary shares of £5 each, when 25,467 preference and 8,000 ordinary shares were taken up, and of these the ordinary shares were issued as fully paid to the vendors or their nominees (John F. Albright 2,432 shares and R. E. Crompton, 5,568 shares). Upon 20,000 of the preference shares the full amounts were called, upon 5,219 preference shares £2 per share called, and upon the remaining 248 preference shares £1 per share was called, resulting in the payment of £120,730 (which includes the payment of £10,044 in full).

HANLEY (STAFFS.) ELECTRICITY SUPPLY COMPANY (LIMITED).—This Company is to be dissolved.

J. C. HOWELL (LIMITED).—The statutory return of this Company, made up to November 1, 1892, has been filed. The Company was registered on July 9, 1892, with a capital of £25,000 in £5 shares. By an agreement of August 26, 1892, the Company acquired the said business in consideration for £10,000, which was fully satisfied by the allotment of 2,000 fully paid-up shares. At the time of making up 2,907 shares had been taken up, of which 2,000 had been issued as fully paid. Upon the remaining 907 shares the full amount had been called, resulting in the payment of £4,510 and leaving £25 as yet in arrears.

LINEFF ELECTRIC TRACTION AND LIGHTING SYNDICATE (LIMITED).—The annual return of this Company, made up to October 5th, has been filed. The Company was registered on August 8, 1888, with a capital of £10,000, in £1 shares, to acquire, introduce, work, and develop patents Nos. 8,380 and 13,447, of 1887. The patents were acquired by the Company for £8,003, which was fully satisfied by the allotment of 8,003 fully paid-up shares. At the time of making up 9,131 shares had been taken up, of which 8,003 shares had been issued as fully paid in accordance with the above agreement. Upon the remaining 1,128 shares the full amounts had been called, and all calls had been paid. The principal subscribers are Edward H. Bayley (3,396), J. Seymour Keay (3,932), Ann Batchmanoff (1,200), and Robert Applegarth (600).

LIVERPOOL SILVER AND COPPER COMPANY (LIMITED).—The annual return of this Company has been filed. The Company was registered in 1889 with a capital of £50,000, in £10 shares, to carry on the business of treating, by electrical or other processes, smelting, refining, converting, reducing, or assaying gold, silver, copper, or other ores and metals, and the manufacture of wire sheets and other forms of copper and copper alloys. At the time of making up all the shares had been taken up, £7 per share called, and all calls paid (£35,000).

LONDON AND HAMPSTEAD BATTERY COMPANY (LIMITED).—The statutory return of this Company has been filed. The Company was registered on May 13, 1892, with a capital of £50,000, divided into 7,000 preference and 3,000 ordinary shares of £5 each. At the time of making up 457 preference and 3,000 deferred shares had been taken up, of which the deferred shares had been issued as fully paid to Alfred W. Armstrong, the vendor. Upon 157 preference shares the full amount had been called, and upon the remaining 300 preference shares £2 per share had been called, resulting in the payment of £1,335, leaving £50 in arrears.

MAQUAY SYNDICATE (LIMITED).—A notice has been filed that at an extraordinary general meeting of the members of the above Company, held at 9, Frith-street, Soho, on August 27th, a resolution was unanimously passed (and at a subsequent extraordinary general meeting was duly confirmed), "That the Syndicate be wound up voluntarily under the provisions of the Companies' Acts, 1862 and 1867, and that Mr. Thomas Rawlins, of 45, King William-street, London, E.C., chartered accountant, be appointed liquidator." The Company was registered in September, 1889, with a capital of £12,000, in £100 shares. At the time of the last return (December 25, 1891) 92 shares had been taken up, of which 60 had been issued to Sir Edward R. Sullivan, Bart. (51), and Samuel W. Maquay (9), the vendors. Upon the remaining 29 shares the full amounts had been called, resulting in the payment of £2,550, leaving £350 in arrears.

NATIONAL TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to June 30, 1892, was filed on October 17th following. The Company was registered on March 10, 1881, with a capital of £600,000, divided into 15,000 preference shares of £10 each, and 90,000 ordinary shares of £5 each, to unite the businesses of the United Telephone Company (Limited) and the Provincial Telephone Company (Limited). The capital is now £4,000,000, divided into 30,000 preference shares of £10 each, and 740,000 ordinary shares of £5 each. At the time of making up, all the preference and 454,747 of the ordinary shares have been taken up, the full amounts called or considered as paid, and all calls (£2,573,735) paid. An agreement dated October 10th between George Gilmore, of Douglas, Isle of Man, and this Company, provides for the sale to the Company of the business and effects of the vendor relating to telephones, including the telephone exchange carried on by him, the benefit of all contracts with the subscribers to that exchange, the fittings, cables, wires, receivers, &c., in consideration for £2,100, which was to be satisfied by the payment of £1,500 in cash and the remainder in fully-paid ordinary shares.

CITY NOTES, &c.

CALLS DUE.—*Nov. 15:* CITY OF LONDON ELECTRIC LIGHTING COMPANY, £2 on 20,000 Cumulative Six per Cent £10 Preferences. *Nov. 21:* NOTTING HILL ELECTRIC LIGHTING COMPANY, £2 on 2,998 Preferences of £10.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The Stock Exchange Committee have ordered the further issue of 9,848 ordinary shares, Nos. 70,153 to 80,000, to be quoted in the Official List.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended November 6 were £891, as against £783 for the corresponding period of last year, being an increase of £108. The total receipts for half-year amount to £15,163, against £13,756 in the corresponding period of 1891, being an increase of £1,407.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the month of October were £2,307, against £2,436 for the corresponding period last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of the Company for the month of October amounted to £61,069 and to £60,784 in the corresponding period of last year, an increase of £285.

ELMORE'S.—The *Daily Chronicle* of yesterday contains the following:—"The Secretary of the Elmore's Patent Copper Depositing Company (Limited) has issued a circular to the shareholders, stating that the accounts of the Company for the past year are now in course of preparation, and will be shortly submitted to them. Since the date of the last general meeting the process has, it is stated, undergone further important developments, which have been brought to a thorough state of perfection. A thorough reorganisation has taken place with regard to the management of the business, and it has been considered necessary for the effectual control of the Company's affairs that the offices and books should be removed to Leeds, and that the Board meetings should be held at the works[!]. To facilitate this change, three of the London Directors [names not given] have retired in favour of two gentlemen resident in the Midlands, who have agreed to join the Board, both of the Elmore's Patent Copper Depositing Company, Limited, and the Elmore's Wire Manufacturing Company, Limited. The two new Directors—Mr. Terah Hooley and Mr. William Goode Johnson—have lately acquired a very considerable interest in the companies, one of them holding over 10,000 shares."

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GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for October amounted to £24,000, and from January 1st to October 31st to £223,600. In the corresponding months of 1890 and 1891 the amounts were £232,800 and £237,800 respectively.

REUTER'S TELEGRAM COMPANY.—An error occurred in a City Note in our last issue referring to the application made by this Company to the Stock Exchange Committee to appoint a settling day. The amount should have been 1,000 shares of £8 each, instead of £1,000 in shares.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended October 31st show an increase of £67, as compared with the corresponding period. The traffic receipts for the two weeks ended 15th October, 1892, were £2,072, and not £2,470, as previously published.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Nov. 4, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,834.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 2.	Price Wednesday, Nov. 9.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 9. Highest.	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	50½ 51¼	50½ 51½	4 17 1	Jan., Apr., July, Oct.	51½	50½
£2,876,140	Stock	25/0	Do. Preferred	91 92	91 92	5 15 5	" "	91¾	90¾
£2,876,140	Stock	5/0	Do. Deferred	11¼ 11¾	11½ 12	..	" "	11⅝	11¼
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July ..	..	..
130,000	£10	4/0	Brazilian Submarine xd and bonus	10¾ 11¼	10¾ 11½	5 15 7	Mar., June, Oct., Dec.	11⅛	10⅞
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	103 107	103 107	4 13 6	June and December	..	..
$7,716,000	$100	$1½	Commercial Cable Capital Stock	168 173	174 176	3 19 7	Jan., Apr., July, Oct.	175	171
16,000	10	8/0	Cuba Submarine	11½ 12½	11½ 12½	6 19 2	February and August	..	..
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	3¼ 3¾	3 3½	4 11 5	April and October..	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅛ 11⅜	11½ 11⅝	5 19 2	Jan., Apr., July, Oct.	11⅜	11 9/16
400,000	10	2/6	Eastern	14⅜ 15⅛	14⅞ 15⅛	4 5 10	" "	15⅛	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	15½ 16	15⅝ 16½	3 13 10	" "	..	..
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock.. xd	110 113	109 112	3 11 5	May and November	111½	110
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	110	..
250,000	10	2/6	Eastern Extension	15¼ 15½	14⅞ 15⅛	4 12 7	Jan., Apr., July, Oct.	15⅜	15 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	110½	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	103 106	104 107	4 13 6	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103 106	103 106	4 14 4	" "	105½	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	103 106	3 15 6	February & August	105¾	..
180,227	10	1/9	Globe Telegraph and Trust	10⅛ 10⅜	10 10⅛	4 12 8	Jan., Apr., July, Oct.	10⅜	10⅛
180,042	10	6%	Do. 6 per Cent. Preference	15⅜ 15⅝	15⅛ 15⅜	3 18 1	" "	15⅝	15
150,000	10	5/0	Great Northern	18⅜ 19	18⅜ 19¼	4 8 4	Jan., April, and July	19	18⅞
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	105 108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European xd	43 45	43 45	5 11 1	May and November	44	..
38,348	10	4/0	London Platino-Brazilian	6 7	6 7	5 14 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	106 109	107 110	5 9 1	March & September	..	..
10,802	8	4/0	Reuter's	7 8	7 8	5 0 0	April and October..	7 11/16	..
3,381	£100 Cert.	30,0	Submarine Cables Trust 6%	118 122	117 121	4 19 2	" "	118	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	102¼	..
30,000	10	2/0	West Coast of America	3 4	3 4	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	103 107	103 107	7 9 7	June and December	..	..
88,321	10	6d.	West India and Panama	1⅜ 1⅝	1¼ 1½	..	" "	1 7/8	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10¼ 10⅜	5 11 7	May and November	10 1/16	10¼
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½ 9½	9 10	6 0 0	" "	..	..
64,242	15	6/0	Western and Brazilian	8½ 9	8½ 8⅝	5 3 0	" "	8⅝	8½
33,129	7½	1/6	Do 5 per Cent. Cumulative Preferred	6 6½	6 6⅛	5 15 3	" "	6½	6 1/16
33,129	7½	4/6	Do. 5 per Cent. Deferred	2½ 3	2½ 2⅝	..	" "	2⅛	2⅜
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	105 108	5 11 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	105 108	5 11 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage xd	120 125	120 125	5 12 0	May and November	123½	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	3 4 0	..	..	..
224,880	14/0	1⅝d.	Consolidated Telephone Const. & Maintenance	⅛ ⅝	¼ ⅜	6 10 10	May and November	..	..
220,000	£1	4⅜d.	Oriental (11s. paid)	5/16 5/16	⅜ 7/16	7 18 2	Yearly	..	..
438,984	5	3/6	National	4⅜ 4⅝	4¾ 5	6 0 0	June and December	..	..
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 14½	14 14½	4 2 9	" "	4 1/16	4⅜
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13½ 14	13½ 14	4 5 9	" "	14½	14
420,000	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	111 113	111 113	3 19 8	January and July ..	13⅜	..
43,000	£10	..	New Telephone, Limited (£2 paid)	3½ 4	3⅝ 3¾	..	..	112½	111½
58,000	5	1/0	United River Plate	2¼ 2⅜	2¼ 2⅜	..	January and July ..	3 1/16	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	..	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	10½ 11	10½ 11½	..	..	10⅞	10 11/16
19,900	£5	..	Electricity Supply Co. of Spain	..	..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	..	..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	..	..	..
8,332	£5	..	House to House Electric	2¼ 3⅛	..	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5½	..	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	5½ 5¾	..	..	..	..	..
30,000	£5	4½% '91	Liverpool Electric Supply (£3 10s. paid)	3 7/16 3 9/16	3 7/16 3 9/16	3 15 9	January and July ..	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 1/16 5 3/16	5 1/16 5 3/16	4 6 9	March	..	..
111,000	5	..	London Electric Supply	⅞ 1	⅞ 1	..	March	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	..	..	..
£50,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	104 107	104 107	4 15 3	..	6⅞	6⅝
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	..	June and December	..	..
18,680	£5	2/6	St. James' and Pall Mall	8 8½	8 8½	..	..	..	..
7,900	£5	7%	Do. 7% Preference	7⅞ 8¼	8 8⅛	..	..	8 5/16	8 3/16
42,853	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	..	..	8⅜	8¼
						2 10 0	..	5¼	5⅛
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1 9/32	Brush Electrical Engineering	3 3¼	3⅛ 3⅜	..	..	..	..
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2⅛ 2⅜	..	..	3½	3 1/16
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼ 5¾	5¼ 5¾	5 1 1	..	2 3/16	2⅛
12,139	5	17%	Edison and Swan United	..	..	6 7 3	January and July ..	5½	5¼
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	2¾ 3¼	..	..	..	..	..
45,000	10	12/0	Electric Construction	4¼ 4⅜	..	..	..	..	..
70,000	2	10/0	Elmore's Patent Copper Depositing	3⅛ 4	..	..	..	4¼	3
20,000	5	..	Fowler-Waring Cables (fully paid)	1¼ 1½	1⅜ 1⅝	..	..	1⅞	1⅜
50,000	10	10/0	India Rubber, Gutta Percha & c., Works	1½ 2½	2 3	..	..	2 3/16	2 1/16
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	21½ 22½	21½ 22½	5 11 1	February & August	22⅛	21⅜
11,334	£10	6/4	International Okonite Limited Ordinary	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	8/0	Do. Preference	2¼ 3½	2½ 3½	..	..	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	6 7	6 7	..	December and June	..	..
78,949	5	2/9⅜	Swan United (£3. 10s. paid)	3/16 ¼	3/16 ¼	..	..	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	3½ 4	3½ 3¾	10 4 10	May and November	3 1/16	3½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	44 46	45 47	5 2 2	March and July..	45⅜	45⅛
—	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	102 105	103 106	4 14 4	January and July	..	..
—	£5	8%	Do. Preference (fully paid)	¼ ¾	..	..	..	..	..
				2½ 3	..	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
50,000	£10	½%	City and South London Railway	2½ 3½	2½ 3½	1 8 6	..	..	..

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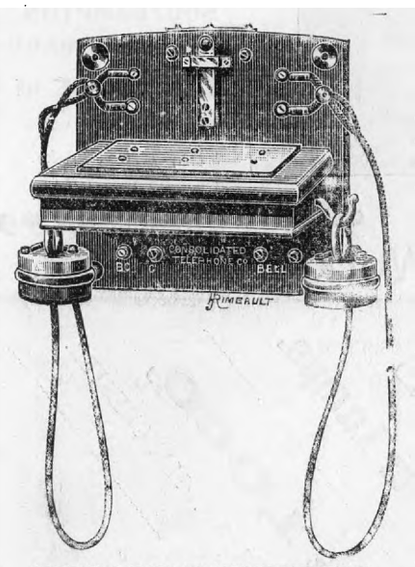

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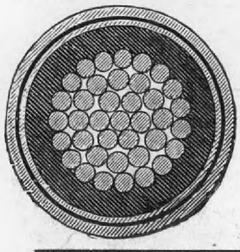

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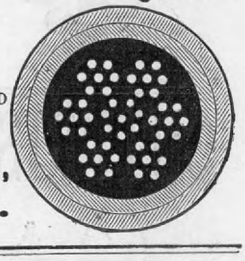

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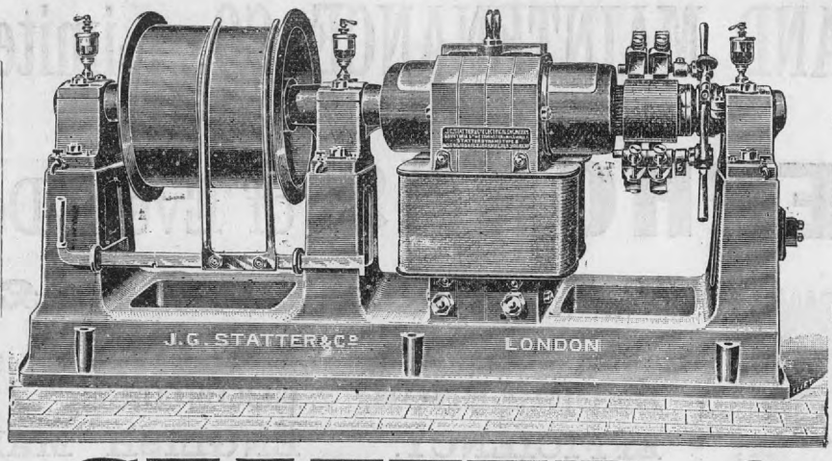

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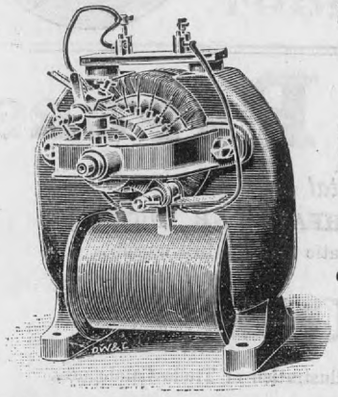

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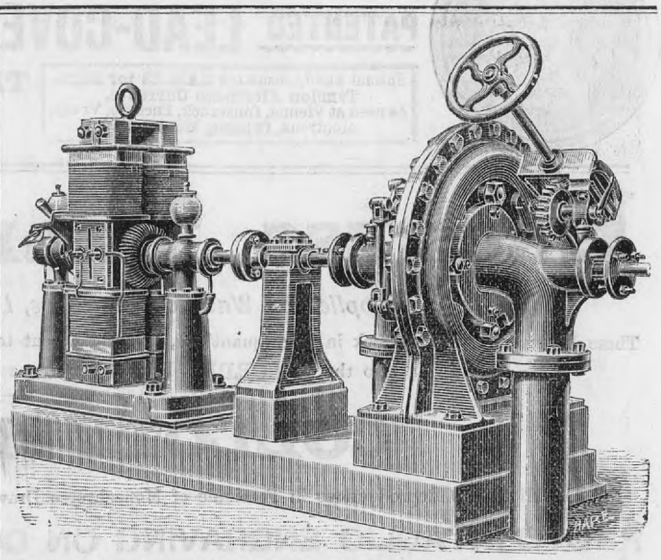

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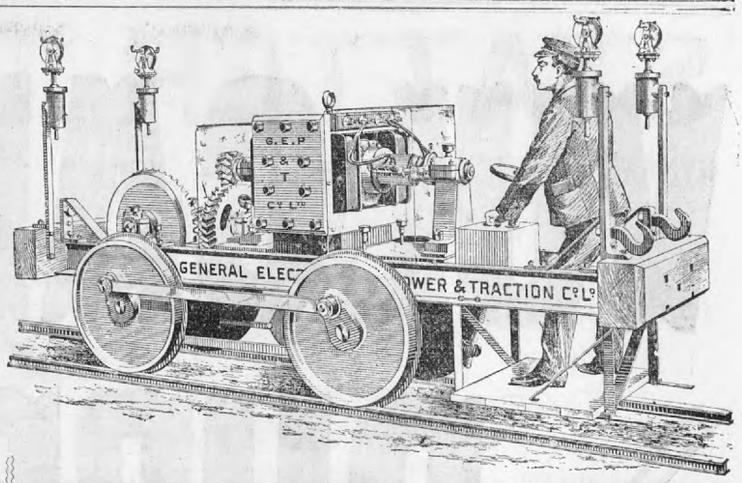

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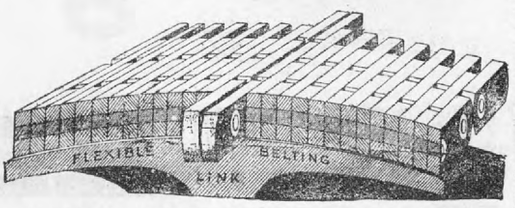

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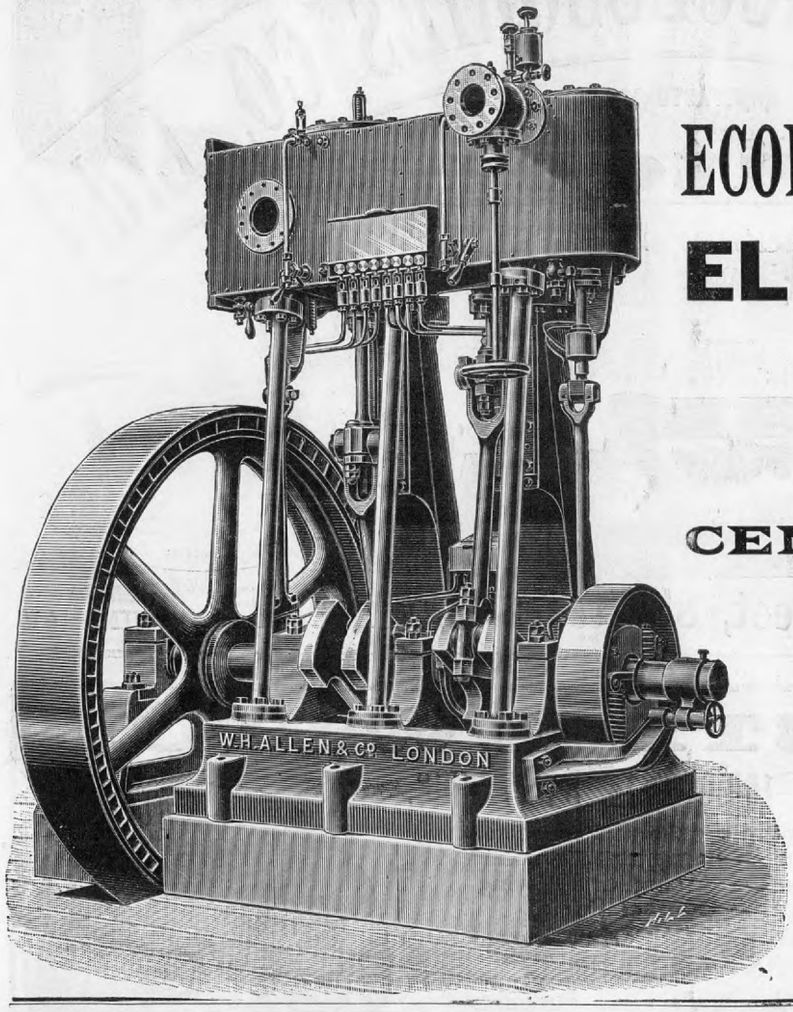

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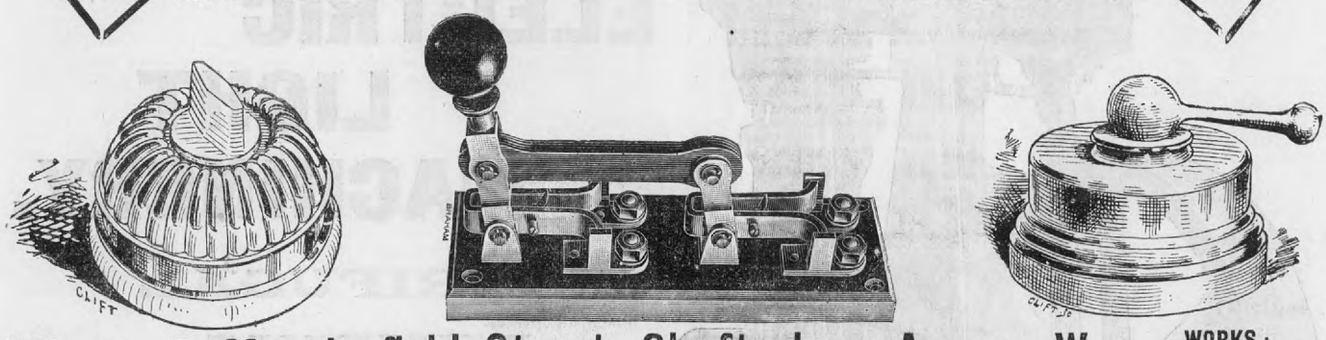

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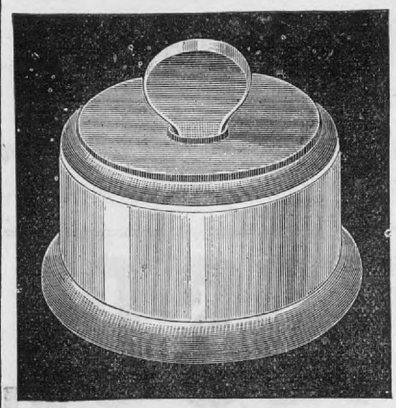

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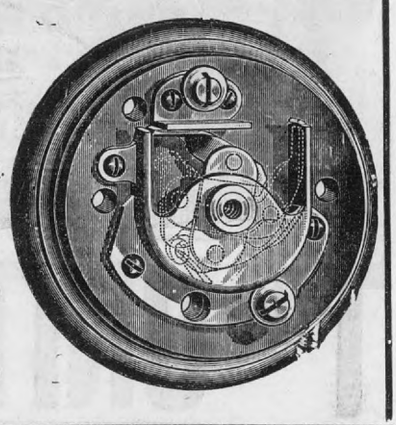

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Tenders must be made on the prescribed forms, and delivered at the offices of the Authority, 51, Prince-street, Bristol, by THURSDAY, the 1st December, 1892, and endorsed "Tender for Mains."

Copies of the Specification and form of Tender are now ready, and may be seen and obtained at the offices of the Sanitary Authority on payment of £2, which will be returned on receipt of a bona fide tender.

D. TRAVERS BURGES, Town Clerk.

51, Prince-street, Bristol,
November, 1892.

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NOTICE is Hereby Given that, in conformity with the conditions contained in the Debentures of the above Company, the following Five per Cent. Mortgage Debentures for payment at par, on the 2nd January, 1893, at the Banking House of Messrs. Barclay, Bevan and Co., 54, Lombard-street, London, E.C., when the interest thereon will cease, were this day drawn at the Offices of the said Company, at Winchester House, No. 50, Old Broad-street, in the City of London, in the presence of Sir James Anderson, one of the Directors, George Draper, Esq., Secretary of the said Company, and the undersigned Notary Public.

NUMBER OF DEBENTURES DRAWN THIS DAY.

328 Debentures, Nos.—

3	752	1226	1710	2269	2891	3463	4142	4735	5315
20	753	1258	1714	2299	2892	3510	4159	4742	5321
28	765	1309	1721	2301	2911	3537	4163	4743	5347
53	769	1320	1752	2303	2916	3545	4170	4828	5381
104	779	1321	1757	2308	2937	3573	4175	4832	5408
107	804	1334	1770	2375	2950	3587	4196	4864	5415
123	806	1357	1777	2389	2951	3641	4208	4870	5462
124	825	1389	1778	2398	2954	3647	4216	4902	5477
150	834	1444	1781	2405	2975	3650	4237	4941	5493
169	844	1461	1797	2423	2978	3664	4255	4975	5514
197	851	1470	1857	2437	2989	3704	4265	4978	5520
235	879	1480	1895	2443	3022	3723	4301	4979	5521
242	917	1487	1900	2451	3044	3748	4323	4981	5558
250	919	1492	1907	2485	3059	3753	4352	4989	5567
295	941	1498	1940	2500	3066	3785	4368	4990	5602
298	954	1501	1969	2522	3069	3800	4372	4995	5665
354	956	1503	1978	2537	3135	3829	4418	5025	5675
257	975	1517	2018	2545	3136	3835	4422	5047	5711
358	977	1526	2064	2610	3153	3862	4446	5049	5719
364	1037	1528	2066	2612	3167	3885	4448	5067	5745
403	1067	1530	2080	2676	3207	3895	4493	5081	5765
434	1073	1538	2083	2687	3212	3921	4530	5082	5773
478	1083	1579	2108	2715	3214	3970	4569	5086	5788
559	1089	1590	2123	2724	3244	3991	4571	5121	5799
571	1101	1630	2153	2732	3281	3996	4583	5126	5806
576	1104	1643	2154	2765	3283	4001	4589	5143	5827
607	1105	1647	2159	2785	3246	4002	4606	5145	5894
655	1121	1660	2171	2787	3327	4004	4616	5156	5915
675	1133	1666	2184	2814	3333	4045	4623	5161	5936
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688	1179	1697	2232	2835	3413	4077	4678	5198	5955
712	1181	1703	2240	2840	3433	4079	4692	5217	
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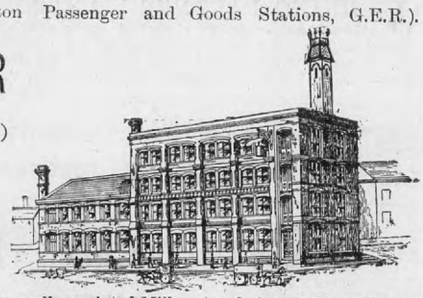

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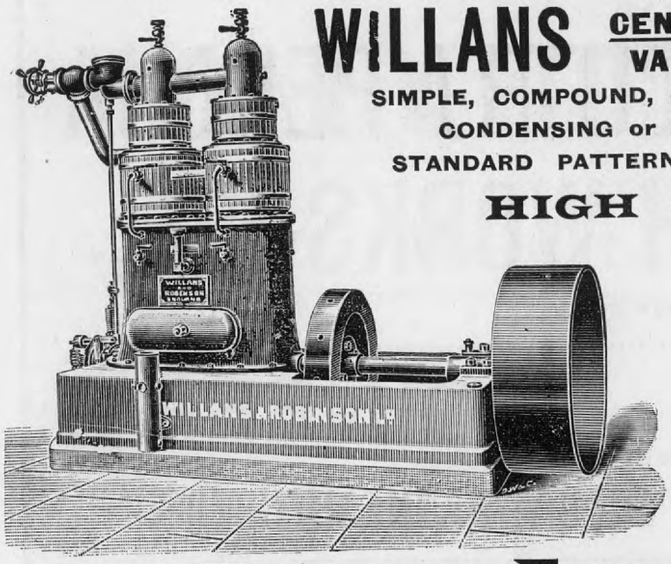

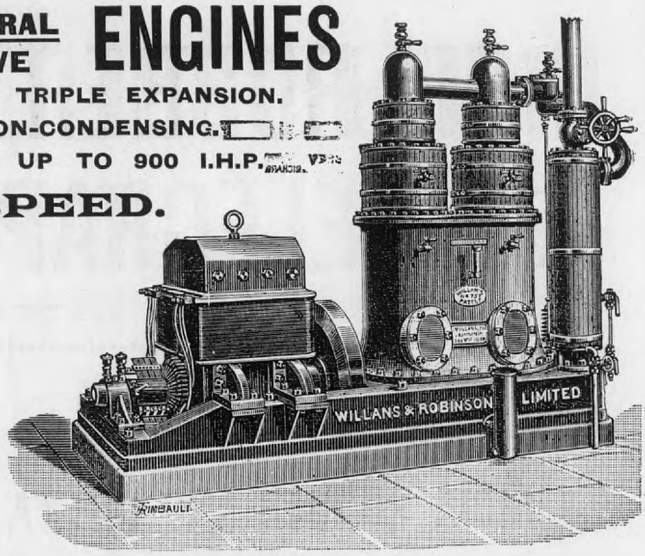

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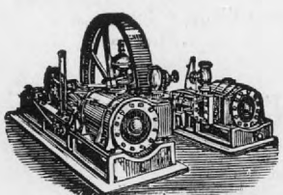

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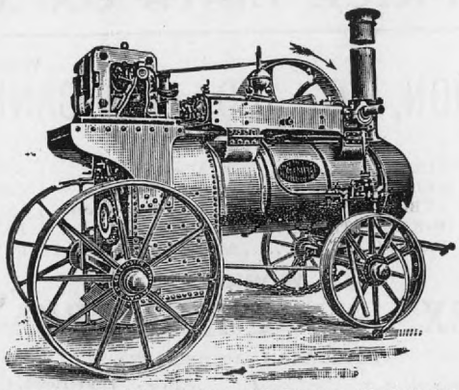

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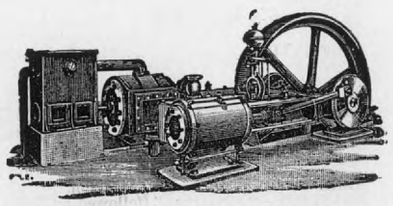

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 757.—Vol. XXX. FRIDAY, NOVEMBER 18, 1892. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6.

NOTES.

The sad fatality on the 9th instant is the first case in this country of the death of a workman while engaged in work upon high-pressure electric conductors. On January 3, 1887, a fire broke out in Regent-street, either in the transformer closet or near it, and a man went on the roof and cut the wires with a pair of shears. A moment later he fell through a skylight a distance of 60ft. There was no evidence to show that he received a shock. On March 7th last a tailor's salesman at Chatham, seeing sparks coming from a transformer, attempted "to beat out the fire" with an iron bar, and received a fatal shock. In one sense these were accidents, and though at Chatham the insulation was undoubtedly defective the fatal result was not directly due to this fault.

The accident at Brompton, on the other hand, occurred under ordinary conditions of everyday work, and in spite of precautions, which a coroner's jury deemed to be sufficient. The Supply Company is protected by the following letter, of which Mr. Gay has, at our request, sent us a copy :—

The House-to-House Electric Light Supply Company (Limited).
Central Electric Lighting Station (Kensington),
Richmond-road, S.W., June 24, 1892.

Mr. Lang. Works.

Sir,—Under no conditions must any part of any high tension main be touched while the current is on, and no work of any description to be done on the mains or instruments connected therewith without using the rubber gloves provided for that purpose.

Great care must be taken to see that these gloves are in proper condition before using.—Yours faithfully,

(Signed) H. W. Bowden, Assistant Manager.

It appears that the current was turned off at 11 a.m., and was turned on again at 3 p.m. The accident occurred after 4 o'clock. The inconvenience of working in rubber gloves, and the temptation to discard them, may be compared with the use of the Davy lamp by coal miners. By long practice with rubber gloves it may be possible to do something more than haul at a cable, but they are a nuisance, even for such work as that, and it is no wonder that the men do not wear them. The real causes of the accident appear to have been due to the continuing of the work after the current was on, and the non-observance of the rule about wearing gloves. The fault on the cable was a matter of comparatively small importance, the leak would soon have been discovered in the usual way, and such defects are sure to occur sooner or later. It would be better to assume that such bad places are common. In the management of fiery coal mines and powder magazines a letter to each *employé*, together with verbal cautions, would hardly be considered sufficient; nor would an elaborate code of rules be of much value unless they were enforced by careful superintendence.

It will be remembered that Prof. Ewing showed two forms of his magnetic curve-tracing instrument at Edinburgh during the meeting of the British Association. One of these was arranged for moveable test bars, and the other was provided with a fixed core of soft iron wire. The curve-tracer, illustrated in another column, is of the second type, but it has passed from the rough experimental form into a very neatly designed and symmetrical instrument. No description of the rotary commutator used with this apparatus has previously been published. The most obvious use of this curve-tracer is for lecture purposes, or class demonstrations, but we confidently expect to find that some interesting additions to our knowledge of the magnetic properties of iron will be made by means of it, especially if mechanical improvements can be introduced to allow higher speeds to be used. Prof. Ewing has probably given careful consideration to this point, and the difficulties in the way of projecting a fair-sized diagram on a screen at a high speed are considerable. An inspection of the diagram of the mirror and aluminium cradle suggests that the dimensions of this essential part of the apparatus might be greatly reduced if the projection were abandoned, and the image observed by a microscope, as in the original form of Lissajous' experiment. Any new phenomena thus observed might be photographed with low amplification, and afterwards enlarged. Helmholtz, it will be remembered, examined the vibrations of stretched strings by observing through a microscope the movements of a brightly illuminated starch grain fixed to the string.

Independently of Prof. Ewing, and we understand before he had constructed the early form of his curve-tracer, Mr. Searle had drawn magnetisation curves by means of an instrument recently described by him before the Cambridge Philosophical Society. In his apparatus a vertical wire is suspended in galvanometer fashion, and is turned on the axis of suspension by a needle fixed to the upper end of the wire while the lower end carries a fork, in which a mirror is strung on a horizontal axis. The control being feeble, the system must be allowed to come to rest between successive readings

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(about five seconds is sufficient), and a curve with 30 points may be described in about five minutes. For lecture purposes the spot of light may be taken round in about one-and-a-half minutes.

A GALVANOMETER recently shown to the Physical Society was, if we remember aright, described as of the Ayrton-Mather-Deprez-d'Arsonval type, and as it contained a mirror, the name THOMSON ought to have been added. We illustrate in another column a dynamo and engine, which should, by the same process, be called a Parsons-Ewing-Tesla-Gordon-Lontin-Muirhead-Hopkinson-high-frequency-turbine-combination. MUIRHEAD and HOPKINSON were, we believe, the first to use the zigzag winding, LONTIN used radial magnets and armature coils, TESLA largely increased their number, GORDON constructed a cone of boiler plate. Without a Parsons' engine to run it at 12,000 revolutions per minute, 14,000 complete cycles per second could not have been achieved, and it remained for EWING to cast the whole together. This is not called invention nowadays; nor was he the designing engineer, for how can a professor be an engineer? (See our Correspondence Columns.) But for EWING it would not have been built, that is safe; and but for Messrs. C. A. PARSONS and Co. it would not have been presented to the Engineering Laboratory at Cambridge.

OF the many experimenters who have investigated the fusing current of wires, none have taken into account the conditions which so greatly modify the result with such care as Herr C. FELDMANN. In ordinary practice, the size of the terminals is of considerable importance, and reliance placed upon the fusing point of long wires will lead not only to errors, but errors which are in the direction of danger. In another column we print a diagram prepared by Herr FELDMANN, to show the fusing current for any length and diameter of a given material, and clamped between terminals of given dimensions. By arranging special scales of length and diameter, the lines from which the co-efficients are found become straight. In such diagrams, interpolation between any two co-ordinates is rather difficult, especially for small values, but as the result has to be determined by interpolation between two of the slanting lines, only an approximation can be arrived at. In several other respects this form of diagram presents advantages.

IN commenting upon the driving of a loom by an electric motor, some time ago, we briefly discussed the application of motors to cotton-spinning machinery. After throwing out the suggestion that there was ample choice for the electrical engineer between one motor for each mule, or smaller ones at higher speeds, mounted on the carriages and driving the tin rollers direct, we made the very safe estimate that one-third, if not one-half, of the power at present expended might be saved. A Paper, by Mr. ALFRED SAXON, was read recently before the Manchester Association of Engineers upon "The Comparison of Friction in Cotton Mill Engines and Gearing to the Actual Work Done." In this Paper, of which we give an abstract in another column, the author appears to have compared the indicator diagrams of certain engines under full load and the same engines when running light. For the purpose in view he is no doubt justified in taking the difference between these two quantities as the "percentage of friction and total load," while this percentage deducted from 100 leaves "actual work done."

CAREFUL mechanical engineers, such as he from whom a quotation is given at the beginning of Mr. SAXON'S Paper, would hesitate to accept this mode of reckoning the efficiency, for several reasons into which we need not enter; but it must be admitted that an analysis of the different kinds of friction, of the differently resolved stresses, and of the behaviour of the steam would be extremely difficult, and would not, perhaps, materially alter the general result. About one quarter of the indicated power was spent on the engines and gearing (the main gearing only, we presume), the remaining 75 per cent. going to "friction in the machinery itself and the work done by the machinery." The distributing shafting appears to have been included as "machinery." This Paper makes, then, the first step in an inquiry which should be of great interest to those who are engaged in the construction of electric motors, and the determination of the power spent on the separate machines is a matter which could be settled without much difficulty by some of our Midland technical colleges.

WHETHER the distribution of power from a direct-driven dynamo to each machine in a cotton mill would pay or not depends largely upon the ratio of the cost of coal to the other manufacturing expenses. The enthusiasm, which we hope to share some day, about the utilisation of Niagara seems to be based upon the idea that, not only is the cost of coal so great that an enormous capital may be safely expended in supplying a cheaper source of energy, but that cheap power is such a *desideratum* that new industries and manufactures will be attracted to a district within which such power is available. If coal is of this importance in cotton spinning it must be worth while to save it. Shafting is cheap enough, and belts have wonderful lives in textile work, under careful management. The question practically becomes merely one of interest on dynamos and motors against cost of coal wasted on friction.

ABOUT this time last year we published an account of some experiments, by Prof. J. J. THOMSON, on the electrical oscillations induced in vacuum tubes. Certain tests made in connection with magnetic materials showed that iron and similar substances remained magnetic even for such rapid oscillations. Some of the numerous experiments made by Dr. LODGE, to account for the action of lightning rods, can also only be explained by supposing that the magnetism of iron is capable of following extremely rapid changes of magnetic force. We publish this week an account of some work of M. V. BJERKNES, which offers independent evidence confirming this conclusion. The object of the research was to investigate the rate at which the energy in Hertz resonators is dissipated in heat, and it was found that, for non-magnetic wires, this rate depends

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merely on the resistance of the wire, and is independent of the nature of the material. With magnetic substances, however, a different law holds, and these results are in accordance with the theoretical conclusions of OLIVER HEAVISIDE and Lord RAYLEIGH, who showed that the magnetic nature of the material causes an increase of what is known as the "skin effect" occurring in all conductors through which rapid alternating currents pass. The increase in the resistance of the conductor, due to the crowding of the currents to the surface of the metal, was first shown experimentally by Prof. HUGHES, and forms the explanation of many of the results of Dr. LODGE. M. BJERKNES has investigated this effect in a most ingenious way, and his results are conclusive in showing that iron remains magnetic under the action of very rapid magnetic forces.

Coventry.—Mr. Graff Baker is negotiating with the Town Council for equipping the tramway system of the town with electric cars.

Hopkinson v. St. James and Pall Mall Electric Light Company.—The hearing of this case is expected to be resumed on Tuesday next.

Whitehaven.—The Local Government Board has sanctioned the borrowing of £14,000 for purposes of electric lighting, to be repaid within a period not exceeding 20 years from the date of borrowing.

Bristol.—At their meeting last week the Town Council resolved, without discussion, that the area included in Schedule B in the Bristol Electric Lighting Order, 1883, should be added to the area of supply under the said Order.

Electric Traction in Chicago.—The Westinghouse Electric Manufacturing Company have signed a contract with the Chicago City Railway Company for the complete equipment of 61 cars with single-reduction motors; also for four 200 H.P. generators.

The Protection of Buildings from Lightning.—Some five-and-twenty lightning rods guard the Louvre against the depredations of lightning. It is reported that only one is in good order, the remaining four-and-twenty being either discontinuous or disconnected from earth.

National Telephone Company.—The National Telephone Company are making rapid strides in the Newcastle district. From August 1st to October 31st 123 subscribers have been added to the system, making the total number in the northern district at the latter date 2,375, or on Tyneside only, 886.

Presentation.—The *employés* of the New Telephone Company at Manchester recently presented Mr. G. J. Somerville, the late Manager, with a silver tea service. Mr. Somerville is leaving Lancashire, where he has managed the Manchester Exchange since its opening, to take charge of the Company's metropolitan district.

Personal.—Mr. H. F. Lewis, of the National Telephone Company, and for several years Manager and Secretary of the late Western Counties and South Wales Telephone Company, has, it is stated, been appointed General Manager to the London Electric Supply Corporation, and takes up his new duties at the beginning of next month.

Chesterfield.—At a special meeting of the Town Council last week, it was decided, by ten votes to seven, to apply for an Electric Lighting Provisional Order, "so that, whether they went in for supplying the town with electricity or not, they would be in a position to avert any monopoly, and to make terms with any company which might approach them on the subject."

Magnetische Induktion.—We have received from Herr Julius Springer, of Berlin, a copy of Prof. Ewing's "Magnetic Induction in Iron and Other Metals," which has been translated into German by Dr. L. Holborn and Dr. St. Lindeck. We notice that in an appendix a description is given of Prof. Ewing's curve-tracer, and of the du Bois magnetic balance, with illustrations.

Proposed Tubular Railways.—It is intended to proceed during next session with a Bill for the construction of an underground electric railway from Paddington to South Kensington. It is understood that the promoters of the Bill believe that the scheme has been so altered as to meet the objections raised last year. It is intended to extend the subway to Clapham Junction, passing under the Thames at Chelsea.

Fire in Regent Street.—A fire broke out at about 4 o'clock on Wednesday morning in one of the windows of the London Stereoscopic Company's premises. The official report states that it was due to "overheat of electric wires." We learn from the St. James' and Pall Mall Company that the wiring was noted in their books as good, and our inquiries on the spot failed to elicit anything to support the suggestion that the fire was due to electrical causes.

Cable Restorations:—

	Interrupted.		Restored.
Jamaica-Colon	Oct. 13, 1892	.....	Nov. 8, 1892
Hong Kong-Amoy	Oct. 22, 1892	.....	Nov. 10, 1892
Chuy-Monte Video	Nov. 9, 1892	.....	Nov. 11, 1892

Cables actually interrupted.	Date of interruption.
Bolama-Bissao (communication with)	September 9, 1892
Cayenne-Vizeu	September 24, 1892
Para-Maranham.....	October 15, 1892
Ceara-Maranham	November 9, 1892

The London Telephone System.—Mr. Barrs has placed the following motion on the agenda paper of the London County Council:—"That it be referred to the General Purposes Committee to consider and report whether the Council has powers to establish and work a telephone system in London similar to the system established and worked by the municipalities of Christiana, Liverpool, Manchester, and other towns; and, if so, to consider and report as to the desirability of exercising such powers." It may be worth while observing that not one of the municipalities referred to works—the telephone?

Huddersfield.—The work in connection with laying the electric light mains, which has been done in a most substantial and careful manner, has made very satisfactory progress, and is now nearly completed, there being 2,900 yards of conduit laid for the high pressure mains, 3,550 yards of conduit laid for the low pressure mains, and 64 junction boxes. The occupiers of a number of shops and offices have already applied to be connected to the mains. Some very advantageous positions have been secured for the transformer stations which are now in course of erection, and will be soon completed. By the spring of the coming year the electric supply will be commenced.

Taunton.—At a special meeting of the Town Council on Friday last the following resolution was passed by 14 votes to 1:—"That application be made to the Board of Trade for a Provisional Order under the Electric Lighting Acts, 1882 and 1888, authorising the Mayor, Aldermen, and Burgesses of the Borough of Taunton to supply electricity for public and private purposes within the said borough, and also within the Rural Sanitary District of the Taunton Union, or some part thereof, and that the Town Clerk be authorised to take the necessary steps for carrying this resolution into effect, and that the corporate seal be affixed to the memorial to the Board of Trade and all other documents relating to the application."

The Late Mr. Graves.—The remains of the late Mr. Graves were interred at Hammersmith Cemetery on Saturday noon last, in the presence of a large concourse of friends who had assembled at the grounds, in addition to the mourners who rode in the funeral *cortége* from Earl's Court. At the gates of the cemetery the procession was met by a detachment of Royal Engineers employed by the Post Office and the crew of the Department's cable-ship "Monarch," the whole falling in with the civilians who immediately followed the coaches. Divisonal engineers, besides higher officials, past and present, of the Postal Telegraph Service, and representatives from many tele-

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graph construction and engineering firms attended in considerable numbers.

The Electric Lighting of the Guildhall.—The electric lighting at the Guildhall, says the *City Press*, naturally attracted particular attention on the 9th. "The Library installation will clearly need some alteration, the lamps in the bays shedding a sufficient light on the books below, but leaving the rows above in almost absolute darkness. If these lamps, instead of being suspended in the middle of the bays, were raised a few feet higher, and arms were projected from the lower shelves, every part, including the tables, would be sufficiently illuminated. Even then we could not fail to remark that the Library installation is exceedingly plain as compared with the installations in the Council Chamber at Guildhall, which is really beautiful, the electroliers being most artistically coloured and designed."

Engineering at Cambridge.—The following letter from Prof. J. A. Ewing appeared in *The Times* of Monday :—

"The report of 'University Intelligence' which appears to-day (Friday) in *The Times* omits an item of sufficient consequence to excuse my asking you to give it this publicity. Amongst the 'graces' voted yesterday were three which have the effect of establishing a Tripos of Mechanical Science. The new tripos has been framed in the interests, especially, of engineering students, its purpose being to allow them to follow a curriculum of study in mathematics, mechanics, and the theory of engineering of the kind most appropriate to men who are afterwards to adopt the profession of engineer. The first examination in the new tripos will be held in 1894, and I am glad to say that a good number of students have already begun to prepare for it. The scheme was adopted by the Senate without opposition or even criticism. It would be a pity, however, if the very unanimity with which it has been received were to prevent the public from being made aware that a tripos in engineering is now an accomplished piece of University legislation. The University is appealing for subscriptions to enable it to supply what is yet lacking in the way of engineering laboratories. Meanwhile it has taken a step of vital importance in the development of its engineering school by making a scientific training in engineering form one of the avenues to its honours degree."

The Drilling of Telegraph Messengers.—The new Postmaster-General is said to be giving much encouragement to the arrangements, which are now taking permanent form, for the drilling of telegraph messengers in London. More than 3,000 messengers are distributed over the metropolitan districts, and 1,000 of these are drilled alternately every third week. Nearly 500 boys from the Central Telegraph Office, the Eastern Central district, and the Eastern district, whose duties do not begin until after 10 a.m., paraded early Thursday morning last week, and marched to the Tower, where they were put through certain military evolutions and physical drill in the presence of the Postmaster-General, who subsequently addressed the lads. He announced that the Department was arranging a system of prizes as rewards for proficiency at drill and general smartness. With Mr. Arnold Morley were Mr. J. C. Lamb, assistant-secretary, the controllers of the Central Telegraph Office and the London postal service, several district postmasters, and other of the higher officials of the Department.

The Hydrophone.—The Portsmouth correspondent of *The Times* states that Capt. M'Evoy's ingenious telephonic apparatus for defending roadsteads, anchorages, and minefields, by giving warning by visible and audible signals on shore of the approach at night, or during thick weather, of torpedo boats or other hostile vessels, has just been subjected to experiments extending over several weeks at the mining establishment in Stokes Bay, where it was witnessed in operation by Col. Vetch, of the War Department, a committee of Royal Engineers from Chatham, and various officers belonging to H.M.S. "Vernon." The instrument is called a hydrophone, and consists of two parts. One part is placed on the sea bottom at a depth of from 5 to 15 fathoms, and the other is fixed in a station on the shore. In the present instance the instrument was sunk in 7 fathoms and about 300 yards off Fort Gilkicker. The submerged part consists of a bell-shaped iron case, three-quarters of an inch thick, 20in. in height, and extreme diameter, and weighing about 340lb. At the top a diaphragm is fitted. No sooner does a boat approach within a radius of half-a-mile or so than the pulsations of her propeller produce a vibratory movement inside the case, which is transmitted electrically to the shore. The whole of the operations were successfully performed in the presence of the visitors. It is contended, also, that another field of operations is open to hydrophones in dangerous zones around certain headlands.

Electric Light Fatality.—An inquest was held on Monday last at the Kensington Town Hall concerning the death of T. P. Lang, aged 23 years, an *employé* of the House-to-House Electric Lighting Company, who was killed by an electric shock on Wednesday last week. David Young said that Lang was working with him on the day in question in Roland-gardens, Brompton-road. Lang was in a box, and the witness signalled to him to draw in the slack of a 7/21s. cable after a joint had been made on a service wire. Lang drew it about a foot and then suddenly stopped. The witness looked and saw him lying over the hole, and immediately procured a pick and broke the wire. Only half a minute elapsed from the time when the witness noticed the deceased until the time he broke the cable. The current was on at the time. He did not notice if there was any rubber between Lang's hand and the wire. Mr. H. W. Bowden, engineer and assistant manager to the Company, said that he had examined the cable and had no hesitation in saying that it was a cable that any man could safely work on with the current on, but he thought that while the man was pulling the cable out, he must have come to a part where the rubber was off the wire. The part of the cable where it touched the man's hand was bare. He could not say whether the rubber was removed before the accident, or by the heat of the man's hand. The current was at a pressure of 2,000 volts. The men were supposed to use rubber gloves, and a letter was sent to Lang on June 24 cautioning him against touching any of the wires without using the gloves provided. If Lang had worn the gloves the accident could not have occurred. Dr. H. A. Clowes said the deceased was dead when admitted to the Jubilee Hospital. The palm of the hand and the two first fingers of his left hand were charred and burned. There was no burning or singeing of other parts of the body. There was a marked fluidity of blood throughout the body, but there was not a clot of any sort. The jury returned a verdict of "Accidental death," and exonerated the Company from all blame.

The Telephones and Electric Traction.—The case of the Hudson River Telephone Company against the Watervliet Turnpike and Railroad Company was decided at the end of last month by the New York Court of Appeal. The Telephone Company complained of injuries to its system due to the adoption of the single trolley system. The Court stated that the Telephone Company was not using the streets for one of the purposes to which they had been dedicated as public highways, while the Turnpike Company was using them in such a manner as to expedite public travel. The Telephone Company was there by virtue of a legislative grant, revocable at the pleasure of the power that created it, and it was a part of its contract with the State that the maintenance of its lines of communication should not prevent the adoption by the public of any safe and expeditious mode of transit. It was found that the Turnpike Company's use of electricity in the propelling of its cars rendered the operation of the Telephone Company's telephones at all times difficult and sometimes impracticable, and this disturbance could not be avoided by the Turnpike Company without a complete change of the system adopted by it. To require such change to be made would be to grant to the Telephone Company that which the Legislature had expressly withheld. But the Telephone Company was exposed to another danger. The Turnpike Company allowed the electric current to escape directly into the ground, and the most serious loss which the Telephone Company sustained resulted in the current spreading upon the Telephone Company's grounded wires. The Court was not prepared to say that a person, even in the prosecution of a lawful business upon his own land, could gather there by artificial means a natural element like electricity and discharge it in such a volume that, owing to the conductive properties of the earth, it would be conveyed upon the lots of his neighbour with such force as to interfere with the rightful enjoyment of the use of his property, and not be liable for the damages resulting therefrom. Still, it was not required in this case to decide that point. For these reasons the previous decision in favour of the Telephone Company was set aside.

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ELECTROMAGNETIC THEORY.—XXXIX.

BY OLIVER HEAVISIDE.

(*Continued from page 663, Vol. XXIX.*)

§ 171. The reader of Prof. Tait's profound treatise on Quaternions will probably stick at three places in particular, to say nothing of the numerous minor sticking-points that present themselves in all mathematical works of any value, and which may be readily overcome by the reader if he be a real student as well. First, there is the fundamental Chapter II., wherein the rules for the multiplication of vectors are made to depend upon the difficult mathematics of spherical conics, combined with versors, quaternions and metaphysics. Next, Chapter IV., where the reader may be puzzled to find out why the usual simple notion of differentials is departed from, although the departure is said to be obligatory. Thirdly, Chapter V., where the reader will be stopped nearly at the beginning by a rather formidable investigation of Hamilton's cubic. Only when the student is well acquainted with the nature of linear operators and how to work them can he tackle such an investigation. He should, therefore, pass on, to obtain the necessary experience. On then returning to the cubic he may find the investigation not so difficult after all, especially if it be simplified by some changes calculated to bring out the main points of the work more plainly.

The reader is led to think that the object of the investigation is to invert a linear operator—that is, given $\mathbf{D}=c\mathbf{E}$, to find $\mathbf{E}=c^{-1}\mathbf{D}$. But if this were all, it would be a remarkable example of how not to do it. For the inversion of a linear operator can be easily effected by other far simpler and more natural means. The mere inversion is nothing. It is the cubic equation itself that is the real goal. The process of reaching it is simplified by the omission of inverse operations. (It is also simplified by not introducing the auxiliary function called χ.)

The fundamental cubic is derived from equation (105), or the equivalent equation (110) last investigated. I should remark that this equation is frequently useful in advanced vector-analysis as a transformation formula, turning $\mathrm{V}c\mathbf{mcn}$ to a function of $\mathrm{V}\mathbf{mn}$. Now use the form (110), or

$$x\mathrm{V}\mathbf{mn}=c'\mathrm{V}c\mathbf{mcn}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (111)$$

where x is a known function of c, viz.,

$$x=\frac{c\mathbf{l}\mathrm{V}c\mathbf{mcn}}{\mathbf{l}\mathrm{V}\mathbf{mn}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (112)$$

Here c is any linear operator. Now if g be a constant, $g\mathbf{m}$ is a linear function of $\mathbf{m}$, and therefore $(c-g)\mathbf{m}$ is any linear function of $\mathbf{m}$; that is, $c-g$ is a general linear operator. Equation (111) therefore remains true when we substitute $c-g$ for c in it, not forgetting to make the change in x, and also the equivalent change in c', viz., from c' to $c'-g$. Equation (111) then becomes

$$x_g\mathrm{V}\mathbf{mn}=(c'-g)\mathrm{V}(c-g)\mathbf{m}(c-g)\mathbf{n}, \quad (113)$$

where x_g is what x becomes by the change, that is, by (112),

$$x_g=\frac{(c-g)\mathbf{l}\mathrm{V}(c-g)\mathbf{m}(c-g)\mathbf{n}}{\mathbf{l}\mathrm{V}\mathbf{mn}}. \quad . \quad . \quad (114)$$

Remembering that g is a constant, we may readily expand (113) to the form

$$\begin{aligned}&(x-x_1g+x_2g^2-g^3)\mathrm{V}\mathbf{mn}\\&=c'\mathrm{V}c\mathbf{mcn}-g(\mathrm{V}c\mathbf{mcn}+c'\mathrm{V}\mathbf{mcn}+c'\mathrm{V}c\mathbf{mn})\\&\quad-g^3\mathrm{V}\mathbf{mn}+g^2(c'\mathrm{V}\mathbf{mn}+\mathrm{V}\mathbf{mcn}+\mathrm{V}c\mathbf{mn}), \quad . \quad . \quad (115)\end{aligned}$$

where the cubic function of g on the left side is the expansion of x_g. The new coefficients x_1 and x_2 are, of course, to be found by expanding (114), but we do not want their values immediately. Since x is a function of c only, x_g is a function of c and g only, so that x_1 and x_2 are functions of c only.

Now since (111) is an identity, so is (115); and since g may have any value, the last equation must be identically true for every power of g concerned, taken one at a time. That is, it splits into four identities. Now, on comparing the coefficients of g^0 on the left and right sides, we obtain (111) again. Similarly, we observe that the coefficients of g^3 are the same. So far, then, we have nothing new. But the g and g^2 terms give

$$x_1\mathrm{V}\mathbf{mn}=\mathrm{V}c\mathbf{mcn}+c'(\mathrm{V}\mathbf{mcn}+\mathrm{V}c\mathbf{mn}), \quad . \quad . \quad (116)$$

$$x_2\mathrm{V}\mathbf{mn}=c'\mathrm{V}\mathbf{mn}+(\mathrm{V}\mathbf{mcn}+\mathrm{V}c\mathbf{mn}), \quad . \quad . \quad . \quad (117)$$

which are fresh identities. From these various others may be deduced by elimination or combination. The one we are seeking is obtained by operating on the first by c' and on the second by c'^2, and then subtracting the second result from the first. This eliminates the vector in the brackets and leaves

$$(x_1c'-x_2c'^2)\mathrm{V}\mathbf{mn}=c'\mathrm{V}c\mathbf{mcn}-c'^3\mathrm{V}\mathbf{mn}, \quad . \quad (118)$$

$$=(x-c'^3)\mathrm{V}\mathbf{mn}, \quad . \quad . \quad . \quad (119)$$

where the transition from (118) to (119) is made by using (111) again. Rearranging, we have the final result,

$$(x-x_1c'+x_2c'^2-c'^3)\mathrm{V}\mathbf{mn}=0, \quad . \quad . \quad . \quad (120)$$

which is Hamilton's cubic. Note that $\mathrm{V}\mathbf{mn}$ may be any vector we please, and may, therefore, be denoted by a single letter. Observe, also, that the cubic function of c' is of the same form as that of g in the expansion of x.

Since (120) is true for all linear operators, we may write c instead of c', giving

$$x-x_1c+x_2c^2-c^3=0. \quad . \quad . \quad . \quad . \quad (121)$$

This form is what we should have arrived at had we started from (105) instead of (110). The value of x is the same in either case, and it may be inferred from this that x_1 and x_2 do not suffer any change when we pass from a linear operator to its conjugate.

That the complex function x_g is independent of $\mathbf{l}$, $\mathbf{m}$, $\mathbf{n}$, may be seen by inspecting (114), and observing the parallelepipedal form of numerator and denominator. For, suppose we alter $\mathbf{l}$ to $\mathbf{l}+a\mathbf{m}$, where a is any constant. The addition made to the numerator vanishes by the parallelepipedal property, and similarly in the denominator. The same invariance obtains when we change $\mathbf{l}$ to $\mathbf{l}+a\mathbf{n}$. But, unless $\mathbf{l}$, $\mathbf{m}$, $\mathbf{n}$ are coplanar, we may turn $\mathbf{l}$ to *any* vector by adding to it vectors parallel to $\mathbf{l}$, $\mathbf{m}$ and $\mathbf{n}$ of the right size. Therefore, x_g is the same whatever vector $\mathbf{l}$ may be. By the same reasoning $\mathbf{m}$ may be any vector, and so may $\mathbf{n}$. But $\mathbf{l}$, $\mathbf{m}$, $\mathbf{n}$ should be independent vectors (that is, not coplanar). This is not because we can suppose that an actual discontinuity occurs when (for example) $\mathbf{l}$ is brought into the plane $\mathbf{m}$, $\mathbf{n}$, but merely because the expression x_g assumes an indeterminate form in the coplanar case.

From the invariance of x_g follows that of the three functions it contains, namely, x, x_1, and x_2. That of x, of course, may be independently seen by itself, readily enough, but that of the others is less plain, because on expansion they are found to each involve three parallelepipedal products in the numerator instead of only one. Thus, expanding (114) we obtain

$$x_1=\frac{\mathbf{l}\mathrm{V}c\mathbf{mcn}+\mathbf{m}\mathrm{V}c\mathbf{ncl}+\mathbf{n}\mathrm{V}c\mathbf{lcm}}{\mathbf{l}\mathrm{V}\mathbf{mn}}, \quad . \quad (122)$$

$$x_2=\frac{c\mathbf{l}\mathrm{V}\mathbf{mn}+c\mathbf{m}\mathrm{V}\mathbf{nl}+c\mathbf{n}\mathrm{V}\mathbf{lm}}{\mathbf{l}\mathrm{V}\mathbf{mn}}. \quad . \quad . \quad (123)$$

In these we may, by the above, substitute c' for c, that is, turn the linear operator to its conjugate. This does not mean that x_g is independent of the vector $\mathbf{a}$ which comes in when the operator is not symmetrical, but that it only involves $\mathbf{a}$ quadratically.

The value of x being

$$x=c_1c_2c_3+\mathbf{aca}, \quad . \quad . \quad . \quad . \quad . \quad (124)$$

expressed in terms of the principal constants of the symmetrical operator and the rotation vector, we may obtain the reduced values of x_1 and x_2 from it directly instead of from their general expressions. Thus: turn c to $c-g$ (in 124), making it

$$x_g=(c_1-g)(c_2-g)(c_3-g)+\mathbf{a}(c-g)\mathbf{a}. \quad . \quad (125)$$

On expansion, the coefficients of g and g^2 show that

$$x_1=c_2c_3+c_3c_1+c_1c_2+\mathbf{a}^2, \quad . \quad . \quad . \quad (126)$$

$$x_2=c_1+c_2+c_3.$$

Thus x_2 is independent of $\mathbf{a}$, whilst x_1 involves its square, as we concluded previously.

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When referred to the principal axes, Hamilton's cubic therefore reduces to

$$0 = (c_1c_2c_3 + \mathbf{a}c\mathbf{a}) - (c_1c_2 + c_2c_3 + c_3c_1 + \mathbf{a}^2)c + (c_1 + c_2 + c_3)c^2 - c^3, \qquad (127)$$

and in the symmetrical case of vanishing $\mathbf{a}$ to

$$0 = (c - c_1)(c - c_2)(c - c_3). \quad . \quad . \quad . \quad (128)$$

Here the axes are coperpendicular. But we may disregard the principal axes altogether, and write the general cubic in the form

$$0 = (c - g_1)(c - g_2)(c - g_3), \quad . \quad . \quad . \quad (129)$$

where the g's are the roots of $x_g = 0$. If, then, these roots are all real and different, there are three directions of parallelism of $\mathbf{r}$ and $c\mathbf{r}$, or three $\mathbf{r}$'s such that

$$c\mathbf{r}_1 = g_1\mathbf{r}_1, \qquad c\mathbf{r}_2 = g_2\mathbf{r}_2, \qquad c\mathbf{r}_3 = g_3\mathbf{r}_3. \quad (130)$$

Now multiply the first by $\mathbf{r}_2$ and the second by $\mathbf{r}_1$, giving

$$\mathbf{r}_2c\mathbf{r}_1 = g_1\mathbf{r}_1\mathbf{r}_2, \qquad \mathbf{r}_1c\mathbf{r}_2 = g_2\mathbf{r}_1\mathbf{r}_2 \quad . \quad . \quad . \quad (131)$$

The left members are not usually equal, but in the symmetrical case they are, and then the right members are equalised. Then $\mathbf{r}_1\mathbf{r}_2 = 0$, or $\mathbf{r}_1$ is perpendicular to $\mathbf{r}_2$. Similarly $\mathbf{r}_2$ is perpendicular to $\mathbf{r}_3$. This is the case of three mutually perpendicular axes of parallelism of force and flux we started from.

§ **172.** If we write c^{-1} for c in the cubic (121) we see that $c^{-1}\mathbf{r}$ becomes expressed as a function of $\mathbf{r}$, $c\mathbf{r}$, and $c^2\mathbf{r}$. This is one way of inverting the operator, but a very clumsy way. The simple way is in terms of dyads, and is fully described by saying that if

$$c = \mathbf{a.l} + \mathbf{b.m} + \mathbf{c.n} \quad . \quad . \quad . \quad . \quad (132)$$

is any linear operator in dyadical form, then its reciprocal is

$$c^{-1} = \mathbf{L.A} + \mathbf{M.B} + \mathbf{N.C}, \quad . \quad . \quad . \quad (133)$$

where $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$ is the set complementary to $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$, and $\mathbf{L}$, $\mathbf{M}$, $\mathbf{N}$ the set complementary to $\mathbf{l}$, $\mathbf{m}$, $\mathbf{n}$. We have already used these complementary vectors in the early part of this chapter, equations (54) and (55), § 114. We showed by elementary considerations that any vector $\mathbf{r}$ could be expressed in terms of any three independent vectors $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$ by

$$\mathbf{r} = \mathbf{rA.a} + \mathbf{rB.b} + \mathbf{rC.c}, \quad . \quad . \quad . \quad (134)$$

where the complementary vectors $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$ are got from $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$ by

$$\mathbf{A} = \frac{\mathrm{V}\mathbf{bc}}{\mathbf{a}\mathrm{V}\mathbf{bc}}, \qquad \mathbf{B} = \frac{\mathrm{V}\mathbf{ca}}{\mathbf{a}\mathrm{V}\mathbf{bc}}, \qquad \mathbf{C} = \frac{\mathrm{V}\mathbf{ab}}{\mathbf{a}\mathrm{V}\mathbf{bc}}. \quad (135)$$

These equations serve to define the set complementary to $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$. We also showed at the same time that the vector $\mathbf{r}$ could be expressed in terms of the complementary set by

$$\mathbf{r} = \mathbf{ra.A} + \mathbf{rb.B} + \mathbf{rc.C}. \quad . \quad . \quad . \quad (136)$$

To verify, we have merely to multiply (134) by $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$ in turn, and (136) by $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$ in turn.

These equations may be written

$$\mathbf{r} = (\mathbf{a.A} + \mathbf{b.B} + \mathbf{c.C})\mathbf{r}, \quad . \quad . \quad . \quad (137)$$

$$\mathbf{r} = (\mathbf{A.a} + \mathbf{B.b} + \mathbf{C.c})\mathbf{r}, \quad . \quad . \quad . \quad (138)$$

showing that the dyadic in the brackets is of a very peculiar kind, inasmuch as its resultant effect on any vector is to reproduce the vector. That is, taken as a whole, and disregarding its detailed functions, the dyadic is equivalent to unity.

Now, suppose it is given that

$$\mathbf{R} = (\mathbf{a.l} + \mathbf{b.m} + \mathbf{c.n})\mathbf{r}, \quad . \quad . \quad . \quad (139)$$

so that $\mathbf{R}$ is any linear function of $\mathbf{r}$. We know that

$$\mathbf{R} = (\mathbf{a.A} + \mathbf{b.B} + \mathbf{c.C})\mathbf{R}, \quad . \quad . \quad . \quad (140)$$

and that

$$\mathbf{r} = (\mathbf{L.l} + \mathbf{M.m} + \mathbf{N.n})\mathbf{r}, \quad . \quad . \quad . \quad (141)$$

by the property of the complementary vectors explained. Comparing (140) with (139), we see that

$$\mathbf{lr} = \mathbf{AR}, \qquad \mathbf{mr} = \mathbf{BR}, \qquad \mathbf{nr} = \mathbf{CR}. \quad . \quad . \quad (142)$$

Using these in (141), we convert it to

$$\mathbf{r} = (\mathbf{L.A} + \mathbf{M.B} + \mathbf{N.C})\mathbf{R}, \quad . \quad . \quad . \quad (143)$$

comparing which with (139), we see that the inversion of the dyadic has been effected in a simple and neat manner.

Professor Gibbs calls the vectors $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$ the reciprocals of $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$. They have some of the properties of reciprocals. Thus,

$$\mathbf{aA} = 1, \qquad \mathbf{bB} = 1, \qquad \mathbf{cC} = 1\,; \quad . \quad . \quad . \quad (144)$$

and in Gibbs's language $\mathbf{a}$ and $\mathbf{A}$ are reciprocal. But it seems to me that the use of the word reciprocal in this manner is open to objection. It is in conflict with the obvious meaning of the recipocal $\mathbf{a}^{-1}$ of a vector $\mathbf{a}$, that it is the vector whose tensor is the reciprocal of that of $\mathbf{a}$ with unchanged ort (or with ort reversed in the quaternionic system). It will also be observed that Gibbs's reciprocal of a vector depends not upon that vector alone, but upon two others as well. It would seem desirable, therefore, to choose some other name than reciprocal. I have provisionally used the word "complementary" in the above, to avoid confusion with the more natural use of "reciprocal."

§ **173.** In connection with the dyadic, it should be remarked that we have only employed them in the manner they usually present themselves in physical mathematics, namely, so as to make scalar products with the vectors they are associated with. But there is also the vector product to be consided in a complete treatment. Thus,

$$\mathrm{V}\phi\mathbf{r} = \mathbf{a}.\mathrm{V}\mathbf{lr} + \mathbf{b}.\mathrm{V}\mathbf{mr} + \mathbf{c}.\mathrm{V}\mathbf{nr}, \quad . \quad . \quad (145)$$

$$\mathrm{V}\mathbf{r}\phi = \mathrm{V}\mathbf{ra.l} + \mathrm{V}\mathbf{rb.m} + \mathrm{V}\mathbf{rc.n}. \quad . \quad . \quad (146)$$

Observe that, as before with the scalar products, the vector $\mathbf{r}$ only combines with the vectors nearest to it in the dyadic, and not separated from it by the dots. Notice, too, that whereas the scalar product $\phi\mathbf{r}$ of the dyadic ϕ and a vector $\mathbf{r}$ is a vector; on the other hand, the vector products $\mathrm{V}\phi\mathbf{r}$ and $\mathrm{V}\mathbf{r}\phi$ are themselves dyadics, and behave as such in union with other vectors. Thus $\mathbf{s}\mathrm{V}\phi\mathbf{r}$ is a vector, and so is $\mathbf{s}\mathrm{V}\mathbf{r}\phi$, the first being got by making scalar products of $\mathbf{s}$ with $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$, and the second with $\mathrm{V}\mathbf{ra}$, &c. But to go further in this direction would be to go beyond the scope of the present treatment.

The differentiation of linear operators must, however, be mentioned, because the process is of frequent occurrence in electromagnetic investigations. If we think only of the differential coefficient of a scalar, that it is its rate of increase with some variable, it might seem at first sight that the differential coefficient of a linear operator was nonsense. But a little consideration will show that it is a perfectly natural, and by no means a difficult conception. Thus, from

$$\mathbf{D} = c\mathbf{E}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (147)$$

where c is a linear operator, we obtain, by differentiation with respect to a scalar variable, say the time,

$$\dot{\mathbf{D}} = \dot{c}\mathbf{E} + c\dot{\mathbf{E}}. \quad . \quad . \quad . \quad . \quad . \quad (148)$$

Here in the second term on the right we suppose that c is constant, and in the first that $\mathbf{E}$ is constant. The meaning of $\dot{c}\mathbf{E}$, then, is the rate of increase of $\mathbf{D}$ when c alone varies. It is the linear operator whose constituents are the rates of increase of the constituents of c. That this is so will be evident on differentiating the set of equations (79). Therefore, if

$$c = \mathbf{a.l} + \mathbf{b.m} + \mathbf{c.n}, \quad . \quad . \quad . \quad . \quad (149)$$

we shall have

$$\dot{\mathbf{c}} = \dot{\mathbf{a}}.\mathbf{l} + \dot{\mathbf{b}}.\mathbf{m} + \dot{\mathbf{c}}.\mathbf{n} + \mathbf{a}.\dot{\mathbf{l}} + \mathbf{b}.\dot{\mathbf{m}} + \mathbf{c}.\dot{\mathbf{n}}, \quad . \quad . \quad (150)$$

the sum of two dyadics. But it may be that our axes of reference are invariable, as for example when

$$c = \mathbf{i.c}_1 + \mathbf{j.c}_2 + \mathbf{k.c}_3, \quad . \quad . \quad . \quad . \quad (151)$$

$\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$ being a fixed set of rectangular orts. Then we have the one dyadic

$$\dot{c} = \mathbf{i}.\dot{\mathbf{c}}_1 + \mathbf{j}.\dot{\mathbf{c}}_2 + \mathbf{k}.\dot{\mathbf{c}}_3, \quad . \quad . \quad . \quad . \quad . \quad (152)$$

where, of course, the dots over the i and j do not signify any differentiation.

In an isotropic dielectric of variable permittivity the electric stress leads to the force $-\nabla_c(\frac{1}{2}c\mathbf{E}^2)$ per unit volume, where the scalar c alone is differentiated, so that the result is $-\frac{1}{2}\mathbf{E}^2\nabla c$.

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But if the dielectric be eolotropic, the corresponding force is $-\nabla_c(\frac{1}{2}\mathbf{E}c\mathbf{E})$. This is equivalent to

$$-\tfrac{1}{2}\left(\mathbf{i}.\mathbf{E}\frac{dc}{dx}\mathbf{E}+\mathbf{j}.\mathbf{E}\frac{dc}{dy}\mathbf{E}+\mathbf{k}.\mathbf{E}\frac{dc}{dz}\mathbf{E}\right), \quad . \quad (153)$$

where dc/dx, &c., are differential coefficients of c as above explained. It means the same as

$$-(\nabla_D-\nabla\mathbf{E})(\tfrac{1}{2}\mathbf{E}\mathbf{D}), \quad . \quad . \quad . \quad . \quad (154)$$

where ∇_D means that **D** alone, and $\nabla\mathbf{E}$ that **E** alone is differentiated.

(To be continued.)

FUSE WIRES.

BY C. P. FELDMANN.

If for any set of terminals the fusing current for a fuse wire of given length, diameter, and substance be known, the current necessary to fuse a wire of any other length, or diameter, but of the same substance, and clamped between the same terminals, may be found as the product of two constants—$c = af$. The constant a is the current necessary to fuse a wire of unit length and unit diameter, and has to be found by previously experimenting upon any wire whose constant f is known. f itself is a function of the length l and diameter d of the wire, and may be taken from the accompanying diagram, the use of which is best explained by an example:

To find the constant f for a wire whose length $l = 25$ mms., and whose diameter $d = 1{\cdot}5$mms., follow a vertical line nearly midways between 1·4 and 1·6 till it intersects with the horizontal line marked 25. Near the point of intersection you will find a stout line marked $f = 0{\cdot}8$. This is the value

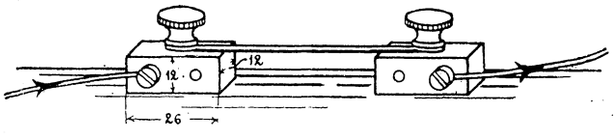

FIG. 2.

wanted. For the alloy which I tested,* and for the small terminals (Fig. 2), I found $a = 31{\cdot}6$ ($a^2 = 1{,}000$); for the large terminals (Fig. 3), I found $a = 36{\cdot}8$ ($a^2 = 1{,}350$). The fusing current would have been, for the small terminals,

$$c = 31{\cdot}6 \times 0{\cdot}8 = 25{\cdot}4 \text{ amp.},$$

and for the large terminals,

$$c = 36{\cdot}8 \times 0{\cdot}8 = 29{\cdot}4 \text{ amp.}$$

Of course a varies with the terminals, with the unit chosen to measure diameter and length, and with the substance of the fuse wire.

* *The Electrician*, Vol. XXIX., p. 87.

The diagram has been constructed by plotting as ordinates the $\sqrt[4]{e}$, and as abscissæ the $d^3/^2$. If for any special purpose the values shown in the figure should not be found suitable, the units of length and diameter may be changed so as to fit the scale of the diagram. *But it must not be forgotten that the constant a has to be changed, too, in a suitable manner, that is, it has to be determined by another experiment and for the new units chosen.*

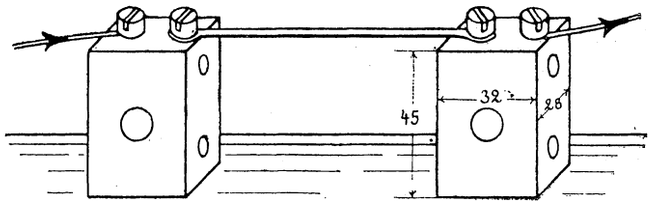

FIG. 3.

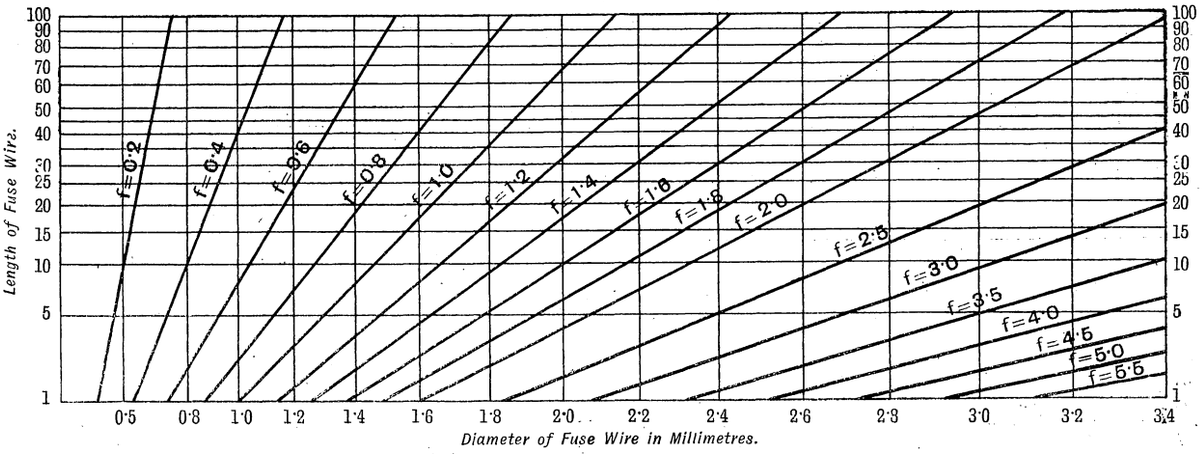

FIG. 1.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Annual Dinner at the Criterion Restaurant.

MONDAY, November 21st.

SOCIETY OF ARTS.

8 p.m. Cantor Lectures. I., 1., "The Generation of Light from Coal Gas," by Prof. Vivian B. Lewes.

TUESDAY, November 22nd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be discussed:—(1) "Halifax Graving Dock, Nova Scotia," by the Hon. R. C. Parsons, M.A.; (2) "Cockatoo Island Graving Dock, New South Wales," by E. W. Young, M.Inst.C.E.; (3) "The Alexandra Graving Dock, Belfast," by W. Redfern Kelly, M.Inst.C.E.; (4) "Construction of a Concrete Graving Dock at Newport, Monmouthshire," by Robert Pickwell, Assoc.M.Inst.C.E.

WEDNESDAY, November 23rd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read:—'Cremation as an Incentive to Crime," by F. Seymour Haden, F.R.C.S.

THURSDAY, November 24th.

INSTITUTION OF CIVIL ENGINEERS.

2:30 p.m. Students' Visit to the Gas Light nd Coke Company's Chief Office, Westminster.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read (in the event of the discussion on Mr. Swinburne's Paper being terminated):—"Experimental Researches on the Alternate Current Transformer," by Dr. J. A. Fleming, F.R.S.

FRIDAY, November 25th.

PHYSICAL SOCIETY

5 p.m. Paper to be read:—"Experiments in Electric and Magnetic Fields, Constant and Varying," by E. C. Rimington and E. Wythe Smith.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read The Telephone," by Howard Little.

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The Electrician.

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THE SOCIAL EFFECTS OF ELECTRIC POWER SUPPLY.

At the time when the public supply of power by electric current was scarcely an accomplished fact, but when its immediate prospect called for speculation on every hand, it was a common thing to hear of the social and industrial revolution which the new power would inaugurate. The age of electricity, we were told, as contrasted with the iron age of steam and coal, would witness tremendous changes in the conditions of civilised life. Vast cities, grimy, foggy, colonies of labour, such as the Black Country, huge factories, would no longer be necessary. Every man would work during the day, as he would rest during the evening, "under his vine and under his fig tree." Electric supply would be laid on at every door, and power would be brought to the operative instead of, as before, the operative going to the power. Such was the dream, and such is undoubtedly the popular opinion even to-day; but what are the facts?

The chief influences which have tended to produce the present industrial system are the advantages accruing from a combination of capital, and the absolute necessity, in these days of fierce commercial competition, for cheap power, cheap labour, rapid transit during the stages of manufacture, and efficient supervision. In any industry involving several stages of manufacture, or requiring the use of expensive machinery and power on a large scale, it is impracticable to conduct each branch on a separate capital footing and in a separate establishment. The integration of the several processes under one commercial head is an evil it may be, but a necessary one, and it cannot be altered by electric supply, as this element does not affect the economic principle upon which the phenomenon is

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based. Assuming, then, that some sort of factory system is needful, let us inquire into the possibility of carrying out the various processes of manufacture in a number of separate homesteads in place of in a large building. The necessity for cheap power at present compels the manufacturer to place all his machinery as closely together as possible, since steam power cannot be cheaply transmitted to a distance by shafting and belting. But will the advent of electric power revolutionise the present system? It would appear not. Even should the actual cost of power per unit supplied be the same for small as for large supplies, the prime cost of putting down machinery and wiring in a number of isolated houses would greatly exceed that for a large factory of the same power. Moreover, in some districts where electric power is to be supplied on the largest scale, the tariff is not fixed at the same rate for small as for large consumers. At Niagara, the Power Supply Company propose to charge an annual rental of $21 per horse-power for a 300-H.P. supply, but only $10 per horse-power for a 5,000-H.P. supply. It seems probable that some such sliding scale will be adopted by other electric power stations, even by those employing steam engines, when the experience of a few years shall have evolved the best working details of supply. But whether power is to be obtained on a sliding scale of charges or at a fixed rental per unit, the total cost of utilising that power in a large factory will be always less than that of utilising it in a set of isolated, decentralised homes. The idea of distributing power has great fascination to many minds. In its crudest form we find factories and power, or even a "floor with power" is frequently rented, energy being supplied by a shaft sticking through the party wall. Supply by compressed air has struggled fitfully in Paris, and engineers have never been wanting who could add just those improvements which were needed to make it a success. It has had a trial at Birmingham, where there are many small industries and a fair prospect of a good business. A large number of small steam plants are used in that city, and tests proved that these were very extravagant in steam, and that high insurance premiums were asked. But the initial expenses were greater, and the demand was less than was expected, the leakage was about 45 per cent. instead of the 20 which had been expected, the motors gave only about 30 per cent. efficiency without heating the air, and at the end of 1891 the Company was wound up.

If the cost of power is not to be reduced by the proposed change, how much less will be the reduction in the cost of labour. Consider the immense expense involved in distributing raw material to a number of isolated cottages, of passing on material from one cottage to another, and, finally, of collecting the finished article. Even the cheapest and most rapid system of electric transit will not make it simpler or better to have detached and distant houses rather than a compact single building. Consider, also, the expense and difficulty in superintending work on such a system. The workshop foreman will depart, and who or what is to take his place? Nor will the crowded city vanish any more rapidly than the close and (it is said) unhealthy factory life. The circumstances which combine to make it necessary or advisable for mankind to congregate in cities are even less affected by systems of engineering than are the circumstances which lead to factories. The long tentaculæ of electric power cables may reach out in every direction to the rural districts, offering power as cheaply there as in the towns, but the manufacturer who would prefer to build his factory at the far end of the cable rather than at the town end is yet to be found, unless, indeed, there were other and stronger inducements to adopt a rural site. In the aggregation of factories into industrial centres the commercial and market considerations outweigh the advantages of cheap land and labour; and, even should power be obtained for nothing in every part of the United Kingdom, the forces which build up great industrial cities would still be as effective as they now are.

What, then, may we reasonably expect to be the immediate social and industrial effects of the general introduction of electric power supply? Chiefly these. As regards city life, the generation of power at large central stations will enable a more efficient and rigid system of smoke abatement to be enforced; for at such stations it will be both easier and more economical to consume smoke than is the case in the innumerable small factories and private chimneys which now pollute the atmosphere. City life will become more healthy. Moreover, electric power will probably be used for every manner of private and public vehicle, which would largely eliminate the domestic horse, and, with him, much of the dust and mud which make our streets intolerable. Cities will become more clean. In small factories and industrial shops the introduction of electric power will substitute cool, convenient and silent electro-motors for noisy heat engines of various kinds, with their clumsy gearing. On the whole, therefore, it does not appear that any serious and immediate revolution in our industrial systems will follow the substitution of electricity for steam; but that many useful and pleasant changes of a less pretentious character will probably result.

REVIEWS.

Telephones: Their Construction and Fitting. By F. C. Allsop. Second Edition, 1892. (E. and F. N. Spon, London and New York.)

The rapid exhaustion of the first edition of this useful book is a surer test of its merits, from the publishers' point of view, than anything that can be said by its reviewers. Perhaps this very fact may afford the reviewer somewhat greater freedom in handling a book which, from his point of view, might have been made more to his liking in a second edition. That it has been enlarged, that the illustrations have been multiplied, and that the text has, to use the common phrase, been brought "up to date," may be taken as a matter of course when, as in this case, the subject-matter is closely related to a growing and constantly improving industry. We lose no time in saying, as to this, that the additions have been well done; and the "practical" character of the "treatise" thoroughly sustained. But we employ the term "practical" in the limited sense evidently intended by the author, that is to say, in a non-scientific sense. If, however, the author had been literally true to his intentions he would have omitted probably a sixth part of what he has written in explanation of the appliance with which he is dealing. It is nothing to the author's discredit, perhaps, that he is not himself quite master of the whole of his subject; but it would have been more to his credit if he had let one part of it alone. Whether the practical part of telephone "construction and fitting" can be rightly taught without a thorough knowledge of what, for want of a better phrase, we may call the scientific understanding of it, is a question we should hesitate to answer. But Mr. Allsop answers it himself by attempting at some length to make it understandable. In this he has not quite succeeded; and we rather think he might just as well have come to his "practical" treatment straight away without any pretence of scientific examination of first principles. They will be of little use to the "practical man" who wants to know what he has to do in given conditions; and still less to the theoretical or scientific student who wants to learn what the telephone essentially is. The book is profusely illustrated; and it would seem that illustrations are easy and cheap, while explanations are difficult and expensive. Many of these illustrations are of the trade catalogue order, pictorially pretty but devoid of instruction. What, for example, is the value of Fig. 41?—a microphone induction coil it is called; but for all the meaning it conveys,

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it might be a drum or a reel of cotton. Yet the function of induction which comes into play at that stage of telephonic development is in need of the fullest explanation if the task of explanation be undertaken at all. In reality, it is shirked altogether, and the inquiring student is left with a bewildering impression that, although it is possible to erect a telephone line and connect up the apparatus in a "practical" way without knowing what it means, it is impossible to obtain an intelligible explanation of its operation—which is by no means the case. Having said this, however, we gladly give our tribute of praise to the painstaking care with which that portion of the work has been executed, which the author is thoroughly acquainted with. Here the diagrams, namely, those descriptive of connections, switches, exchanges and line constructions, are all that can be desired. As a guide to the practical man who desires to know what he has to do, without troubling himself about why he does it, this book may be frankly recommended as the best of its kind.

Magnetism and Electricity. By R. WALLACE STEWART, B.Sc. (University Correspondence College Press.)

This is a text-book, designed to assist students preparing for the examinations of the University of London. A new work of this kind should have some special pretension—something beyond the claims of the host of text-books already in existence—to recommend it; some new or modern discoveries or theories; some better mode of expressing old truths. In this work we can find no such *raison d'être*. There are far better, far more exact, text-books already in extensive circulation. The principal claim to consideration in books of this class seems to be the "cut and dried" way in which the information is served up for the student to swallow before going up for examination. Not that the author of this new text-book does not tell us anything new. On the contrary, there are statements which must be new to the most advanced electrician. In the section on Ohm's law, for example, we are told that—"The *law* involved is, perhaps, best explained by reference to the definition of resistance given in the preceding article. The resistance of a conductor is there defined as the ratio of the E.M.F. applied to the conductor to the current produced in it. Now, Ohm's law states that, assuming resistance to be defined in this way, the resistance of a given conductor is constant for all values of E and C; that is, a given conductor presents the same resistance to all currents, and is independent of the E.M.F. producing the current. Hence, combining our definition of resistance with Ohm's law, we may write $-C = \frac{E}{R}$, where C denotes the current produced by an E.M.F. E in a conductor of resistance R, and R is *assumed* to be constant for a given conductor." This, then, is the real *law!* A law which assumes what it is designed to prove, and which tells us that if R equals E over C, then C equals E over R. But this "law" is dead against Nature, for it is *not* true that the resistance of a given conductor is independent of the current flowing through it. As for the logic, it is all a piece of *petitionem principii per circulum;* a method of "reasoning" which, by-the-bye, crops up in other parts of the book. Now a book which cannot give a clear and correct account of so fundamental a matter as Ohm's law is untrustworthy as a student's text-book. In books of this class especially, where proofs are omitted and the student has to take things on trust, unless he *can* trust he is lost.

The author tends a little towards modern applications of electricity in the later portion of his work, and tells us that an arc lamp is a device in which "a strong current is forced by a powerful E.M.F. through a small air-gap," and "the air heated to incandescence is the source of light." A description and illustration of the obsolete Clark's dynamo is also given.

We very much regret to say that we cannot recommend this work as a student's text-book.

Uppenborn's Kalender, 1893. (Munich and Leipzig: R. Oldenburg.)

The tenth edition of this well-known Year Book is before us. While maintaining the original form, the editor has enlarged many of the sections, and the information given appears to be very complete; for instance, the question of dynamo design (from an electrical point of view) is carefully gone into, and curves are given by which the application of Hopkinson's methods is made easy. It seems, however, hopeless to convince people that standard curves for cast-iron are quite useless, owing to the enormous variations in the molecular and magnetic structure of the material. Among other information which does not, so far as we know, figure in any similar publication in this country, are details of German central stations, giving the output for which the stations are designed, the maximum load on any one day, and other information. The "Kalender," while not pretending to be an engineering work, is among the most complete note-books on purely electrical and physical subjects that we have seen.

THE EWING MAGNETIC CURVE-TRACER.

At a meeting of the Cavendish Physical Society, Cambridge, held last week, Prof. Ewing gave an exhibition of his magnetic curve-tracer, using a form of the instrument which has just been constructed by Messrs. Nalder Bros, with the object of allowing the magnetic cycle to be performed at a high speed. The instrument is shown in Fig. 1, which is engraved from a photograph. The magnetic circuit, whose variations of magnetism are exhibited, is arranged as a rectangle standing up from the base-plate, and supported by a post in the centre. It is laminated, consisting of a number of strips of thin sheet iron, of the kind used in transformer cores. The ends of these are securely clamped in a pair of wrought-iron pole-pieces on the base-plate, which is a slab of slate, and the poles have a narrow gap between them within which the stretched wire works which gives vertical motion to the mirror, proportional to the varying magnetism of the laminated circuit. A gun-metal casting, arranged in the form of a bridge, supports the compound lever by which the pivot of the mirror is supported, as well as the springs which serve to keep the connecting threads taut; and the same bridge piece forms a post for the support of the main magnet, and also carries the other electro-magnet, which consists of a piece of iron tube split longitudinally to form a slot for a second stretched wire, which gives horizontal deflection to the mirror, proportional to the magnetising force. It will be remembered that this result is secured by keeping the magnetisation of the tubular magnet constant, and by allowing the current which circulates in the magnetising coil of the main magnetic circuit to pass through the wire that is stretched in the slot of the tubular magnet. The pivot-point of the mirror is held by a system of two adjusting levers which are moved by milled-headed screws to give it two adjustments, vertical and horizontal, for the purpose of bringing the zero position of the spot of light to any desired point of the screen. The mirror itself is pivoted in the manner shown in Fig. 2. The mirror *a* is cemented to a little cradle *b* of aluminium, in which a small hole or rather recess is drilled just behind the mirror. Into this recess a needlepoint, held by the fixed piece *c*, enters. At the other side of the cradle two threads are attached, of which one, *d*, goes down to the vertically-moving wire in the gap of the variable magnetic circuit, and the other comes out, perpendicular to the plane of the paper, to the horizontally moving wire in the gap of the constant magnetic circuit. A pair of light spiral springs, of which one is indicated in the sketch at *e*, hold the threads taut and are set to rake back a little, so that they give a component of force pressing the mirror cradle against its pivot sufficiently to prevent it from slipping off.

The magnetic cycle is performed in one-tenth of a second or less, but so smoothly that the mirror is at no stage subjected to any jerk. This requires that the variations of magnetising current shall be continuous and gradual. An ordinary commutator with sudden makes and breaks of contact will not do, and the necessary smoothness is obtained by using a continuous commutator, the joint invention of Prof. Ewing and Mr. C. G. Lamb, which was described at the Cavendish Physical Society for the first time. The principle of the continuous commutator will be seen by reference to Fig. 3, which gives a sectional plan of the essential parts of the instrument. A cylindrical vessel of glass

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or earthenware, containing a solution of sulphate of zinc, has two zinc plates, A and A′, fixed in it at diametrically opposite portions of the inner circumference. These plates are connected respectively to the two poles of a battery. A boss of non-conducting material nearly fills the vessel, leaving only a narrow clearance space round it for the sulphate solution. The boss is supported on a footstep, which allows it freedom to revolve, and is turned either by hand or by a pulley at the top

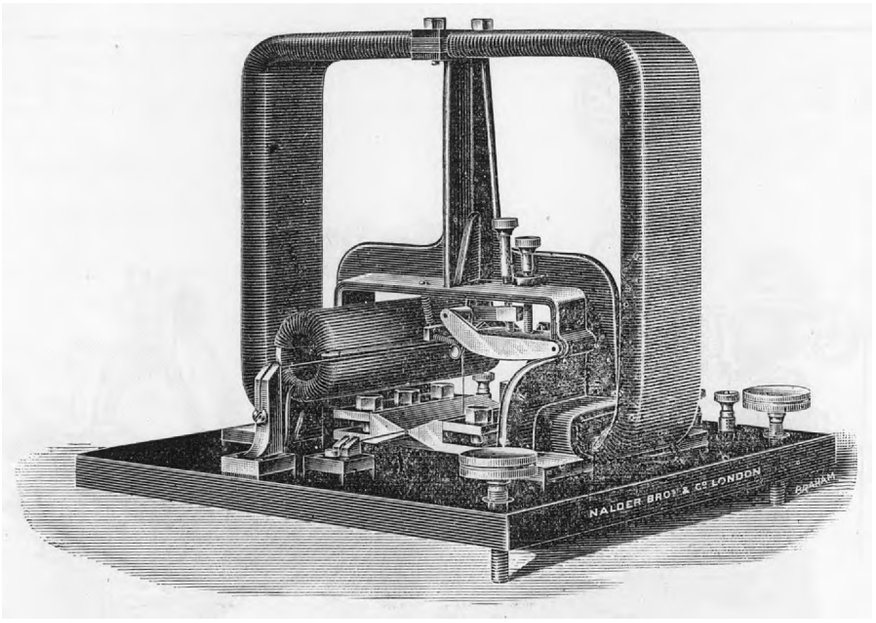

Fig. 1.—General View of the Ewing Magnetic Curve Tracer.

connected with an electric motor. A second pair of zinc plates, B and B′, are fixed to the boss itself, on opposite sides of its circumference. As the boss revolves the plates fixed on it take a potential difference approximating to that of the fixed plates, as they pass these; then a quarter revolution brings the potential difference gradually to zero, the next quarter revolution raises it gradually to a value equal and opposite to the first, and so on. The plates carried by the boss are connected to collecting rings on the vertical spindle, from which currents are led off through brushes to the magnetising coil of the magnetic curve-tracer. By having one of these continuous commutators placed in series with a

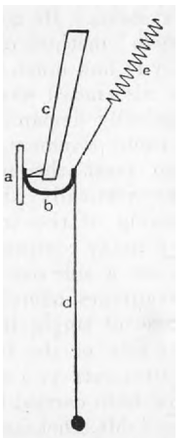

Fig. 2.—Suspension of Mirror in Magnetic Curve Tracer.

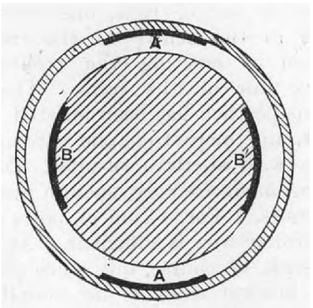

Fig. 3.—Continuous Commutator.

fluid resistance slide, to superpose a continuous reduction of the strength of the current on periodic changes on its sign. the experiment was shown of "demagnetising by reversals," in which the curve-tracer exhibited the cyclic process gradually diminishing its range until the area of the diagram vanished. The "Rayleigh" stage of the magnetisation, when a feeble force applied or reversed gives magnetic changes involving no hysteresis, was well shown in this way. A still more striking experiment consisted in placing two of the continuous fluid commutators in series, and turning one slowly or quickly by hand, while the other was left revolving uniformly at a high speed, when small loops appeared superposed on the principal cycle of magnetisation.

The main magnet of the instrument, shown in Fig. 1, is wound with two magnetising coils, which allow experiments to be readily made showing the influence exerted by a permanent magnetisation of any assigned value on the behaviour of the metal with respect to a supplementary force subject to cyclic variation, and on the amount of hysteresis which such a supplementary cycle involves.

THE EWING HIGH FREQUENCY ALTERNATOR.

The steam turbine combined with two dynamos on one shaft, which we illustrate, has been presented by Messrs. C. A. Parsons and Co., of Newcastle, to the Engineering Laboratory of Cambridge. Its chief point of interest is that one of the dynamos, designed by Professor Ewing, has a periodicity of 14,000 complete cycles per second at 12,000 revolutions per minute.

There are two distinct dynamos—one of the usual two-poled type, with a continuous current armature for an output of 15 amperes at 100 volts. This armature can be converted into an alternator by slipping two contact rings on the commutator, each ring being connected to diametrically opposite segments of the commutator and insulated from the others; the magnets being in this case separately excited. An output of 20 amperes at 40 volts, with a periodicity of 200 cycles per second, is obtained.

Professor Ewing's alternator is complete in itself, and is bolted on to a prolongation of the bedplate. The construction of the poles of the armature and field magnet is shown in Figs. 2 and 3. Fig. 2 is a part section and part elevation showing several poles *a a a* of the field-magnet, which revolves, and corresponding poles *b b b* of the laminated armature, which is stationary. Fig. 3 is a radial section. The poles *a a a* (140 in number) are made by toothing a pair of mild steel discs which are placed back to back, as is shown in Fig. 3, and the poles *b b b* are made by toothing a ring of 60 sheet iron plates, each about 10 mils thick, which are clasped together by a cast-iron supporting ring *c c*. The armature ring is bored $\frac{1}{32}$in. larger than the magnet disc and sawn radially by 140 cuts $\frac{3}{8}$in. deep. The winding of *a a a* is done with insulated copper strip, which is held from flying out by the projecting lip or fillet which appears on each side of the

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poles in Fig. 3. The winding of the armature poles *b b b* is done with insulated wire of a considerably finer gauge than that shown in the illustration. Both windings are put on in zigzag fashion. The two discs into which the revolving field-magnet is divided are insulated from one another, and are used as conductors between the brushes by which the exciting current enters and the copper tape with which the teeth are wound. These two discs form mechanically a single disc of conical form, thickest near the axis to give it strength to resist the centrifugal force due to the high speed of rotation. The whole arrangement has the effect of reducing the revolving parts to the utmost simplicity—a matter of some consequence when the speed is 12,000 revolutions per minute.

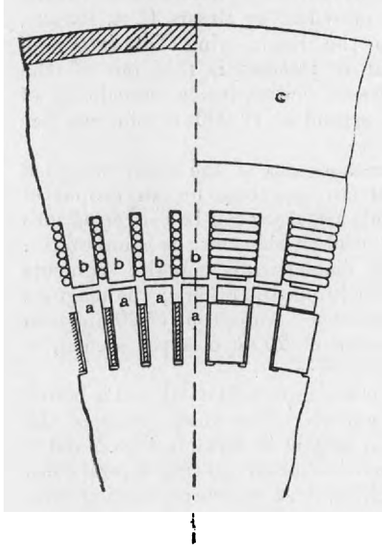

FIG. 2.

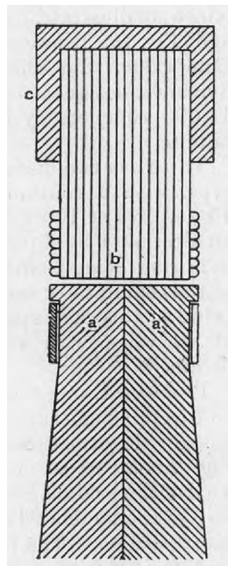

FIG. 3

Field Magnet and Armature Poles of Ewing High-Frequency Alternator.

It will be seen that there are 70 complete cycles of current per revolution, and at 12,000 revolutions per minute this gives 14,000 complete cycles per second. The output is about 5 amperes at 100 volts. It is, we believe, intended to carry out a series of experiments on the physiological effects of alternating currents of high frequency, as well as other interesting investigations.

ELECTRIC TRACTION ON THE SOUTH STAFFORDSHIRE TRAMWAYS.

The Electric Street Railway in South Staffordshire, between Walsall, Wednesbury, Bloxwich and Darlaston, deserves special mention. It is not only the first application of the trolley system paid for by English capital, but the details are boldly original and due to an English engineer who has attained to no little celebrity in the tramway world. Mr. Alfred Dickinson, the engineer to the South Staffordshire Tramway Company, has been the mainspring of the undertaking, and he is alone responsible for the many novel features and new departures from the received American practice. This gentleman visited the United States about two years ago and there made an exhaustive study of the "span" and "bracket" trolley systems. He noticed the many objectionable features of the "span" method of wiring, and felt convinced that it was not likely to find much favour in England. The "bracket" system he also noted was not applicable to small lines, because it practically demanded either a double set of rails, one close to each pavement, or else posts in the centre of the track to meet the invariable custom of erecting the trolley wire vertically above the centre line of the tram. The running of the trolley-rod in this position has been insisted on by many competent engineers, and more than one attempt to use a side-rod has been made with abortive results. The advantages offered by the arrangement are clear enough in the case of single lines with turn-outs. For, a line of posts on one side of the road with one trolley wire is sufficient. At the turn-outs two wires are required, of course, but since they are both carried from the same bracket there is no complication. Mr. Dickinson came back from America with this idea clearly fixed in his mind, and ultimately convinced his company of its feasibility. The objections raised to the trolley system on æsthetic grounds are no longer tenable, for the South Staffordshire line is really *far less prominent* than the telegraph poles and wires, which run parallel with it for a considerable part of the way. From the point of economy there can be little doubt that the side trolley-system is far superior to the vertical pole for long lines with light traffic. It should be noted that a trolley wire running vertically over the car is decidedly objectionable for outside passengers, since there is always a risk of injuring from falling wires. This does not matter very much in America where the

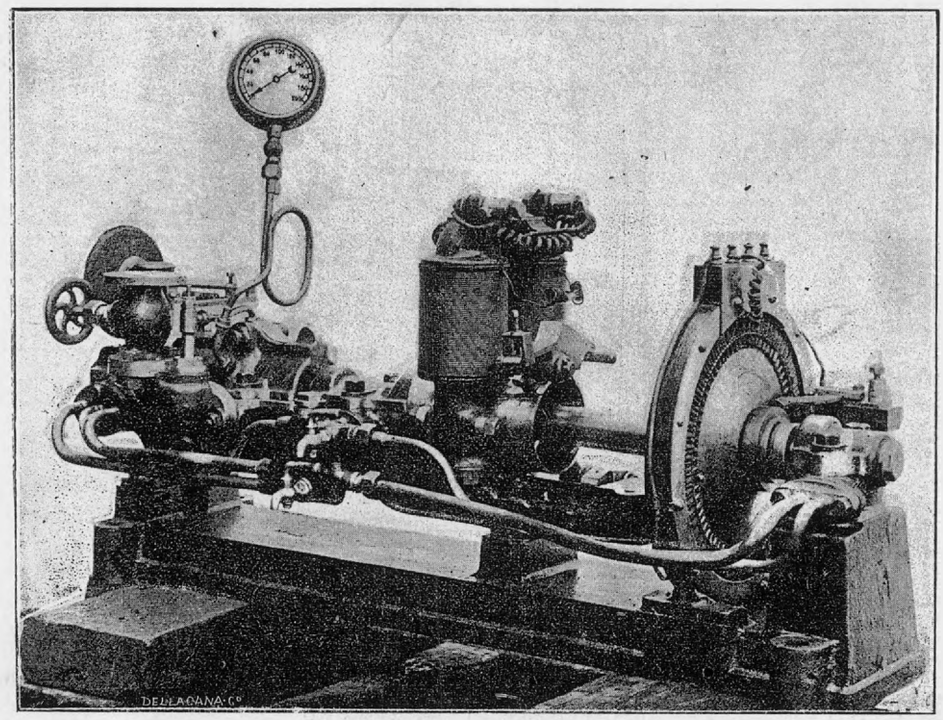

FIG. 1.—Parsons' Steam Turbine and Dynamos presented to the Cambridge Engineering Laboratory.

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cars usually carry the passengers inside only; but it is of great importance in England, because outside seats are in such common use. The side trolley wire is, of course, entirely free from this objection, and this single point is likely to give it much favour with the travelling public. In crowded streets with two lines the double bracket centre post is, perhaps, advisable, particularly in very wide streets. But for narrow roads with double lines the side trolley will prove to be the cheaper and better.

We are indebted for the following particulars to the courtesy of Mr. Dickinson:—The circuit roughly resembles two Y's joined at the bases. The road from the Bull Stake is perhaps the least irregular in levels of any of the four, on which these trams run. It starts fairly level for about 150 yards, after which there is a rise for about 200 yards, of 1 in 40, followed by a long down gradient for 1,400 yards, of 1 in 56. After another sharp rise followed by an equally abrupt fall, there succeeds, for some 700 yards, a rise in the road of 1 in 60, and another down gradient of 1 in 75 completes this portion of the road at the Pleck. At this point there converges another line from the White Horse, which, commencing at the latter with a rising gradient of 1 in 36, succeeded by a fall for 2,000 yards of 1 in 60, the Pleck being reached in the course of a gentle rise of 1 in 150. The two lines just dealt with unite at the Pleck and run in one direction as far as Mellish Road. For some 700 yards the road maintains an average level, then succeeds for 900 yards a rise of 1 in 70, a fall of 1 in 28, and finally a fairly level section for about 1,200 yards. A line branching off from Walsall Bridge on the last section to Bloxwich, a distance of rather more than 2 miles, is a constant ascent for almost the whole distance, the average gradient being 1 in 90.

The power station is near Darlaston Station, on the London and North-Western Railway, and is not far from the centre of the system. The cars have been specially built to meet the conditions of a 3ft. 6in. gauge, and yet to carry a pair of 15 B.H.P. motors. The under-carriages (Fig. 1) are light and strong, and the pair of independent brakes are neatly fitted into the limited space. Room has also been found for two sand boxes, under the control of the driver. Some of the cars were built by Messrs. Brown, Marshall and Co., of Birmingham, and the remainder by the Lancaster Carriage and Wagon Company. They have excellent steel under-carriages, and the seats are arranged crosswise, inside as well as outside; a general view is shown in Fig. 2, and a sectional end elevation in Fig. 3. The motors are of the double-magnetic circuit type, with single reduction by helical gearing, the angle between the two sides of the teeth being about 130 deg. The pinions are 5¼in. in diameter, and the wheels 20¼in., the ratio of gearing being 1/3·87. The rolling wheels are 33in., so that a car speed of nine miles per hour will require 330 revolutions of the armature per minute. The armatures are drum-wound, and the brushes are of carbon. The design of the machines is substantially the same as that used by the Electric Construction Corporation at Birmingham. The speed is controlled by a rheostat, and a separate reversing switch is used. The trolley line posts are made entirely of rolled steel, and are particularly good examples of this class of work, being strong and yet elegant; the straining

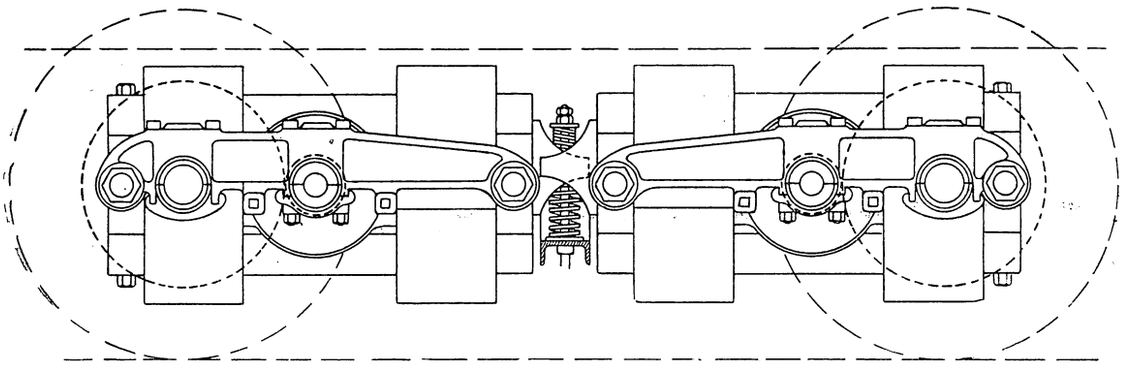

FIG. 1.—General View of Under Carriages and Motors.

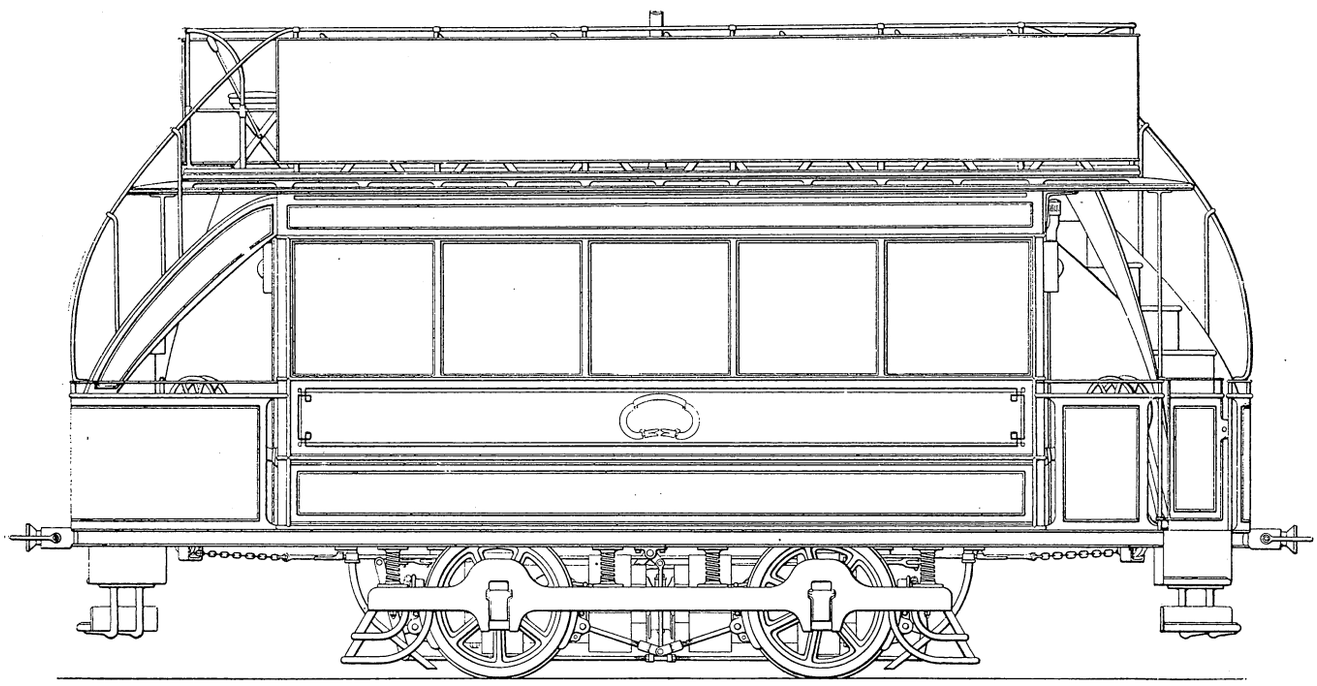

FIG. 2.—General View of Car.

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posts, also used as lamp-posts, are specially worthy of notice. These were supplied by James Russell and Sons, of Wednesbury.

The trolley wire is 21ft. above the road level, and is No. 00 gauge. It is carried by specially devised compressed mica insulators. The feeders are laid underground, and are coupled to the "line" at intervals of half a mile. Each of these junctions has a switch so arranged that either of the two sections can be disconnected for testing or other purposes. The "line" turnouts at the passing places are made in brass, with frogs for leading the trolley wheel on the up line, and with springs for letting the wheel run through on the down line. They are thus automatic, and, though so simple, are evidently the outcome of much thought and careful work. How they will stand the wear and tear of every day working remains to be seen; but certainly the trolley takes the points so smoothly that it appears as if no difficulty of a serious character need be feared in practice.

The most interesting feature of the system is, of course, the side trolley, the details of which are shown in Fig. 4. The mast on the top of the car is just out of reach of the passengers. It is a hollow steel post, and the cable to the motor passes through

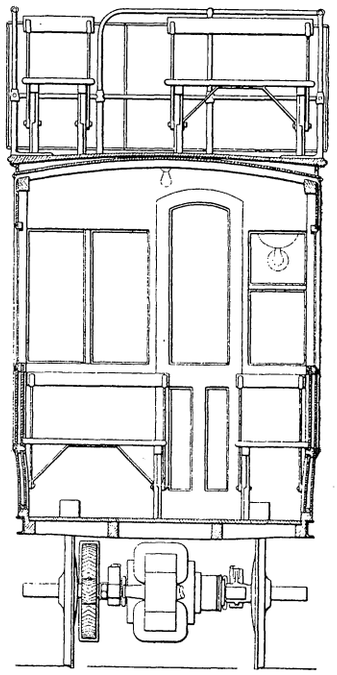

FIG. 3.—Sectional End Elevation of Car.

its centre. The pole obviously requires two motions, each of which must be automatically directed as quickly as the movement of the car may require it. In the first place there must be an upward thrust on the wheel, so as to press it firmly against the trolley-wire. This is managed by six strong cylindrical springs in tension acting on a tail bar. But in addition, a radial motion is required, to compensate the distance between the wire and the car, which varies from 13 to only a few feet. This is accomplished by allowing the trolley-pole to radiate freely about the centre of the mast on which it is mounted. The wheel is also swivelled at its point of support, and so keeps parallel to the line as the pole swings. The deep flanges of the trolley-wheel, and the upward thrust of the six springs, give the necessary directive motion to the pole. The arrangement is very simple, and works admirably, no doubt to the surprise of the many engineers, who said the side trolley was impossible in practice. Fig. 5 shows the bonding and fishing of the rails.

The power station has been designed by Mr. Dickinson with due appreciation of the necessities of the work. It presents a handsome exterior, in red brick with stone facings. At the back of the plot of ground is a canal, and a basin has been built alongside the coal-bunkers, so that barges can be cheaply unloaded. The three boilers, which are near the bunkers, are of the Lancashire type, with Galloway tubes, and are fitted with the usual injectors and steam pumps. The boiler shed is separated from the engines and dynamos by a brick wall. There are three engines and the same number of dynamos. The former, by Musgrave, of Bolton, are compound-condensing engines, with Corliss valve gear, and are each coupled to a dynamo by ropes. The dynamos are shunt-wound with drum armatures, each giving 350 volts and 275 amperes at 450 revolutions per minute. They are of the usual Elwell-Parker, two-pole single magnetic circuit type, with three bearings. It is proposed to run about 14 cars at first, so

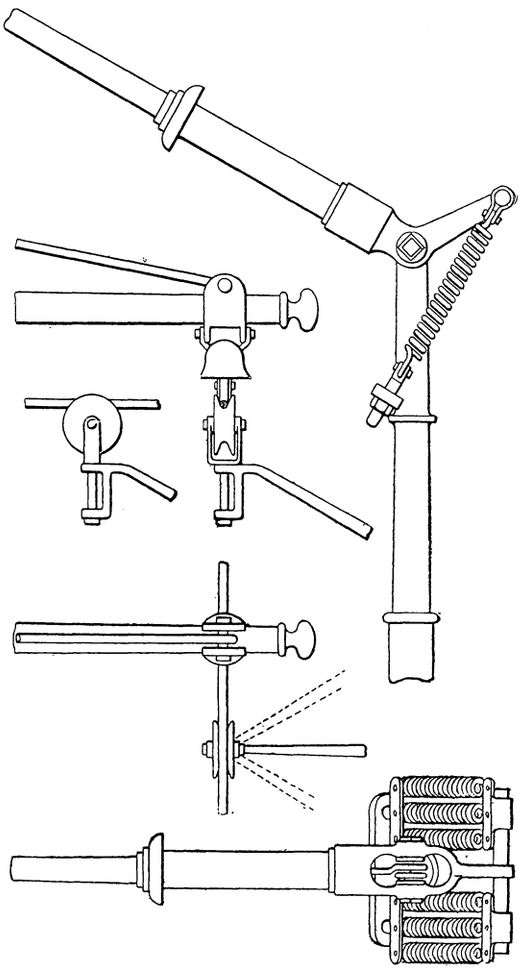

FIG. 4.—Plan and Elevation of Joint in Trolley Rod, showing Springs and details of end of Bracket and Wire.

that two dynamos will be amply sufficient to cope with the work, and the third will be in reserve. The dynamo-room is sufficiently large to allow for additional plant should the traffic require it at a future date.

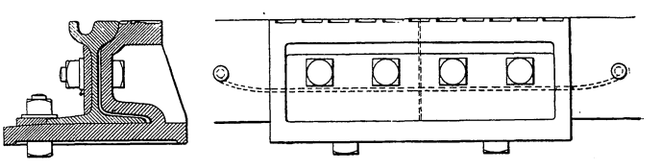

FIG. 5.—Joint in Rails. Combined Fish Chair and Sole Plate and Bonding Wire.

The whole of the work has been carried out by the Electric Construction Corporation, to the specification of Mr. Dickinson, Mr. Ted Parker acting as resident engineer on behalf of the Wolverhampton firm. We are pleased to see electric traction so energetically and ably carried out by a British firm, and hope that the South Staffordshire Street Railway will prove to be the forerunner of a number of similar installations. Our engineers evidently do not need the assistance of Americans to show them how traction work should be done; they only lack opportunity.

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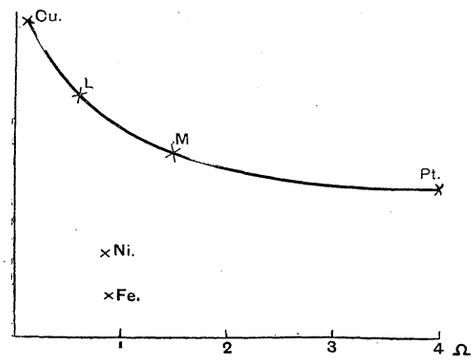
The official inspection of the plant was made on Saturday last by Major-General Hutchinson and Major Cardew. The inspecting officers reached James Bridge soon after half-past twelve, and were met there by the Mayor of Walsall, the Town Clerk and the Borough Surveyor; the Mayor of Wednesbury, the Town Clerk and the Borough Surveyor; Messrs. C. James, C. E. Davison and F. H. Lloyd (Directors of the Company); Mr. A. Dickinson, General Manager; Mr. T. Parker, of the Electrical Construction Company; M. Max Johannet, of Paris. The party mounted one of the new cars which was in waiting, and proceeded to the depôt at Darlaston, where the motors were inspected. Thence a run was made back to the generating station, and, after the appliances there had been passed in review, the line itself was gone over. The passage of the car attracted crowds of spectators at various points, and the inspection extended over $3\frac{1}{2}$ hours. The several steep gradients on the route, and the curves and junctions were all passed smoothly, and there was not a hitch from beginning to end. The date for the beginning of traffic under the new system will be definitely fixed when the sanction of the Board of Trade has been received.

ON THE DISSIPATION OF THE ELECTRICAL ENERGY OF THE HERTZ RESONATOR.*

BY V. BJERKNES.

In introducing conducting wires on different metals into his resonator Hertz asserted that neither the resistance nor the magnetic properties of the metal involved a sensible change in the length of the secondary spark.† We should, therefore, be tempted to conclude that the oscillations are completely independent of the nature of the metal. This independence is, however, only apparent. In my researches I employed a circular resonator having a diameter of 0·40m., and a complete period (double) of 14×10^{-8} second. The poles took the shape of vertical parallel discs 0·008m. apart, and 0·03m. in diameter. In the field constituted by the gap between these discs a piece of aluminium foil, forming an angle of 45deg. with the azimuth of the discs, was suspended by a quartz thread as an electrometer needle. Instead of the secondary spark the deflection of this needle was observed.

In this resonator I employed in succession geometrically identical conducting wires of different metals, and I obtained very different deflections. In the annexed diagram I give the



results obtained with six wires, all of 0·5mm. diameter, but made of copper (Cu), brass (L), nickel (Ni), iron (Fe), German silver (M), and platinum (Pt) respectively. The resistances of the wires are marked as abscissæ, and the ordinates show the deflections of the electrometer needle.

The results given in this figure appear at first glance singularly opposed to those obtained by Hertz. I think, however, that this divergence is only due to the difference of the methods. The oscillations of the resonator commence at zero and rapidly tend to a maximum, and gradually decrease afterwards. By the spark we evidently measure the height of this maximum; by the electrometer we measure the sum of all the oscillations. Owing to damping, this sum may have very different values without materially altering the height of the maximum. Consequently, the observations of Hertz show that the resonator always receives the same amount of electrical energy; the electro-magnetic measurements show that this energy is dissipated more or less quickly, according to the nature of the metal.

The capital point is thus the dissipation. The laws which govern it are represented indirectly by the diagram; a small ordinate corresponding to a rapid dissipation. It will be seen that the four non-magnetic metals ranged themselves on a curve having uniformly decreasing ordinates. On the other hand, the two magnetic metals, that is to say iron and nickel, are quite outside the curve, and the most magnetic metal is that which is the furthest from the curve. I have, therefore, come to the following conclusion:—*The rapidity with which the electrical energy of the resonator is dissipated is increased by the resistance and the magnetism of the conducting wire.* This dissipation may take place in two different ways, by radiation across the dielectric medium or by transformation into heat in the conducting wire. The considerable influence possessed by the physical constants of the metals seems to indicate that the transformation into heat is the principal cause. This transformation takes place in the thin superficial layer along which the electric currents flow. I endeavoured to determine the thickness of this layer with a view of getting to the bottom of the question.

To ascertain this, I covered the iron wire with thicker and thicker electrolytic layers of copper, and I found that the deflections of the electrometer increased, approaching asymptotically to the value of the deflections which took place in the case of the solid copper wire; the difference between the wires disappeared when the layer had a thickness of 0·01mm. I next covered the copper wire with electrolytic layers of iron; even a layer 0·0002mm. thick had an appreciable effect. The deflections very quickly approached the value which they had in the case of the solid iron wire, and all difference disappeared at the moment when the layer exceeded 0·003mm. in thickness. *I conclude, therefore, that the currents penetrate less deeply into the magnetic metals than into the non-magnetic metals.*

This result explains the part played by magnetism in the dissipation of electrical energy. The currents being confined to a thin layer, these would encounter a greater resistance, and consequently there would be a greater generation of heat. This explanation agrees with the theory already put forward by Lord Rayleigh and Herr Stefan. I may remark in conclusion that the penetration of alternating currents into the metals is a phenomenon of the same nature as the penetration of light into them. The results which I have obtained are sufficient to prove that metals are more transparent to luminous undulations, which agrees perfectly with theory.

* From the *Comptes Rendus*, Vol. CXV., No. 19.
† Hertz *Ausbreitung der Elektrischen Kraft*, p. 50.

THE PROBLEMS OF COMMERCIAL ELECTROLYSIS.

The following is an abstract of the Discussion of Mr. Swinburne's Paper on "The Problems of Commercial Electrolysis" which took place on Thursday last week at the Institution of Electrical Engineers. Speakers whose remarks are prefixed by an asterisk have returned their abstract revised. Mr. Swinburne's Paper appeared in *The Electrician* of August 5th and 12th.

Mr. C. F. COOPER said that he had been for some years connected with the Hermite process, and would give a short description of the way in which this is worked. On the Continent this was a going concern and a great success. There was a little châlet in the grounds of the Antwerp Exhibition in which an electrolytic process of bleaching was carried on. Mr. Hermite at that time was bleaching linen yarns. Diagrams were exhibited showing the arrangement of the plant in its present form. The electrolyser consists of a galvanised cast-iron box, and of a certain number of electrodes. They experimented with everything that could be imagined in the endeavour to get an unattackable anode, and fell back at last on platinum. Of course it was necessary to reduce the weight of platinum as much as possible for commercial reasons, and they originally started with very thin foil. The foil had many disadvantages; it had a knack of expanding and short-circuiting, and generally behaving like the secondary battery of old days. Eventually a platinum gauze anode was used. Prac-

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tically the results were the same with the same weight of platinum as if a solid sheet had been employed. These gauzes were mounted in ebonite frames. In practice there is practically no attack on the platinum anode. The process has been in use for six years and out of ten electrolysers they had certainly not put in one new set of anodes. The Hermite process was based on the decomposition of magnesium chloride. The process was essentially a continuous one. A solution of magnesium chloride in the top tank ran down to the bottom tank. They used a thousand amperes at five volts. They occasionally ran them as many as eight in series, but preferred five in practice. The decomposition took place in the second tank, and ran down into the poacher. It was washed in the ordinary washing drum used in a paper mill. When the pulp was bleached of course there was a certain amount of solution left in the pulp. This was treated and got back again, because one of the principal points in the Hermite process was that they used the same solution over and over again. It was run down from the poacher either into a drainer or over a press-plate. A press-plate took out, say, about 40 per cent. of moisture, and it was necessary to pass the pulp over a press-plate in the first instance, and then, after bleaching, to pass it over another press-plate. In dealing with carbon, he used various sorts years ago, and always found that it disintegrated on the water line, and they got small specks of black in their pulp ; instead of a bleaching solution they had practically a dyeing solution. They had the same difficulty in dealing with the pipes and conduits which conveyed the solution from one part of the mill to the other. They thus dyed many tons of pulp a beautiful green. That was due to the copper in the washing ground. They had to take all the copper away and put in zinc. They used occasionally to dye a very nice rich red, from the fact of peroxide of iron being present.

* Mr. C. K. FALKENSTEIN said that Mr. Swinburne stated, in the reference which he made to electric tanning, "If the skin is merely left in the tan liquor, it takes months for the liquor to penetrate even into the interstices." From this it would appear that the structure of the hide and the pores or interstices between the fibres were very close and narrow indeed. But in the preparatory process of liming, the cement-substance which joined the fibres together was dissolved away by means of the lime, which also "plumped" or swelled up the hide and separated the fibres, leaving it fairly porous, for the diffusion and absorption of the tan liquor. When the hide went into the tan, the tannage at first progressed very rapidly, for this reason, viz., that the pores were filled with water and organic salts, which diffused out very rapidly, thus creating a partial vacuum which tended to draw the tan liquor in. The rate of absorption, however, gradually grew slower and slower as the amount of these bodies present in the hide became less and less, since tannin, being a colloid body, had a very slow rate of diffusion by itself. If, now, a current of electricity were passed through the hides, it impelled the tan liquor in the same direction as the lines of current flow, a greater quantity of tannic acid solution being thus brought into contact with the gelatinous fibres of the hide. In tannic acid solution, endosmose effects were fairly powerful, this being due, perhaps, to the molecular structure of tannic acid ; and from the fact that it had a high resistance, comparatively high differences of potential could be employed to produce this endosmotic flow without necessitating the use of a large current and therefore a large expenditure of energy in the process. The fact observed by Messrs. Rideal and Trotter last year in their work on this subject, viz., that the increased rate of absorption was maintained for some time after the current was stopped, was due, no doubt, to the pores having been cleansed and opened by the endosmotic flow of liquor through them. The above accounted for increased diffusion, but there was another effect which may be noticed, viz., that electricity was of the nature of a vibration, and thereby tended to accelerate or assist the combination of the tannic acid with the gelatinous fibres. Mechanical agitation, too, was commented upon in the Paper, and had, he thought, two functions, viz.—1st. To mix the liquor and render it of uniform strength. 2nd. To bend the hide and open the pores on the outer side of the bend, thereby also assisting diffusion.

Mr. STEPNEY RAWSON said that Mr. Swinburne put the cost of the kilowatt hour at about a farthing, and said it would appear ridiculous in connection with central stations. Unless he had some figures arising out of his visit to Bridgeport to confirm the farthing per hour, it would appear not ridiculous but very small to those who are engaged in commercial electrolysis ; but at the same time he did mention the best engines and modern dynamos. They knew pretty nearly what the modern dynamo is capable of, but they did not quite know what the modern engine was capable of. An exceedingly good authority told him that, in a succession of tests he had made on the commercial working, the efficiency ran anywhere between 28lb. and about 4lb., so that there was a certain margin ! People were very fond of putting down on paper 2¼lb., and in France a kilo corresponds so nearly with that that they always called it a kilo, but it was almost impossible to get it in practice. In actual working one of the greatest enemies is leakage. Theoretically, it was easy to get rid of it. There were a thousand ways in which leakage took place which would surprise even an old hand ; moreover, a large number of parasitical currents were set up, and they might hunt round for weeks before they find out where they arose. Therefore, although at the dynamo terminals they might arrive at a farthing, he thought by the time the current had, so to speak, got back again, they would find it took a great deal more. With regard to the carbon that, no doubt, is a source of difficulty, and many people have had trouble with it. With a very heavy current density, that was a current density of 100, carbon behaved tolerably well. When he got down to ten, it disintegrated very much faster. Regarding the treeing of zinc and lead, the arrangement of burnisher which the Elmores used, has proved very successful in removing that difficulty. He had seen a solution of zinc deposited with a sulphate solution with a porous partition come out very definitely indeed. In the same way the treeing of lead could be fairly easily kept down.

Mr. C. F. CROSS was interested in the Hermite process when it was first brought to this country in 1884-5, and of course viewed it with the amount of scepticism which, specialist as he was at that time in matters of bleaching, and knowing nothing of electrolysis, he was entitled to feel. A somewhat acute controversy on the subject took place in 1887-8, and was recorded in the *Journal* of the Society of Chemical Industry. So long as electrolysis had been confined to the actual separation of bodies in a condition to be weighed, there could be no doubt, of course, as to the efficiency of the current, and no doubt either as to the measurement of the current in the terms of the product obtained. But when they had to get that product to do work in a transitional state, and having done work to revert to something like the *status in quo* there came, of course, an element of doubt and difficulty. They had to catch a particular element, namely, oxygen, flying, and that led to some very remarkable results. They had found that in bleaching powder units, the work of a ton of bleaching powder could be effected on the electrolytic plan at a cost of from £2. 10s. to £4. That is to say, given a certain amount of bleaching work to do, and requiring a certain amount of bleaching powder to do it to the weight of one ton, and costing, of course, from £7 to £8 at then rates, it could be done at from £2. 10s. to £4. They found always from 70 to 90 per cent. of the current efficiency, and the compound produced clearly was not the ordinary chlorine. They showed that there was formed at the cathode an active oxidising compound, and this stirred into the solution was dissolved, and no doubt contributed largely to the particular efficiency of the solution. In these experimeuts they carefully compared bleaching powder in the ordinary chemical process, and the electrolysis in Hermite's method, and they found that 26 per cent. of the bleaching powder was used in the chlorination effect ; 14 per cent. of the total used, went into this by-path or in some other direction, but with the electrolysed solution prepared by Hermite there was no chlorination at all.

Prof. PERRY suggested that for a society of that kind they should have actual figures of the cost, as compared with the cost of bleaching powder, not speculative figures, such as appeared in the papers five or six years ago. He would also suggest that Mr. Swinburne should put, as an addition to his Paper, the materials from which he had produced this farthing per unit.

Mr. DESMOND G. FITZGERALD said that every sample of peroxide of lead he had tried contained a considerable proportion of sulphate. In that case acid would be produced at the anode, and the sulphuric acid reacting on the sodium chloride would, of course, produce hydrochloric acid ; but in practice it was the easiest thing possible to maintain the solution at the anode in the alkaline condition to any required extent. There need never be any free acid where chlorine is being evolved ; but supposing that hydrochloric acid were evolved, peroxide of lead in the form of lithanode was perfectly indifferent to the action of hydrochloric acid, so long as the current was continued. If peroxide of lead or a plate of lithanode was placed in hydrochloric, they would obtain chloride of lead and chlorine would be evolved ; but if the peroxide was made the anode, chlorine would be evolved, but no chloride of lead would be produced. He handed round a plate, which he took out of a solution of hydrochloric acid, in which it had been used as anode, and producing chlorine for eight or ten hours. The plate was not affected, and that would also have been the case if it had been left two or three days, or two or three weeks. Anyone interested in the matter could examine that. Mr. Falconer, the only person capable of speaking from actual experience of the use of lithanode as an anode employed on a large scale, had sent some old anodes of lithanode and peroxide of lead, which had been used in a solution of chloride magnesium, and which had been exposed to the solution for a long time. The plates were covered with a white substance, which suggested chloride of lead, but it was magnesium hydrate ; the peroxide underneath was perfectly intact. A thing which was quite fatal to the use of magnesium chloride as a supplier of chlorine, was the fact that at ordinary temperature magnesium hypochlorite had a strong tendency to become converted into chlorate. He could speak with a little authority on this point, because after a certain experiment, to which Prof. Perry and Prof. Meldola were called in, they were all very much surprised to find that there did not seem to be any relation between the quantity of current expended and the quantity of chlorine produced. After these unsatisfactory results in conjunction with his assistant, Mr. Burman, they compared the quantity of current expended and the quantity of chlorine produced. After a certain strength had been obtained, there seemed in some instances to be an actual disappearance of chlorine by the passage of the current, and the solution of the mystery ultimately turned out to be that chlorates were produced at ordinary temperatures in considerable abundance. As instances of the many small operations in which electrolysis might probably be advantageously introduced, he suggested the conversion of arsenious acid into arsenic acid ; the conversion of ferrous prussiate of potash into the ferric, or the yellow prussiate into the red ; and again the purification of acids, sulphuric acid and hydrochloric acid on a large scale, the separation of lead from sulphuric acid and iron and zinc from hydrochloric acid.

* Mr. A. E. MAVOR alluded to Mr. Swinburne's remark : "The first manufacturers to take up copper refining by electrolysis on really modern principles have a chance of making fortunes before the market is disturbed." Now this would really have been a most momentous sentence were it not for the fact that some manufacturers had already taken the matter up, and were making fortunes. Some of the oldest copper manufacturers in the country had taken it up with great enthusiasm and energy, precisely on the principles Mr. Swinburne described, and he did not think there was any danger that that particular branch of the electrical industry was the least likely to fall asleep.

Mr. A. C. FALCONER had carried out certain experiments, extending over close upon four years, and lithanode anodes that he had brought to the meeting had been in solution at least three years, and had not been injured in any way whatever. He did not replace one single plate, except

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when they were broken, but all the others were in solution for about two years. His experience extending over four years was that lithanode was indestructible in solution, and he believed that Mr. Fitzgerald's theory was perfectly correct, that they could even decompose hydrochloric acid by lithanode without injury.

Mr. SWINBURNE asked Mr. FALCONER whether there was oxide of magnesia on the lithanode.

Mr. FALCONER replied that Mr. Fitzgerald thought it would be better to have the anodes at the bottom of the bath with plenty of magnesia on them. He was surprised to hear Mr. Cooper defend so strongly the use of platinum. He could tell them that platinum was attacked by chlorine. It must give way sooner or later.

Mr. SWINBURNE asked whether the lithanode stood perfectly untouched when it was vertical without any magnesia on it.

Mr. FALCONER pointed to a specimen of the anode of the vertical pattern on the table. They connected up the lithanode in the ordinary way with platinum connections. They found if there was the merest pinhole in the insulation the platinum would disconnect itself from the anode.

* Dr. S. P. THOMPSON desired to direct the discussion towards some points, perhaps, of more general interest than the detail of a single process, however important that process may be in itself. He questioned whether details of processes were much worth discussing unless they had the commercial basis, namely, the figures. He would like to point out that when one comes to put any one of these processes on to a commercial basis one is bound to meet with difficulties that cannot be anticipated from the laboratory, and which seriously interfere with the question of possible profit in working. He described the failure of the Hermite processes in a paper mill where, though the bleach liquor was satisfactorily made, the pulp was bleached and dyed at the same time, with the consequence that the dilute liquor coming into the vat brought a large quantity of water with it. It was not that the bleach liquor was defective, but their way of using bleach liquor made the process one that did not pay. Mr. Swinburne had not touched on one or two processes which he believed were used commercially. He did not mention the process of galvanising iron by the aid of a skin deposit of zinc, first of all deposited electrically, before the sheets are dipped into molten zinc. Then, again, Mr. Swinburne did not do him the honour of mentioning a process of depositing cobalt, he supposed for the very good reason that it did not come under the head of *commercial* electrolysis. He wished it did. He found from experience that the one white metal which would stand a London atmosphere, fog, and the products of combustion, was the metal cobalt. In text-books on such subjects figures are given for electro-chemical equivalents of metals in their different states, of ferrous iron for example and for ferric iron. He was not at all sure whether those distinctions were not absolutely absurd ; at any rate they were so in the case of ferric salts. They were not able to get a deposit of iron from ferric salts. Before they could obtain a deposit from ferric salt it had to be reduced to the ferrous state, and they only got a deposit from ferrous iron and not truly from ferric iron. Another point which ought to be borne in mind was the necessary minimum electromotive force to produce any action whatever of a chemical nature. Probably it might make the whole difference between its being commercially valuable and commercially valueless that they should know that minimum electromotive force in each case. He would say a word about processes, such as that of Hermite, which were cyclic processes where the material went round and round and was regenerated after being used. The difference between a non-cyclic process and a cyclic process made all the difference in the world between success and failure. He believed Dr. Hurter's mistakes arose very largely from his not recognising the difference between a cyclic process and a non-cyclic one. A cyclic process would pay where a non-cyclic process possibly could not. He further remarked that as in electric tanning, in which electrolysis played so small a part and electric osmose played so important a part, so he believed there were other cases in which osmose is the important part. For example, it was quite possible to separate to a certain extent animal and vegetable oils from mineral oils by subjecting them to a species of electric osmosis.

PHYSICAL SOCIETY.

At a meeting of the Physical Society on October 28, 1892, Dr. J. H. Gladstone, F.R.S., past-president, in the Chair, the discussion on Mr. Williams's Paper

"On the Relation of the Dimensions of Physical Quantities to Directions in Space"

was opened by Prof. PERRY reading a communication from Prof. Fitzgerald, President.

The writer said Mr. Williams disagreed with the suggestion that electric and magnetic inductive capacity are quantities of the same kind, principally because he had not got over the curious prejudice that potential and kinetic energy are different. No theory of the ether could be complete unless it reduced its energy to the kinetic form. Electric and magnetic inductive capacity would probably be found to be similar in the ether, and ultimately have the same dimensions. The analogues were not yet complete, but only in respect of *matter* was it probable that any difference existed between them. Diamagnetism corresponded to electrostatic induction, but paramagnetism had no definite electrical analogue. He was inclined to regard the phenomena of paramagnetism as connected with the arrangement of the material molecules, whilst diamagnetism depended on the electric charges on those molecules. So far no matter had been found which conducts magnetism, and such may not exist in our universe, but it may be gravitationally repelled by matter as we know it.

Mr. W. M. MADDEN remarked that in the first part of his paper Mr. Williams recognised that dimensional formulæ were originally change-ratios, but puts this aside for the higher conception which regards these formulæ as expressing the nature of the quantity. Fourier showed how to find the dimensions of units by making the size of the fundamental units vary. But k (specific inductive capacity) did not vary with the fundamental units, for it was merely the ratio of the capacities of two condensers, and, therefore, by Mr. Williams's definition, a pure number. It was difficult, he said, to see how k could have dimensions, but Mr. Williams regarded it as a physical quantity, and, therefore, possessing dimensions. The object in giving dimensions to k and u seemed to be to get over the double system of units. That Mr. Madden did not think that the suppressed dimensions of μ and k were not generally accepted was shown by Dr. J. Hopkinson's insistance, at the last B.A. Meeting, that the coefficient of self-induction was a length, which Prof. Rücker said was inconsistent with belief in the physical dimensions of μ and k. Nor were these suppressed dimensions necessary to reconcile the two systems. The connecting link between them was the formula $Q = Ct$, which expresses a theory of the nature of an electric current admittedly inadequate to explain the facts, and recently much called in question. That the dimensions did not express the physical nature of the quantities might be seen from considering the astronomical unit of mass whose dimensions were $[L^3 T^{-2}]$. No one could contend that this formula indicated "how our conception of the physical nature of matter is formed." Mr. Madden argued that the obvious interpretation of this dimensional formula, and the way it was obtained, indicated the meaning of all such formulæ, and showed that they are the result of a convention that certain definitions should hold true generally, but they contain no further information respecting the nature of the quantities, beyond that involved in those definitions. As an example of the inability of such formulæ to express the nature of quantities, he pointed out that whilst physical differences were known to exist between + and − electricity, the dimensional formulæ showed no signs of such differences.

Prof. RÜCKER said every correct physical equation consisted of a numerical relation between physical quantities of the same kind, and might be written either as a mere numerical equation or as a relation between the physical quantities themselves. The equation $2 + 1 = 3$ may correspond to $2\text{ft.} + 1\text{ft.} = 3\text{ft.}$, and the latter may be writen

$$2[\mathrm{L}] + 1[\mathrm{L}] = 3[\mathrm{L}],$$

where [L] represents the unit of length. So far as he was aware nobody but a recent writer in *The Electrician* had denied that in such an equation [L] represented a concrete quantity, Maxwell explicitly stated that it does in his article on "Dimensions" (Encyl. Britt.) and elsewhere, and Prof. J. Thomson, in his Paper on the same subject, makes no statement contrary to this. The above equation might also be written

$$2[\text{ft.}] + 1[\text{ft.}] = 1[\text{yd.}]$$

Another equation involving time is

$$60[\text{sec.}] = 1[1\text{ min}],$$

and dividing one by the other, one gets

$$\frac{2}{60}\left[\frac{\text{foot}}{\text{sec.}}\right] + \frac{1}{60}\left[\frac{\text{foot}}{\text{sec.}}\right] = 1\left[\frac{\text{yard}}{\text{min.}}\right]$$

A difficulty was felt here in understanding what dividing a foot by a second meant, bnt this difficulty, Professor Rücker considered, was not greater than that involved in dividing an impossible by a real quantity ; a very familiar analytical device. Reasons for regarding the symbol

$$\left[\frac{\text{foot}}{\text{sec.}}\right]$$

as legitimate were then given.

Prof. HENRICI said the communication under discussion was one of the most important contributions to physical science which he had come across for a long time. Such difficulties as presented themselves in the Paper arose from its fundamental character. The author had attempted to express all physical quantities in terms of three, but quantities may exist which cannot be completely represented in terms of L, M, and T. The tendency of modern mathematics was to express everything dynamically. Mathematicians had long been in the habit of using quantities which were neither numbers nor concretes in the ordinary sense, and different kinds of algebra with units not understandable had been developed. If a quantity, a times a unit u, be multiplied by b times another unit v, the result is expressed by $a\,b$, $u\,v$, where $a\,b$ is a number and $u\,v$ a new unit, which may or may not be physically interpretable. The interpretation of a product depended on the meaning attached to "multiplication," and if this be restricted to "repeated addition" the range is very limited. The narrow conceptions concerning multiplication acquired at school could only be removed by a careful study of vectors. Mr. Williams had treated his subject by vector methods, but a few traces of quaternions remained which might be omitted. To truly understand the subject, vectors must be treated vectorially. Dimensions might then show the nature of the quantities involved. The system adopted in Mr. Williams's Paper was probably the best attainable at present, but he (Prof. Henrici) looked forward to the use of a more fundamental quantity than the vector, viz., "the point," as the ultimate basis. Grassmann had worked out a "point calculus" in 1844, which was republished in 1880. Quantities more complex than vectors, viz., rotors, screws, motors, &c., had been used with advantage by Clifford, Ball, and others.

Dr. SUMPNER thought the first ideas of students on the subject of dimensions were that they represented the nature of the quantities, but could not see why every quantity should be expressed in terms of L, M,

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and T. Prof. Rücker's Paper on "Suppressed Dimensions" had cleared up several important points, and he (Dr. Sumpner) now considered that every quantity must be expressed in terms of a unit of the same kind as itself. He viewed Mr. Williams's attempt to express everything in terms of L, M, and T, as rather a retrograde step.

The discussion on Mr. Williams's Paper was adjourned, and Dr. Young made some remarks on Mr. Sutherland's communication, "On the Laws of Molecular Force." A Paper "On the Determination of the Critical Density," by Dr. Young and Mr. G. L. Thomas, B.Sc., and two Papers, "On the Determination of the Critical Volume," and "On the Boiling Points of Different Liquids at Equal Pressures," by Dr. Young, were taken as read.

On Nov. 11th the discussion on Mr. Williams' Paper, "The Dimensions of Physical Quantities" was resumed by Dr. BURTON.

He remarked that the idea that so-called "specific quantities," such as specific gravity are pure numbers, was an erroneous one, and liable to lead to difficulties. The specific gravity of a substance was of the nature of density, and was only a simple number on the convention that the density of water was taken as unity. If dimensions be given to specific quantities, their interpretation would, he thought, be easy when the rational dimensional formulæ were found. Referring to Prof. Fitzgerald's comments, he said, although the contention that all energy is ultimately kinetic, could not be gainsaid, the distinction commonly drawn between kinetic and potential energy involved nothing contrary to this view, and was useful and convenient in many cases. As to the dimensions of μ and k he was inclined to favour Mr. Williams' views, for several considerations suggest that the two capacities of the medium are essentially different. Arguments to show that μ was probably absolutely constant in the ether, whilst k might be variable were brought forward. Of the two systems of dimensions for μ and k suggested by Mr. Williams, that which made μ a density seemed preferable.

Prof. A. LODGE said he was greatly interested in propagating the idea that physical quantities are concrete, and therefore welcomed Mr. Williams' Paper. He thought it desirable to keep some names for abstract numbers, and "specific gravity" should be one. If another name involving dimensions was required, "specific weight" or "weight per unit volume" might be used. Speaking of the dimensions of the various terms of an equation, he did not think it was usually recognised that in ordinary algebra or Cartesian geometry the principle of directed terms was rigidly adhered to, for, if directed at all, every term of such an equation was directed along the same line. In this respect ordinary algebra was more rigid than vector algebra. Even if circular functions were involved, as in polar co-ordinates, they had the effect of making the directions of the terms the same. Other instances of problems bringing out the same fact were mentioned.

Prof. V. BOYS thought Mr. Madden had been arguing in a circle when he spoke of the astronomical unit of mass, and deduced the dimensions of mass as L^3/T^2 from the equation $M L T^{-2} = M^2/L^2$, for it was quite impossible that this equation could be true, unless γ the gravitation constant was introduced on the right-hand side. Mr. Williams' method was quite the reverse, for he maintained that unless k and μ were introduced in the dimensions of electric and magnetic quantities, their dimensional formulæ could not indicate the true nature of those quantities, and hence were open to objection.

Mr. W. BAILY, whilst agreeing with Mr. Williams on most essential points, thought the total omission of L from dimensional formulæ made the expressions more complicated and less symmetrical. For example, such expressions as $X Y/Z$, X^2, and $X Y Z$, which respectively represent undirected length, area, and volume, might with advantage be written L, L^2, and L^3 respectively. The restriction of the dimensions of μ and k to those which give interpretable dimensional formulæ for electrical and magnetic quantities seemed scarcely justified. Both the systems proposed could not be right, and he thought it would be more in accordance with our present want of knowledge if a quantity U of unknown dimentions were introduced such that μ or $k = U^2$ density, and k^{-1} or $\mu^{-1} U^2$ rigidity. This would keep in view the fact that the absolute dimensions of quantities involving U were unknown. A list of the dimensions of the various quantities based on this arrangement was given.

Mr. SWINBURNE, referring to the conventional nature of many units, said great differences exist between the ideas held by different persons about such units. Starting with the convention that unlike quantities could be multiplied together, he might have six amperes flowing in an electric circuit under a pressure of 10 volts, and he might say he had 60-volt amperes. The term "volt ampere" could be regarded as indicating that the 60 was the numerical result of multiplying a number of volts by a number of amperes, or, on the other hand, it might be understood as a new unit, a *watt* compounded of a volt and an ampere. Before Prof. Rücker's Paper on "Suppressed Dimensions" was published, an electrician might have suggested measuring the length of a bench by sending an alternating current through it, and determining its self-induction, which he regarded as a length. Prof. Rücker, however, would say that this could not give the right result, for μ must be taken into account. He was inclined to think that dimensions were liable to mislead. Referring to scientific writers as authorities, he said Maxwell had been careless in some cases, for he had sometimes given dimensional formulæ as zero, which really ought to have been $L^\circ M^\circ T^\circ$, or unity. In French text-books the errors had been corrected.

Mr. WILLIAMS, in reply to Mr. Madden's remarks about self-induction being a length, pointed out that the subject might be looked at in two different ways, depending on whether one thinks of the *standard* of self-induction as the practical standard of measurement, or the *unit* of self-induction as a physical quantity. In the former case the *standard* was a length; but in the latter the *unit* was a quantity of the same *species* as self-induction, the nature of which was, as yet, unknown. If its dynamical nature was known, then the absolute dimensions of all other magnetic and electric quantities would also be determined. In answer to Prof. Fitzgerald's remarks he said it was hardly likely that he should be unacquainted with the common view that kinetic and potential energies were ultimately quantities of the same kind, for it was a view with which he was quite familiar. The fact that they have the same dimensions was sufficient to show their identity, and the idea that all energy is ultimately kinetic was fundamental to his Paper. This, however, did not imply that electrification and magnetisation are of necessity the same, and the suggestion that they may be the same was only one of several "probable suggestions," all of which were entitled to consideration. His chief reason for regarding Prof. Fitzgerald's suggestion as probably incorrect was that it led to a system of dimensional formulæ incapable of rational mechanical interpretation, and containing fractional powers of the fundamental units. Prof. Fitzgerald's system would make resistance an abstract number, and μ and k directed quantities, whereas the former was a concrete quantity, the two latter must be scalar in isotropic media. If he (Mr. Williams) had erred in treating electrification and magnetisation as different phenomena, he could only plead that he had done nothing more than follow such authorities as Lord Kelvin, Dr. Lodge, and Mr. O. Heaviside in the matter.

COMPARISON OF THE FRICTION OF COTTON MILL ENGINES AND GEARING TO THE ACTUAL WORK DONE.*

BY ALFRED SAXON.

In bringing this subject before your notice I feel it is one that is deserving of our attention, and I trust it will be the means of enabling us to do something to prevent the loss of power and economy which exist in engines and gearing at the present time from this cause. Thurston says, "Friction is a resistance which is always met when two bodies or particles, whether solid, liquid or gaseous, are compelled to move, one upon another. There are three kinds of friction, so called; rolling and sliding with solids, and fluid friction with liquids and gases. These are all governed by different laws, and with each the statement of those laws as usually given in the text-books probably require some modification." It is not my intention to attempt to analyse the different kinds of friction created in engines and gearing; I shall deal with all kinds of friction under the general head of friction. It will also be impossible for me to furnish minor details of such engine and gearing arrangements that I shall refer to, as time and space will be occupied in a general description. I have not been successful in obtaining permission to indicate some of the engines I had intended, and in one or two cases of refusal, perhaps, the least said the better. You will no doubt agree with me that running large engines up to their ordinary working speed without weight on is not a very desirable thing, and is occasionally productive of hot bearings, which I believe is the true explanation of consent being withheld in some instances.

In the examples I shall refer to I have not attempted to select very extreme cases, such as I know do exist, but I have tried to select examples which will fairly illustrate mill engines and gearing which have been constructed within a comparatively recent date. Economies are being effected in steam engines at the present time by utilising higher pressures of steam, but we shall not be long in reaching a safe working limit in that direction.

There is no doubt that along with this increase of pressures, we have had an increase of speeds in engines and gearing. We, as an industrial people, are drawing rapidly upon the coal supply, and if we must leave coal for the use of the generations yet unborn, and at the same time cheapen the cost of our productions, we must, in our different positions as practical engineers, consulting engineers and mill architects, in drawing up specifications and carrying them out, use every available means of improving the efficiency of the engines and gearing of our manufactories. There are a variety of ways of judging of the economy of steam engines and gearing, the commonest being the number of pounds of coal per indicated horse power per hour, another test being that of the weight of steam used; these, however, are only partial tests. The test which many mill owners apply in a rough and ready sort of way, that of reckoning the number of spindles of either twist or weft, or both, and the counts of the yarn and the weight spun for a given quantity or value of coal, in comparison to their neighbours who have similar mills, is a good proof of economical working, if taken into consideration with the tests above mentioned.

In the term "Actual work," in the examples given, I wish it to be understood that I include all the power absorbed in driving the machinery, after deducting the friction of the engines and gearing from the total load. That is, treating the friction in the machinery itself and the work done by the machinery as "Actual

* Abstract of a Paper read before the Manchester Association of Engineers.

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work." If the coal consumption were based on the actual work done it would give some startling results, as is shown by a study of the following examples :—

Spur Gearing Engines.

1st Example.—Pair of horizontal compound tandem engines with high-pressure cylinders 24in. diameter, low pressure cylinders 48in. diameter, all 5ft. 6in. stroke, making 51 revolutions per minute, or a piston speed of 561ft. per minute. Fly spur driving wheel 14ft. 6½in. diameter, 5in. pitch, 18½in. broad, pinion 6ft. 7in. diameter. Indication with full load, and boiler pressure of 110lb. work out to 1309·6 I.H.P. Indication of friction with the whole of the gearing and engines at work equals 385·76 I.H.P., being 29·47 per cent. of the total load, leaving an actual load of 70·53 per cent. on the engines. Description of gearing : Wheel and rope driving, partly new and partly old, not supplied by engine maker.

2nd Example.—Pair of horizontal compound tandem engines with high pressure cylinders 21in. diameter, low pressure cylinders 42in. diameter, all 6ft. stroke, making 35½ revolutions per minute, or a piston speed of 426ft. per minute. Fly spur driving wheel : Indication with full load and boiler pressure of 110lb. work out to 989·54 I.H.P. Indication of friction with the whole of the gearing and engine at work equals 217·49 I.H.P., being 22 per cent. of the total load, leaving an actual load of 78 per cent. on the engines. Description of gearing : Wheel and rope driving new, not supplied by engine maker.

3rd Example.—Pair of horizontal compound engines, with high-pressure cylinder 16in. diameter, low-pressure cylinder 28in. diameter, both 4ft. stroke, making 70 revolutions per minute, or a piston speed of 560ft. per minute. Fly spur wheel. Indication with full load, works out to 250 I.H.P. Indication of friction with the whole of the gearing and engines at work equals 87·62 I.H.P., being 33·2 per cent. of the total load, leaving an actual load of 67 per cent. for the engine. Description of gearing : Old.

P.S.—The friction at 64 revolutions per minute equals 73·17 I.H.P.

5th Examp'e —Pair of horizontal triple-expansion tandem (formerly compound, recently tripled) engines, with high-pressure cylinders 14½in. diameter, intermediate cylinders 23in. diameter, low-pressure cylinders 36½in. diameter, all 6ft. stroke, making 51 revolutions per minute, or a piston speed of 612ft. per minute. Fly spur driving wheel 14ft. 8⅝in. diameter, 4 1/16in. pitch, 18in. broad, 115 teeth ; pinion 6ft. 7⅛in. diameter, 52 teeth. Indication of full load with boiler pressure of 160lb. works out to 1,044·5 I.H.P. Indication of friction with the whole of the gearing and engines at work equals 205·95 I.H.P., being 19·7 per cent. of the total load. Description of gearing : Wheel gearing throughout.

8th Example.— Pair of compound McNaughted beam engines, high-pressure cylinders 35in. diameter, by 3ft. 6in. stroke, low-pressure cylinders 42¼in. diameter by 7ft. stroke, making 33 revolutions per minute, or a piston speed of 462ft. per minute for the low-pressure pistons. Fly spur wheel 25ft. diameter, 4½in. pitch, 16in. broad, 210 teeth, pinion 6ft. 1in. diameter, 51 teeth. Rim speed 2,590½ft. per minute. Indication of full load with a boiler pressure of 90lb. work out to 1,150 I.H.P. Indications of friction with the whole of gearing and engines at work equals 209 I.H.P., being 18·17 per cent. of the total load, leaving 81·83 per cent. of an actual load on the engine. Description of gearing : Wheel gearing throughout ; mule driving direct from line shafts.

9th Example.—Pair of triple expansion (formerly compound, recently tripled) engines with four cylinders. Indication of full load with boiler pressure of 160lb. works out to 1,145 I.H.P. Indication of friction with the whole of gearing and engines at work equals 300 I.H.P., being 26·2 per cent. of the total load, leaving an actual load of 73·8 per cent. on the engine. Description of gearing : Wheel gearing throughout.

10th Example.—Pair of compound McNaughted beam engines. Indication with full load at boiler pressure of 64lb. works out to 821·26 I.H.P. Indication of friction with the whole of gearing and engines at work equals 207·96 I.H.P., being 25·3 per cent. of the total load, leaving 74·7 per cent. of an actual load on the engine.

Rope Driving Engines.

1st Example.—Pair of horizontal compound side-by-side engines, high-pressure cylinder, 32in. diameter, low-pressure cylinder, 60in. diameter, both 7ft. stroke, making 52 revolutions per minute, or a piston speed of 728ft. per minute, Rope pulley 34ft. diameter, grooved for 32 ropes. Speed of ropes 5,554·3ft. per minute. Indications of full load with boiler pressure of 94lb. per square inch work out to 1,272 I.H.P. Indications of friction with the whole of the gearing and engines at work equals 296 I.H.P., giving 23·3 per cent. of friction. Friction at 50 revolutions equals 270·3 I.H.P. Gearing new, but not made by engine maker.

2nd Example.—Horizontal compound tandem engine, high-pressure cylinder 22in. diameter, low-pressure cylinder 44in. diameter, grooved for 28 ropes 1¾in. diameter, speed of ropes 4,838ft. per minute. Indications of full load with boiler pressure of 90lb. work out to 1,025 I.H.P. Indications of friction with the whole of gearing and engines at work equal 32·493 I.H.P., giving 31·7 per cent. of friction. Description of gearing : New, not supplied by engine maker.

5th Example.—Pair of horizontal compound tandem engines, with high-pressure cylinders 20in. diameter, low-pressure cylinders 40in. diameter, all 5ft. stroke, making 60⅓ revolutions per minute, or a piston speed of 603⅓ft. per minute. Rope pulley 28ft. diameter grooved for 26 ropes 1¾in. diameter, speed of ropes 5,306ft. per minute. Indications of full load with a boiler pressure of 90lb. works out to 978·25 I.H.P. Indications of friction with the whole of the gearing and engines at work equal 283 I.H.P., giving 28·9 per cent. of friction. Description of gearing : New, not supplied by engine maker.

6th Example.—Pair of horizontal compound tandem engines, with high-pressure cylinders 20in. diameter, low-pressure cylinders 40in. diameter, all 5ft. stroke, making 57 revolutions per minute, or a piston speed of 570ft. per minute. Rope pulley 28ft. diameter grooved for 24 ropes 1¾in. diameter. Speed of ropes 5,013·9ft. per minute. Indications of full load with a boiler pressure of 90lb. works out to 992·96 I.H.P. Indications of friction with the whole of the gearing and engines at work equals 310·1 I.H.P., giving 31·2 per cent. of friction. Description of gearing : New, not supplied by engine maker.

7th Examp'e —Horizontal compound tandem engine, high-pressure cylinder 19in. diameter, low-pressure cylinder 38in. diameter, 5ft. stroke, making 62 revolutions per minute, or a piston speed of 620ft. per minute, works out to 393·5 I.H.P. Indications of friction with the whole of gearing and engine at work equal 126·8 I.H.P., being 32·3 per cent. of the total load, leaving an actual load of 67·7 per cent. on the engine.

8th Example.—Pair of horizontal compound tandem engines, high-pressure cylinders 27in. diameter, low-pressure cylinders 46in. diameter, all 5ft. 6in. stroke, making 75 revolutions per minute, or a piston speed of 825ft. per minute. Rope pulley 22ft. diameter grooved for 40 ropes 1⅝in. diameter. Speed of ropes 5,183·6ft. per minute. Indications of full load with a boiler pressure of 100lb. works out to 1,579·52 I.H.P. Indications of friction with the whole of gearing and engines at work equal 389·4 I.H.P., being 24·6 per cent. of the total load, leaving 75·4 per cent. of an actual load on the engines.

N.B.—This engine is not fully loaded ; the shafting and engines were fixed to turn 2,000 I.H.P. The friction at this power equals 19·47 per cent. New gearing supplied by the maker of engines.

Belt Driving Engines.

1st Example.—Pair of horizontal compound tandem engines, with high pressure cylinders 18in. diameter, low-pressure cylinders 36in. diameter, all 5ft. stroke, making 53 revolutions per minute, or a piston speed of 530ft. per minute. Fly-belt pulley 26ft. diameter, 8ft. wide, for three belts 2ft. 6in. wide, giving a belt speed of 4,320ft. per minute. Indications of full load 855·95 I.H.P. Indication of friction with the whole of the gearing and engines at work equals 241·85 I.H.P., being 28·2 per cent. of the total load, leaving an actual load of 71·8 per cent. on the engines.

P.S.—There is some rope driving, gearing supplied by maker of engines.

2nd Example.—Pair of horizontal compound tandem engines, with high-pressure cylinders 26in. diameter, low-pressure cylinders 40in. diameter, all 5ft. stroke, making 47¼ revolutions per minute, or a piston speed of 472½ft. per minute. Fly-belt pulley 28ft. diameter, 7ft. wide, prepared for three belts each 26in. in width, and giving a belt speed of 4,158ft. per minute. Indication of full load with a boiler pressure of 85lb. works out to 969 I.H.P. Indication of friction with the whole of the gearing and engine at work equals 262·3 I.H.P., being 27 per cent. of the total load, leaving an actual load of 73 per cent. on the engines.

Direct-Acting Engines.

1st Example.—Horizontal single cylinder condensing engine, with cylinder 32in. diameter, stroke 3ft., making 91 revolutions per minute, or a piston speed of 546ft. per minute. Crank shaft coupled direct to second motion shaft. Indication of full load with boiler pressure of 80lb. works out to 503·85 I.H.P. Indication of friction with the whole of the gearing and engine at work equals 99·1 I.H.P., being 19·67 per cent. of total load, leaving an actual load of 80·33 per cent. on the engine.

P.S.—The gearing in this case is old.

2nd Example.—Inverted vertical three throw crank triple expansion engine, with high-pressure cylinder 14in. diameter intermediate 22½in., low-pressure 36in. diameter, all 3ft. 6in. stroke, making 65½ revolutions per minute, or a piston speed of 458½ft. per minute. Crank shaft coupled direct to second motion shaft.

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stroke 5ft., making 58½ revolutions per minute, or a piston speed of 585ft. per minute. Rope pulley 28ft. diameter, grooved for 16 ropes, 1¾in. diameter, 10 ropes only being used. Speed of ropes, 5,146·9ft. per minute. Indications of full load with boiler pressure of 100lb. works out to 724·9 I.H.P. Indications of friction with the whole of gearing and engines at work equal 232·1 I.H.P., giving 32 per cent. of friction. Description of gearing: New, but badly arranged to assist in driving part of another mill; 24 ropes 1¾in. diameter used in driving in addition to main shafts.

3rd Example.—Pair of horizontal compound side-by-side engines, high-pressure cylinders 24in. diameter, low-pressure cylinders 48in. diameter, both 5ft. 6in. stroke, making 62 revolutions per minute or a piston speed of 682ft. per minute. Rope pulley 24ft. diameter, grooved for 24 ropes 1½in. diameter, speed of ropes 4,674·7ft. per minute. Indications of full load with boiler pressure of 110lb. work out to 859 I.H.P. Indications of friction with the whole of gearing and engines at work equals 274·2 I.H.P., giving 32·8 per cent. of friction. Description of gearing: Old, altered to suit rope driving was previously arranged for belt driving.

4th Example.—Pair of horizontal compound tandem engines, with high-pressure cylinders 22in. diameter, low-pressure cylinders 44in. diameter, all 5ft. stroke, making 55 revolutions per minute or a piston speed of 550ft. per minute. Rope pulley 28ft. diameter Indications of full load work out to 388·8 I.H.P. Indications of friction with the whole of the gearing and engine at work equal 94·5 I.H.P. at 68 revolutions per minute, being 28 per cent. of total load.

P.S.—The gearing in this mill is old and badly arranged from engine.

Summary.

Example.	Full load I.H.P.	Average pressure refrd. to, L.P. cyl.	Friction load. I.H.P.	Average pressure refrd. to, L.P. cyl.	Prentage. of friction to total load.	Actual work done.	Speed of ropes in feet per minute.
Spur Gearing.							
1st....	1309	21·2	385·76	6·2	29·47	70·53	...
2nd...	989·54	27·73	217·49	6·02	22	78	...
3rd ...	250	24	87 62	4·3	33·2	66·8	...
4th ...	802·6	22·4	285·5	7·9	35·6	64·4	...
5th ...	1044·5	26·9	205·95	5·3	19·7	80·3	...
6th ...	840·55	30·6	201·45	7·3	24	76·0	...
7th ...	1008	21	263	5·5	26	74	...
8th ...	1150	22·88	209	7·9	18·17	81·83	...
9th ...	1145·1	33·3	300·27	8·7	26·2	73·8	...
10th ...	820·26	20	207·96	5·09	25·3	74·7	...
Giving an average of.....					25·964	74·036	...
Rope Driving.							
1st ...	1272	18·4	296	4·3	23·3	76·7	5,543
2nd ..	724·9	22·9	232·1	8·6	32	68	5,146
3rd ...	859	23	274·2	7·3	32·8	67·2	4,674
4th ...	1025	22·6	324·93	6·4	31·7	68·3	4,840
5th ...	978·25	21·4	283	6·2	28·9	71·1	5,306
6th ...	992·9	22·9	310·1	7·1	31·2	68·8	5,013
7th ...	393·5	18·5	126·8	5·9	32·3	67·7	...
8th ...	1579·52	19	389·4	4·7	24·6	75·4	5,183
Giving an average of					29·6	70·4	...
Belt Driving Engines.							Speed of belts in ft. per min.
1st ...	855·95	26·1	241·85	7·3	28·2	71·8	4,329
2nd...	969	20·8	262·3	7·5	27	73	4,158
Giving an average of.....					28·6	72·4	...
Direct Acting or Direct Coupled Engines.							
1st ...	503·85	30·7	99·1	7·4	19·67	80·33	...
2nd...	388·8	23·1	94·5 at 68 rvs.	6·4	28	72	...
Giving an average of.....					23·835	76·165	...

The conclusions to be drawn from the examples furnished, although not numerous and varied enough to pronounce a definite and accurate opinion upon, point to the fact that the engines would be found to be fairly efficient in themselves, but that the arrangement, construction, and the lubrication of the gearing is the principal defect. Two examples, No. 4 and No. 6, will prove this point. Example No. 6, engines were indicated without the gearing, the percentage of friction to the total load being 6 per cent., giving an efficiency for the engines of 94 per cent. of power to be transmitted through the crank shaft. Example No. 4, engines were indicated without the gearing, the percentage of friction to the total load being 10 3 per cent., giving an efficiency for the engines of 89·7 per cent.

The power in both cases is transmitted first by spur fly driving-wheel and pinion, afterwards rope driving is introduced; the friction of the gearing only in Example No. 6 being 18 per cent., the friction of the engines and gearing together being 24 per cent. of the total load. In Example No. 4 the friction of the gearing only was 25·3 per cent., the friction of the engines and gearing together being 35·6 per cent. of the total load.

By a reference to the summary it will be seen that the best results will be found in the gearing engine No. 8, but that No. 5 Example in the same class, and No. 1 in the direct-acting engines run it very closely.

The average percentages of the examples given show less actual work than I had expected to find, and I shall be pleased if any of the members will supply me accurate data or permission to indicate other examples for the purpose of revising this Paper and making it more complete. In conclusion I would say that the lessons to be learnt from carefully studying the examples are briefly as follows:—

That spur-gearing engines give the best result when not complicated with rope driving.

That rope-driving engines show the best results at high rope speeds, and that direct driving from the main drum is very desirable.

That belt-driving engines for developing large powers are only equal to the average rope-driving engine, with fewer advantages in other respects.

That the direct-acting type of engine is likely to be very efficient.

LEGAL INTELLIGENCE.

King, Brown, and Co. v. J. C. Gray.

The record has been closed in the Scotch Courts by Lord Kincairney in an action by Messrs. King, Brown, and Co. against James Cooke Gray, head master, Blairlodge School, Polmont Station, Stirlingshire, to recover £100 damages for alleged breach of contract.

The pursuers aver that in August last they entered into a contract with the defender for additions to the electric light installation at Blairlodge, but that on September 7th the defender refused to allow them to proceed with the contract, although a large amount of the work necessary for the carrying out of the contract had been put in hand.

The defender contends that no concluded agreement was ever come to, and that the letters founded on by the pursuers were merely instruments of negotiation.

The case was sent to the Procedure Roll.

National Electric Supply Company (Limited) v. Coward.

The National Electric Supply Company (Limited) have brought an action against a Mr. John Coward, innkeeper, of Friargate, Preston, to recover £14. 6s. 3d. for current for lighting purposes, and for rent of meter. The plaintiff's counsel said that the defendant had paid £4. 13s. 5d. into court as sufficient to satisfy the claim. Some time ago the defendant determined to have the electric light, and it was installed in June of last year. His first bill was sent in and he paid it, and subsequently he had two other bills. He then began to complain about the charges. He did not know what the defence was, but perhaps the defendant was going to try to impugn the meter. One had heard of the remark, "Lying like a gas meter," and it might be they would say, "Lying like an electric light meter." He should be able to satisfy the jury that the defendant's bill only came to the average according to the kind of light he used. A 16-c.p. light would cost ½d. per hour and a 32-c.p. would cost a third of 1d. It was absurd to pay £4 into court to satisfy the claim; people could not expect to have twice the light for the same money.

John Carr Rose, meter inspector for the Company, said the defendant's was an Aron meter. It was an approved instrument, which had obtained some prizes in national contests. It was an accurate meter. It was correct when it was put in, and he examined it from time to time to take the record. The bill was made out on his record. Ultimately, at the beginning of this year, it was taken out. It was working accurately on January 7th, and he took the record then. There had been no debit of the supply of light since January 7th. The bill of £14. 6s. 3d. included £12. 12s. 3d. for current, £1. 3s. 7d. additional up to January 7th, and the rest was for use of meter.

The meter was produced in court, the witness explaining the mechanism of it.

The defence was that there was a mistake between the parties as to the contract under which the light was put in. He had an understanding with the Company's representative that he was to have his light as cheap as the gas. The bills were satisfactory until the putting in of the meter.

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after which the bill jumped up to over £14. Then he began to grumble, and found that his friends were being charged much less sums, and in consequence one other innkeeper had his supply cut off. They changed his meter, and it registered more than before. Afterwards defendant's meter was disconnected, and after that the meter went on registering just as before. That being so, it was fair to assume that it had given a false record all along.

Witnesses were called in support of the defendant's case; but, after a lengthy hearing, the jury found for the plaintiff for £13. 6s. 9d.

CORRESPONDENCE.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If I take up my pen to comment upon the manifesto of Messrs. Erskine, Manville, Mavor, Raworth and Swinton, respecting the composition of the Council of the Institution of Electrical Engineers, it is not at all to formulate any reply to the indictment framed by these good men and true; I merely wish to complete their statement, which, it is well known, embodies partially sentiments that exist pretty widely in the Institution within the Council as well as without. In other words, there are members of the Council who, as individuals, recognise, perhaps even more clearly than do Messrs. Erskine, Manville, Mavor, Raworth and Swinton, the shortcomings which they have in part pointed out. As it is, in the natural course of things, my turn to retire from the Council in six weeks' time, I can speak the more impersonally. The object dear at heart to the memorialists can, therefore, in one instance, be readily attained without friction.

Let me first begin by classifying a little more definitely the membership of the Council. I take the official list, as the memorialists did; but, alas, we have just lost Mr. Graves! As the term electrical engineer has no legal or recognised definition, and as every gasfitter is nowadays an electrician, I avoid these indescriptive terms. In passing, I remark how strange it is that the memorialists are able to discover no fewer than ten professors who are neither "electricians" nor "electrical engineers." Perhaps Prof. Hughes never was an electrician, in spite of his well-known inventions. Perhaps Prof. Hopkinson never was an electrical engineer. But in that case—dreadful thought—who is? However, let that pass.

The Council, including past Presidents and Vice-Presidents, consists, indeed, of the following:—

Manufacturers and contractors	5
Telegraph, telephone, and cable men	13
Chemists	2
Engineers in consulting practice, not included in above	6
Baronets	1
Engineers to manufacturing firms	1
Government officials, not included in above	2
Teachers of electricity, not included in above	2
	32

or, omitting past Presidents and Vice-Presidents,

Manufacturers and contractors	2
Telegraph, telephone, and cable men	5
Chemists	0
Engineers in consulting practice, not included in above	5
Baronets	0
Engineers to manufacturing firms	1
Government officials, not included in above	2
Teachers of electricity, not included in the above	0
	15

Inspection of these figures at once shows on what head the Council is overweighted. But, then, the Institution must be forgiven for the circumstance that it originated as a body of telegraph engineers, and not as a body of manufacturers or contractors.

But really there is a grain of reason in the contention that there are in the Institution and on its Council gentlemen "only indirectly connected with practical engineering." Too often the phrase "practical engineer" is held to denote one who has served seven years of drudgery at the bench. Well, but that is precisely (my friends will pardon me for so personally using them as examples) what my friend John Perry, engineer and Professor, did; it is precisely what my friend William M. Mordey, engineer and inventor, did not do. It is within the bounds of possibility that there may be contractors and manufacturers who are even less directly connected with practical engineering.

It is a pity for the memorialists' case that they have so sadly understated the "professorial element" on the Council. Their delicately-concealed suggestion that if a man has at some time or other held a responsible post as a teacher that circumstance in some way disqualified him to take part in managing a "professional" body such as the Institution, reaches more widely than to the 10 "professors" (including Lord Kelvin) so denominated in the official list of the Council. To these ten should be added Prof. Sir Frederick Abel, Prof. John Hopkinson, Prof. (now General) Webber, and Prof. Crookes, not to add Mr. Mordey and Mr. Swinburne, both of whom have qualified themselves for the same courtesy title by systematic teaching. So the 10 should be written 16. It is evidently high time that the number of "professors" on the Council should be reduced. There is also an undue proportion of members of Council whose names begin with the letter C. Moreover, compared with the civil engineers there is a smaller proportion of "Sirs" on the Council. This is a sad oversight which might be commended to the notice of the P. M. G. (I do not mean the *Pall Mall Gazette*).

What seems to be the saddest fault of all is the complete absence from the Council of any person who, being neither an engineer in consulting practice, a teacher, a soldier, a sailor, an officer in the volunteers, a government official, a company director, a company promoter, a cable man, a telegraph operator, a chemist, an author, a peer, or a baronet, and never having been any one of these things, shall be therefore competent to represent "those actively engaged in constructive work." The omission is not, however, irremediable. Doubtless the Council, awakened at last to a sense of its shortcomings, will fill one of the shortly vacant places by the member entitled to such unique distinction—if he can be found.—Yours, &c.,

SILVANUS P. THOMPSON.

LECLANCHÉ BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your article in last week's issue upon "Improvements in the Leclanché Battery," and in which you specially refer to the new Leclanché-Barbier Patent Cylindrical Cells, which I am now introducing into this country, will you allow me to state in correction of the concluding paragraph of the article that Messrs. Leclanché and Co. have granted me the sole concession to sell in Great Britain and the Colonies their Patent Cylindrical Agglomerate Batteries of both the wet and dry patterns, any such rights previously held by others in this country having been lately terminated in my favour.—Yours, &c.,

R. AYLMER.

47, Victoria-street, London, S.W.

SUNSPOTS, MAGNETIC STORMS AND AURORA BOREALIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It occurred to me while reading Prof. Fitzgerald's letter, and your Editorial Note thereon, that the phenomenon aurora borealis, which, if I mistake not, is usually, if not invariably accompanied by a magnetic storm, may in reality be the attenuated tip or tips of the flame-like protuberances called the corona, or the projected electrified matter streaming past our planet, the actual "licking" probably taking place on a portion of the earth's surface on which the sun's light would prevent observation. If this were so, aurora borealis would be more generally observed near the northern or southern poles, as it is not because of the magnetic polarity of the earth, but simply because of the sun's position below the horizon.—Yours, &c.,

W. B. SAYERS.

Glenwood, Bearsden, N.B., Nov. 14, 1892.

Submarine Telegraphy in Japan.—It is reported that the Japanese Communications Department has decided upon the construction of a steamer for cable-laying purposes.

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THE CABLE SERVICE TO AUSTRALIA.

(From *The Times.*)

A difficulty has arisen between the Australasian Governments and the Government of India in regard to the transit rate to be levied by the latter upon Australasian cable messages passing over the Indian land line from Bombay to Madras. At first the rate charged was £9 9s. 6d. for 20 words, but it has been gradually reduced until it is now 4s. a word. In consideration of the great risk involved in the last reduction it was agreed that the Eastern Extension Telegraph Company should be guaranteed by the Australian colonies a revenue equal to that received in 1889, half the deficiency, if any, to be borne by the cable company. It was further agreed that South Australia should be guaranteed a revenue equal to 1889 on the transcontinental line. The result of the experimental trial for the first twelve months was a decrease in the receipts of the cable company of £55,040, and to South Australia on the transcontinental line of £10,415. The proportion of loss borne by the cable company was £27,520, and by the guaranteeing Colonies (who were also responsible to South Australia), as follows:—Victoria, £15,508; New South Wales, £15,397; South Australia, £4,357; Tasmania. £1,994; and Western Australia, £676. Since then New Zealand has accepted a share of the financial responsibility, but Queensland still holds aloof. Chiefly at the instance of New South Wales, the Australasian colonies have quite recently decided to raise the tariff by 9d. a word, making the through rate 4s. 9d. a word. The European nations who were concerned in the change raised no objection, but India has created an awkward difficulty, the removal of which was the object of a deputation which waited upon the Colonial Office on Tuesday. Until recently the transit rate of 75 centimes a word was charged for the transmission of messages between Bombay and Madras. The Indian Government last year reduced the transit rate to 35 centimes a word. The negotiations with the Australian colonies were at that time being conducted on the basis of a tariff of 5s. a word, but afterwards the cable company consented to try the experiment of a 4s. tariff. It was therefore submitted to the Earl of Kimberley and the Marquis of Ripon on Tuesday by the Agents-General for New South Wales, Victoria, Tasmania, South Australia, New Zealand, and by Sir John Pender, the Chairman of the Eastern Extension Company, who accompanied the deputation, that the imposition by the Colonies of an additional 9d. a word, in which the Indian Government had acquiesced, would not justify the latter in increasing the transit rate as against Australasian messages from 35 to 50 centimes a word. It was argued that the effect would be to place the Colonies at a decided disadvantage as compared with countries further east. The deputation contended that the additional 9d. would scarcely exercise any appreciable influence on the tariff, and would only temporarily retard its development. India had benefited by the reduced tariff of 4s. a word, which had increased the Australasian traffic by over 60 per cent., without involving India in any of the sacrifices borne by the Colonies and the Company. Lord Kimberley was urged to use his influence with the Government of India to secure the withdrawal of their proposal and avert the possible retirement of the Colonies from an arrangement which had proved so beneficial to commerce.

The SECRETARY of STATE for INDIA promised to bring the arguments of the deputation to the notice of the Government of India. He hoped he might be in a position to indicate their reply in time to enable the amended tariff to come into operation at the beginning of the new year.

The deputation thanked Lord Ripon, in whose office the interview was held, and Lord Kimberley, and withdrew.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

TENDERS INVITED.—The Local Authorities of Paisley invite tenders for the transfer of the powers conferred by the Paisley Electric Lighting Order, 1891. All particulars may be obtained of Mr. Bryson, 11, Bothwell-street, Glasgow; and tenders must be delivered to Messrs. Young and Martin, town clerks, Municipal-buildings, Paisley, by the 28th inst.

——— CLOSING OF CONTRACTS.—Readers are reminded that tenders for the supply of electric lighting plant for the City of York have to be in by the 21st inst.; for wiring the Town Hall, Hove, Sussex, this day (Friday), 18th inst.; and for the installation of wires, switches, &c., for the new Police Station at Blackpool, by the 28th inst.

TENDERS ACCEPTED.—The Burnley Corporation have accepted the following tenders for the supply and erection of electric lighting plant :—

Electric Construction Corporation (Limited)—dynamos, accumulators, and switchboards	£2,056
Callender's Bitumen, Telegraph, and Waterproof Company (Limited)—electric cables	4,537
Burnley Ironworks Company (Limited)—engines	1,600
Oldham Boiler Works Company—boilers	700
Messrs. E. Green and Son—economisers	228
Job Isles, Stanningley—cranes	195

BUSINESS FOR DISPOSAL.—Messrs. Wheatley Kirk, Price and Goulty have an old-established engineering business for sale at an exceptionally low price to an immediate purchaser.

APPOINTMENT.—Mr. W. A. Valentine has been appointed district manager of the New Telephone Company at Manchester, *vice* Mr. G. J. Someville, who comes to London to take charge of the metropolitan district.

BELL'S ASBESTOS COMPANY (LIMITED).—This firm have removed to their new premises and offices at Southwark Bridge House, Southwark-street.

IN RE VICTOR SILBERBERG.—Mr. T. W. Gilbert, the trustee under the bankruptcy of this debtor, announces the payment of a first and final dividend of 2s. 6½d. in the pound, payable on Thursday, the 17th inst., or on any subsequent Thursday, between 11 and 3. The estate realised £236. 10s. 2d., out of whic creditors will receive £114. 5s. 5d., the cost of realisation being £112. 4s. 10d.

PATENT EXPERTS.—A "patent expert to the British and Foreign Governments" writes to us from Chancery-lane and informs us that as many of the Council of the Institution of Electrical Engineers "testify to the value of patents" in so unsatisfactory a manner he has decided to raise his fees very considerably, and trusts that we will permit him to offer us a commission of 5 per cent. on any business resulting from our introductions, but he wishes it to be distinctly understood that he will never testify to any unsound affair, or in any way use such influence as he may have to get any patents, &c., taken up by any Government. In the course of his letter, which being marked "not for publication," we cannot give in full, he incidentally remarks that he can assure us that there are more quacks than Harness! He seems to be an authority on this subject. We do not know how to refuse the permission which he petitions.

THE E. P. S. STORAGE BATTERIES.—We have received a notification from the Electrical Power Storage Company (Limited) that a further order for their E. P. S. accumulators has been received from the London, Brighton, and South Coast Railway Company, who have decided upon lighting another seven trains on their system, making 30 trains in all. In addition the E. P. S. Company have received an intimation that a considerable extension of train lighting is likely to be adopted by the Brighton Company in the near future.

THE GUILDHALL LIGHTING.—This installation is now complete, and comprises the Guildhall Council Chamber, the Lobby, and the Corporation Library and Reading Room. In the main building 540 glow lamps are installed, nearly 400 of which are 16 c.p. The beautiful gas pendants, designed by Horace Jones, have been cleverly and tastefully adapted for the electric light, and when on a recent occasion the current was switched on, the effect was very pleasing to those present. The result of the installation is that the Hall is now brilliantly illuminated. At the Lord Mayor's banquet, last week, the Guildhall presented an appearance such as has never before been witnessed. On the occasion of the children's *fête*, which was of considerable magnitude, on the 11th, the electric light added considerably to the beauty of the scene. In the Council Chamber a large centre fitting is provided with 78 bulbs, 60 of 25 c.p., and 18 of 16 c.p., tastefully and systematically arranged. The two large standards, one on each side, are fitted with 13 16 c.p. lamps each, a nine-light fitting being provided for the reporters' gallery. The architectural beauties of the Chamber are well brought out, and an efficient light is provided for every corner of the large space. For the lobby four pendants are used, each with four 25 c.p. lamps. The whole of the pendants have been adapted from the previous gas fittings, and such other fittings as have been required have been supplied by the Electrical Accessories Company (Limited.) The whole of the work has been carried out to the entire satisfaction of Mr. W. H. Preece, and reflects credit upon the contractors, Messrs. Lund Brothers, of Oxford-street, W.

MESSRS. J. AND W. WEEMS.—This firm have just had delivered a casting of a cylinder, weighing 21 tons, which forms a section of a lead press weighing more than 60 tons when completed. This is the largest lead pipe press ever made by this firm, and is used for the enclosing of cable and all classes of electric wires into lead pipes.

RYLANDER AND RUDOLPHS FABRIKS-AKTIEBOLAGS.—We have received from this Swedish firm an illustrated price list of their battery elements, &c. Their speciality is carbon for all kinds of electrical work.

THE STANHOPE COMPANY.—This Company are issuing a pamphlet dealing with their water purifiers and softeners, containing details of the advantages claimed by the Company for their manufactures. At the end, a list is given of the principal users, which includes a number of electric light companies.

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MESSRS. CHRISTY BROS.—This firm have recently completed contracts for several mill-lighting installations, amongst which is a complete plant for 200 lights for Messrs. J. and H. Robinson, of Greenwich (with a number of hand lamps of a new and improved type), and extensions to the mills of Messrs. E. Marriage and Sons, Colchester, and Messrs. Lofthouse and Hammond, of Boroughbridge. Also a 400-light plant for Stockport, a 300-light plant at Maybole in Scotland, and a large combined arc and incandescent plant in a mill at Purfleet. They are busy with a "new application of electricity" in a large clothing factory near Bath in the shape of a large number of electric "geese and irons" for ironing garments.

BRADFORD GAS ENGINES.—Messrs. S. Clayton and Co. send us their illustrated price list of Bradford gas-engines, with a long list of users and testimonials therefrom.

COMPANY'S STATISTICS.—Messrs. Faithful Begg and Co., of Bartholomew House, E.C., have recently issued an interesting sheet giving some financial particulars relating to electric supply and manufacturing companies. The information given is limited to a few leading companies, and is similar to that to be found in "The Electrician" Blue Book.

ELECTRO-HARMONIC SOCIETY.—On Friday, the 25th inst., a "Ladies' Night" Concert will be given in the Banquet Room of the St. James's Hall Restaurant, Regent-street, W., at eight o'clock.

ARUNDEL CASTLE.—The contract for the electric lighting of Arundel Castle, the seat of the Duke of Norfolk, has been secured by the Brush Electrical Engineering Company. It comprises some 1,200 lamps of 16 c.p. for the Castle, together with lamps for the drive and the courtyard. The generating station will be about 500 yards from the Castle. The dynamos are specially wound for this purpose, and are over-compounded for a maximum loss of 13½ volts in the mains.

AYR.—The Town Council, notwithstanding that some time ago they obtained powers to introduce electric lighting into the town, have made little or no progress, to the disappointment of many intending consumers, and private firms are making a number of installations in the district.

BARNARD CASTLE.—On Thursday last the members of the Local Board had under consideration with a representative of the Brush Company the subject of the preparation of an estimate for lighting the town with electricity and the extension of the lighting to the North Eastern County School.

BELFAST.—The Gas Committee have postponed for a further week the appointment of a consulting electrical engineer.

BURNLEY.—At the last meeting of the Town Council it was argeed to adopt the recommendations of the Gas Committee for the placing of the tenders for electric lighting plant, &c., required for the Burnley lighting. These tenders are given in another column. Alderman Collinge said the Gas Committee were anxious that the tenders should be placed over. To save time they had already commenced the building of the electric lighting station and expected to have it finished next spring, and they hoped to supply the light by midsummer. About 200 tenders have been received and, notwithstanding their desire to place the order with one firm, they found that so much would be saved by breaking it up and accepting various tenders for the work, that they had decided upon that course. They had anticipated the cost would have been about £19,000 where the tenders came to £14,500. They had power to borrow £23,000 for the purpose. They gave the tender for the boilers to a Burnley Company as, although they were not the lowest, they were within a little of some of the best engineers in the country, and the Committee were desirous of keeping the work in the town. The area of supply would be about 2,000 yards. Everything was in duplicate, even the engines, so that any possible breakdown was provided against.

BURTON-ON-TRENT.—The Town Council have decided to apply for permission to borrow £80,000 for the purpose of electric lighting and sewerage.

COATBRIDGE.—In reference to a statement that no progress is being made with the Electric Lighting Company's works at Coatbridge, it is explained that certain statutory notices expire on the 28th inst., and that until their expiry nothing can be done. The plant manufacturing work is being actively proceeded with.

DUNDALK.—A special meeting of the Town Commissioners was held last week to consider the reply by the Board of Trade for their application of the renewal of the Electric Lighting License of 1885, which expires on July 1st next. The Board of Trade recommended an application for a Provisional Order, and this is supported by the solicitor of the Commissioners. It was decided to adjourn the consideration of the matter till April next.

HOWTH.—A meeting has been held of those interested to consider as to what steps should be taken to light some of the principal streets by public voluntary subscriptions. A scheme is to be drawn and submitted to a public meeting at a future date.

KINGSTON—The Electric Lighting Committee of the Town Council has been re-appointed, and Mr. Shoolbred's report has been received. At the last meeting a copy of this report was ordered to be furnished to each member of the Committee. The new county buildings are being lighted electrically, but complaint is made of the slow progress of the Corporation in dealing with the matter.

MORPETH.—The East Mills have been lighted electrically by Messrs. Wynne and Barnard, a D type dynamo being driven by the large water-wheel of the old mill.

NEWCASTLE.—At the re-opening of the Art Gallery at Newcastle on Friday last, the National Telephone Company supplied 40 telephones, by means of which music was supplied from Sheffield, Bradford, Liverpool, and Sunderland, to the enjoyment of the numerous visitors.

NEWPORT.—The Sub-Committee of the County Council reported the result of their visit to St. Pancras, and stated that Prof. Robinson had offered to furnish them with a report as to the best mode of setting about their local installation for the sum of £50. Ultimately the subject was adjourned till the next meeting.

PENARTH.—A meeting of the Local Board was held on Monday last to discuss the desirability of lighting the town with electricity. A plan was submitted showing the principal streets proposed to be lighted. The Company, which is being formed to undertake the supply, offer the Board to light the Municipal offices at the same price as gas. The Company also offers to light the principal thoroughfares at a price under £3 per lamp per annum. The proposal was favourably received, but it was decided to obtain information from other Local Authorities before proceeding in the matter.

REDRUTH.—Considerable activity is shown in this district with the electric light, several large blocks of business premises being lighted. Messrs. Tangye have recently placed a memorial stone on the house which was once occupied by W. Murdock, who first invented gas, and was a resident in the neighbourhood a hundred years ago.

SHOREDITCH.—Mr. E. Manville, of Messrs. Waller and Manville, has been appointed consulting engineer of St. Leonard's, Shoreditch, to advise a Parliamentary Committee on their proposed lighting undertaking. At the meeting of the Vestry last week it was decided to seek the advice of an expert as to whether the supply of electricity can be advantageously undertaken by the Vestry, at what cost, the best system to adopt, the best site to select, and the capital required. It was also decided that a committee visit some of the leading stations to compare results.

SIAM.—The affairs of the Siam Electric Light Company are to be satisfactorily settled, £20,000 having been advanced by the Siam Treasury, out of which the creditors are to be paid. The Brush Company, on receipt of the first instalment awarded by the recent court of arbitration, will send out a staff of men to put the machinery in order, after which the balance due to them will be paid. The concern will then either be put up to auction or taken over by the Government by private arrangement with the Company.

WESTON-SUPER-MARE.—The subject of electric lighting came on for discussion at the meeting of the Town Commissioners last week. The Inspection Committee recommended that the Board should be prepared to consider any proposition which may be made for the lighting of the town by electricity.

WINDERMERE.—The Local Board have appointed Messrs. Irving, Harrison, and Garnett, members, to report on the subject of the electric lighting of Windermere, and upon the opening of the streets for the laying of electric light mains.

WITHINGTON.—It has been decided by the Local Board to appoint a special committee to inquire into the subject of lighting the district by electricity, and to report thereon.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

October 19, 1892.

18,716. A. K. FOOTE and H. R. POTTER. Glasgow. Improvements in electric wire or cable conductors or conduits.

18,732. J. S. FAIRFAX. London. Improvements in the regulating devices of alternate current arc lamps. (Messrs. Schuckert and Co., Germany.)

18,739 G. F. SANDERS. London. Improvements in or relating to telescopic slides for electroliers, electric brackets, electric floor lights and the like.

18,763. A. A. MUGNIER. London. Improvements in and relating to electric apparatus for playing mechanical pianos, organs, and other keyed musical instruments.

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October 20, 1892.

18,789. P. H. Driver. London. An improved method of registering the value of an electrical current on one meter where the price per unit varies for different services.

18,807. E. Andreoli. London. Electrodes for secondary batteries.

18,817. J. A. McMullen. London. Improvements relating to galvanic batteries.

18,844. H. Koller. London. Improvements in dry cells or galvanic batteries.

October 21, 1892.

18,847. H. F. Joel. London. Improvements in alternating current motors.

18,866. A. Jamieson and C. R. G. Smythe. Glasgow. Improvements in, and connected with, the protection of electrical conductors and fittings.

18,863. E. Ballet. Manchester. Improvements in unions for electric chandeliers.

18,878. T. Taylor and W. Tunnicliffe. Birmingham. Improvements in the connections of the parts of earthenware articles employed in connection with electrical switches, cut-outs, ceiling roses and the like.

October 22, 1892.

18,926. F. P. Howard. London. Improvements in switch lampholders for electric lighting purposes.

18,966. Siemens Bros. and Co. (Limited). London. Process for the electrolytic decomposition of compounds of metals and sulphur. (Messrs. Siemens and Halske, Germany.)

18,982. E. P. Davis. London. Improvements in telephone apparatus.

18,994. J. A. Timmis. London. Improvements in electro-magnets.

19,019. F. Jukes and J. Charles. London. Improvements in arc lamps.

October 24, 1892.

19,025. A. Wright. Brighton. Electricity meters and improvements therein.

19,061. W. E. Irish. London. Electric railway systems.

19,062. S. A. Hunter. London. Improvements in means or apparatus for enabling electric current to be derived from an incandescent lamp-holder and conducted to a lamp or other electric apparatus at a distance therefrom.

19,076. G. S. Hooker. London. Improvements in or relating to microphone carbons.

19,077. J. Aird. London. Improvements in or connected with mains or conduits for electric cables.

October 25, 1892.

19,118. T. Doddrell. Buckinghamshire. An earth stocking for protecting telegraph and other poles.

19,127. G. J. Philpott. Brighton. Improvements in electric arc lamps.

19,146. H. H. Lake. London. Improvements in insulators for electrical and other purposes. (J. P. Company, United States.)

19,160. W. P. Thompson. Liverpool. Improvements in or connected with telephone receivers. (G. V. Benjamin, United States.)

19,170. H. Blackman. London. Improvements in the production of chlorine, soda, and other products by electrolysis and in apparatus employed therein.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

17,631. Elmore. Electrolytic manufacture of tubes, pans, &c.

18,451. Bennett. Telephonic switching apparatus.

18,976. Parker and Rees. Arc electric lamps.

19,020. Bennett. Telephonic switching apparatus.

19,626. Baker. Magnetic compasses.

19,630. Hardingham (Felten and Guilleaume). Electric cables.

19,775. Breuer. Electrolytic decomposing apparatus.

19,899. Weighill. Telephone closets.

20,144. Egger. Electrical and telephonic signals.

20,234. Mayer. Telephonic transmission.

20,279. Hardingham (Felten and Guilleaume). Electric cables.

20,545. Bennett and McLean. Telephonic exchange signalling.

20,595. Boardman. Arc lamps.

20,718. Pinckney. Electric boot and shoe grindery.

20,825. Edmunds and Preece. Electrical cables.

1892.

13,380. Bedwell. Telegraph cables.

14,089. Lesenberg and another. Galvanic batteries.

14,814. Usher. Storage batteries.

14,816. Usher. Electric battery plates.

15,167. Mills (Page and another). Electrically illuminated signs, &c.

15,173. Bailey and others. Arm rests for telephone operators.

15,225. Schroeder, C. A. J. H. and H. E. R. Electric lamps.

15,469. Heyl. Telephones.

15,477. Kreinsen. Melting metals, &c., by electricity.

15,690. Kochs, B. and A. Electric railways.

15,799. Nunan and Nelson. Galvanic batteries.

COMPANIES' MEETINGS & REPORTS.

West India and Panama Telegraph Company (Limited).

The 31st ordinary general meeting of the members of this Company, was held at Winchester House, Old Broad-street, E.C., on Tuesday last, Mr. C. W. Earle presiding.

The SECRETARY (Mr. R. T. Brown) read the notice convening the meeting, and the minutes of the previous meeting, the latter being approved and signed as correct.

The Directors' report and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen, although the report is one announcing a decrease of £3,493 in revenue, and an increase of £3,721 in expenditure, it is a somewhat better account on the whole than I anticipated. When we were discussing the effect of the reduction of the tariff, which we were impelled to make this time twelve months, if you had asked me whether we were going to pay even the insignificant dividend of 6d. a share on the present occasion, I should certainly have said that I thought not. When we came to our meeting in May last, and had to announce a decrease of £7,350 in our traffic receipts, I was still more confirmed in this unfavourable view of our position. However, from this report it will appear that this six months we have only had a decrease in our traffics of £3,762, which is much less than we expected to have. Now, in comparing the different periods with the view of ascertaining to what extent the diminished tariff that we made in June, 1891, has had on our receipts, there is always the uncertain factor of the ebb and flow of West Indian trade, and I think that the period which we are reporting on now was better in the matter of West Indian trade than the corresponding one of the previous year. I feel pretty confident myself that the reduction we made in the tariffs, amounting to 20 per cent. at most of the stations, has not produced a single extra message over our lines. That, I think, we were all prepared for, because we know very well that people are not in the habit of telegraphing for the fun of the thing. They only send messages which cost them several pounds when they have matters of importance to deal with. Whether a message costs £5 or £3 it has to be sent, and it is just as likely that we should have as many messages at the one tariff as at the other. Therefore, I do not think that the reduction we made in consequence of the competition brought against us would have any effect in the way of an increased volume of traffic. I think our competitors, who invaded our field in so unnecessary a way, must be rather sorry that they have spent their money in laying cables to the West Indies. Their report to last December—they issue a report only once a year—was a very unsatisfactory affair, and I suppose that next year it will be worse. Their line to the Brazils is broken down. It brought them very little traffic, and if they attempt to repair it there will be a great expense involved. At the present moment they have no ships in the West Indian station for repairing purposes, and I have not heard of their sending one out to mend that cable.

Looking to the expenditure side of the account, and to the details of the repairs to cables, which are summarised in abstract "C," I find that we have had 15 interruptions during the half-year that we now report upon, as against seven in the same period of the previous year; and that we used 190 knots of cable in effecting those repairs as against 44 in the corresponding period of 1891. Now that, of course, will explain to you the very large increase in the expenditure on cable repairs. Of these cables, the principal offender was the old one between Jamaica and Porto Rico, which failed in a very great depth of water, namely, 2,234 fathoms or 2½ miles. As it is an old cable, having been down 22 years, it was found not to have sufficient mechanical strength to enable the ship to lift it to the surface. It kept constantly breaking, and the consequence was that our ship had to travel along the cable until it came to ground where the soundings were more favourable for picking up, and the points at which they did get the cable necessitated the laying on of a piece measuring 85 knots in order to effect the repair. A similar case, only to a much less extent, occurred in the Grenada-Trinidad cable, but only 19 knots were expended in that instance. These repairs amount to renewals, and we have followed the practice that we have always followed on previous occasions with repairs of such magnitude, and have charged the cost of the cable to the reserve fund which was established for that very purpose.

The report announces that our steamship "Grappler" has been ordered home to London to be surveyed and fitted with a new boiler. This vessel has been actively in our service for 12 years, and after that time it is considered by prudent people, and it is in accordance with Lloyd's requirements, that the boiler must be renewed, which we intend to have done. The only other point that I have to remark upon is the vacancy that has been caused on this Board by the death of Mr. Ford, whose loss I still continue to feel very much. I should have been very glad indeed to have had Mr. Ford's advice and wise counsel to assist us in our management of this half-year. Seeing the great difficulty which there would be in replacing him, we have thought it advisable not to fill up the vacancy. This will be a small economy to the Company, and, on the whole, we think that is the proper course to pursue in our present circumstances. I shall now be very glad to answer any questions you wish to put to me, and in the meantime I beg to move—

"That the Directors' report and accounts to June 30, 1892, submitted to this meeting, be and the same are hereby received and adopted, and that, as recommended by the Board, dividends of 6s. per share on the First Preference shares, 6s. per share on the Second Preference shares, and 6d. per share on the ordinary shares, the last being free of income-tax, be and the same are hereby declared."

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Sir JAMES ANDERSON seconded the motion.

A SHAREHOLDER asked whether any comparative statement could be given as to the takings since the close of the accounts.

The CHAIRMAN : They show a slight improvement. I think, as nearly as possible, it would be £1,700 more than we had up to the present time last year. At the same time I may say, as a source of further comfort, that our repairs are very much less this half-year.

Mr. CHAMBERLAIN wished to point out that, whereas the repairs to cables amounted to something like £11,000 extra, three-fourths of the amount was charged to the reserve fund and only one-fourth, in round numbers, to current expenditure. With regard to the "Grappler," had the Board considered the advisability of fitting her with triple-expansion engines? Her coal bill must be a very serious item. In the revenue account one of the items was the cost of issuing debentures and obtaining a Stock Exchange quotation, £573. These, he presumed, were the £80,000 Debentures bearing 5 per cent. Would the Chairman kindly tell them whether these were redeemable after a term of years?

The CHAIRMAN : They are issued for 25 years. The cost of issue is an exceptional item. It might have been spread over the 25 years, but we thought it was hardly worth while to do so. We thought it better to get rid of it at once. The principal part of the expenditure was £400 in stamps, printing £50, and the Stock Exchange quotation. With regard to Mr. Chamberlain's other inquiries, as to charging the renewal of our cable to the reserve fund, the latter is based upon a calculation that we make of how long a cable has got to last, and at what rate we should renew it, and also what rate of interest we receive for our reserves ; and our reserve fund stands up to the level it ought to be at in the twenty-third year of our cable's existence, therefore it is a perfectly fair charge. Remember, we laid nearly £7,000 worth of new cable, and charged it to revenue, and the system is bettered to that amount. The question of triple-expansion engines was fully discussed, and the matter reported upon by our surveyor, who decided not to recommend these engines.

In further reply to a SHAREHOLDER,

The CHAIRMAN added that their cables were all duplicated except the Colon one.

The resolution was then agreed to *nem. con.* ; and a vote of thanks having been passed to the Chairman and Directors, the proceedings terminated.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322, *&c., &c.*]

BURGLAR AND FIRE ALARM COMPANY (LIMITED).—This Company has been registered with a capital of £20,000, in 18,000 ordinary and 2,000 Ten per Cent Preference Shares of £1 each, to acquire, develop, and turn to account patents and inventions, particulars of which are not given, and to construct, originate, create, participate in, contract for, develop, administer, control, and manage electric, telegraphic, telephonic, tramway, railway, &c., undertakings and works.

ELECTRICAL WONDER COMPANY (LIMITED).—This Company was registered on November 12th, with a capital of £10,000, in 9,900 ordinary and 100 founders' shares of £1. The founders' shares will receive one-half the net profits remaining after the payment of a dividend of 10 per cent. per annum on the ordinary. The objects are :—To adopt and carry into effect an agreement dated November 4th, 1892, between Edgar Cohen and Howard Felgate (as trustee for, and on behalf of, the Company), for the acquisition of all the rights of the said Edgar Cohen in respect of the Electric Schnelsehed Automatic Apparatus, and to carry on the business of proprietors of automatic and other machines and apparatus, licensees, and exhibitors, caterers for public amusement, by the exhibition of any scientific, photographic, or other apparatus. The signatories are :—

	Shares.
Edwin Howell, Swiss Villas, Hall-road, Peckham Rye, London, E.C.	1
Edgar J. Cohen, 37, Bedford-square, London, W.C.	500
Henry Haufmann, Dashwood House, 9, New Broad-street, London, E.C.	10
Oscar Schölzig, Dashwood House, 9, New Broad-street, London, E.C.	250
Otto Schölzig, 31, Binfield-road, Clapham-road, London, S.W.	250
Percy James, 35, Benyon-road, Southgate-road, London, N...	1
Thomas E. Polden, 2, Amen-corner, London, E.C.	500

The first Directors are Arthur Schwarz, of Dashwood House, New Broad-street, E.C. ; T. E. Polden ; Count Max Hollender, of 135, Sutherland-avenue, London ; and Edgar Cohen.

METAL REDUCTION COMPANY (LIMITED).—This Company has been registered with a capital of £100,000, in £1 shares, to enter into an agreement with the Metal Reduction Syndicate (Limited) for the acquisition of its business ; to carry on the business of manufacturing, smelting, refining, selling, dealing in, and making merchantable metals of every description, and to carry on the business of electrical and mechanical engineers, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, and manufacturers of, and dealers in, all apparatus and things required for or capable of being used in connection with the generation, distribution, accumulation, supply, and employment of electricity.

BARRY AND CARDIFF ELECTRIC LIGHT AND POWER SUPPLY (LIMITED).—KIDDERMINSTER ELECTRIC LIGHT AND POWER SUPPLY (LIMITED).—With reference to these companies, in answer to inquiries from the Registrar of Joint Stock Companies, Robert McA. Inglis, the secretary, notifies that the companies are not carrying on any business, that it is not the intention of the promoters to proceed further with them, and that they can be dissolved.

ELECTRICAL COAL-CUTTING CONTRACT CORPORATION (LIMITED).—The statutory return of this Company made up to Sept. 28, 1892, has been filed. The Company was registered on June 18, 1892, with a capital of £402,000, divided into 60,000 ordinary shares of £5 each, 20,000 deferred shares of £5 each, and 2,000 founders' shares of £1 each. At the time of making up, 8,082 ordinary, 20,000 deferred, and 2,000 founders' shares were taken up, of which 4,000 ordinary and 20,000 deferred shares were issued as fully paid. Upon the remaining 4,082 ordinary shares £3. 10s. per share has been called, and upon the 2,000 founders' shares the full amount per share has been called, resulting in the payment of £15,237, leaving £1,050 as yet unpaid.

"ENERGY" GAS ELECTRIC LIGHTING AND POWER COMPANY (LTD.).—An agreement dated August 29, 1892, between the above-named Company and the Clamond Incandescent Gas Light Company (Limited) (in liquidation) and Ernest H. Hindley and Edward T. Read, the liquidators of the said Company, states that the Energy Company has recently agreed to purchase certain patents belonging to the Clamond Company from Charles Clamond and Louis Denayrouze in consideration of the allotment of 16,000 fully paid £1 shares, of which 5,734 were to be allotted to the Clamond Company, and it is agreed that the Energy Company shall allot the said 5,734 shares (numbered 8 to 5,741 inclusive) to the Clamond Company in full satisfaction of all their claims on the said patents. The Energy Company was registered on August 1, 1891, with a capital of £20,000, in £1 shares, to make gas light cheaper, give it the appearance of electric light, and generally to create by all practical means a lighting industry having the qualities of electricity and of gas without the disadvantages of either.

HOME TELEPHONE COMPANY (LIMITED).—The first annual return of this Company, made up to March 28, 1892, has been filed. The statutory return, made up to December 31, 1891, was filed on July 20th following. The Company was registered in July, 1891, with a capital of £500, in £5 shares. At the time of making up all the shares had been taken up, £1 per share called, and all calls (£100) paid.

ROPER'S ELECTRICAL ENGINEERING COMPANY (LIMITED).—At extraordinary general meetings of this Company, held at Bradford on Oct. 19th and Nov. 4th, the following resolution was passed and confirmed :—"That the Company be wound up voluntarily under the provisions of the Company's Acts, 1862, and subsequent Acts, and that William Martello Gray, of Bradford, in the county of York, chartered accountant, be and he is hereby appointed liquidator for the purposes of such winding up."

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended November 13 were £945, as against £819 for the corresponding period of last year, being an increase of £126. The total receipts for half-year amount to £16,108, against £14,575 in the corresponding period of 1891, being an increase of £1,533.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—Our advertisement columns contain a list of the numbers of 328 Five per Cent. Mortgage Debentures which were drawn on the 14th inst. for payment at par on January 2nd next.

THE ELMORE COMPANIES.—A Mr. T. Satchwell, writing to the financial journals, declares his intention (after the decision in the case of "Russell *v.* Mockford") to take action against the Directors of two of the Elmore Companies,. In reference to this matter, Mr. J. Shurmer, the Secretary of the Companies, writes that Mr. Satchwell has no interest in the companies, and that shareholders can obtain all particulars of the improved prospects of the Company at the Companies' offices in Cannon-street.

HOVE ELECTRIC LIGHTING COMPANY (LIMITED).—Notice is given that the statutory meeting of the shareholders of this Company will be held at the registered offices, Mansion House Buildings, E.C., on the 21st inst , at three o'clock. Messrs. Crompton and Co. have carried out the first portion of their contract with this Company, and the temporary station is practically complete. Two miles of mains have been laid, and everything done to the satisfaction of the Hove Commissioners. The actual supply of current will commence during the present week. Meanwhile, from the applications received for the light the Directors feel that the future success of the Company is assured.

MESSRS. DORMAN, LONG, AND CO.—The gross profit for the year ending September 30th was £53,853, making, with balance from last year, an available sum of £55,688. A dividend of 4s. per share is proposed, after paying off debenture interest and writing off for depreciation £15,658, carrying forward £3,439.

SOCIETE ANONYME D'ECLAIRAGE ELECTRIQUE DU SECTEUR DE LA PLACE CLICHY.—At the general meeting held recently in Paris it was stated that the demand for the electric light was increasing very satisfactorily. The working for the nine months ended June 30, 1891, had shown 9,517 lamps in operation, there being a loss for that period of 20,647fr. ; but at June 30th this year 29,522 lamps had been installed, and the balance of receipts over expenditure for the year 1891-92 had not only wiped out this adverse item, but had left 178,636fr. to the good. Out of this sum a dividend of 4 per cent. was declared. At a subsequent

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extraordinary general meeting it was decided to increase the capital of the Société by 1,000,000fr.

SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—Subject to audit, the Directors have resolved to recommened the shareholders to declare a dividend as follows for the year ended September 30, 1892:—4s. 2⅔d. per share on the ordinary shares of the Company (£3. 10s. paid) and 4s. 11⅔d. per share on the £5 fully-paid shares, free of income-tax. This, together with the interim dividend paid on May 31st last, will make a total distribution of 10 per cent. for the year on the ordinary (£3. 10s. paid) shares of the Company. The dividend will be paid upon the register as it stood on Wednesday, and the warrants will be issued on December 13th.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Nov. 11, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,816.

WESTERN UNION TELEGRAPH COMPANY.—This Company has now declared an extra dividend of 10 per cent. in stock, payable on December 3rd. The Company's books close to-morrow (the 19th inst.).

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 9.	Price Wednesday, Nov. 16.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 16	
						£ s. d.		Highest.	Lowest.
			TELEGRAPHS						
£1,247,720	Stock	12/6	Anglo-American	50½ 51½	50⅝ 51⅛	4 17 1	Jan., Apr., July, Oct.	50¾	..
£2,876,140	Stock	25/0	Do. Preferred	91 92	91 92	5 15 5	" "	92	91
£2,876,140	Stock	5/0	Do. Deferred	11¼ 12	11½ 12	..	" "	11⅞	11½
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July	..	..
130,000	£10	4/0	Brazilian Submarine xd and bonus	10¾ 11¼	10¾ 11¼	5 15 7	Mar., June, Oct., Dec.	11⅛	10 15/16
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	101 104	4 16 2	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	103 107	104 108	4 12 7	June and December	106	..
$7,716,000	$100	$1½	Commercial Cable Capital Stock	174 176	181 183	3 16 6	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11¼ 12½	11½ 12½	6 19 2	February and August	..	..
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	" "	..	..
12,931	5	1/7 1/5	Direct Spanish (£4 paid)	3 3½	3 3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	9	..
60,710	20	3/6	Direct United States	11¼ 11⅝	11½ 11¾	5 19 2	Jan., Apr., July, Oct.	11 1/16	11⅛
400,000	10	2/6	Eastern	14⅞ 15⅛	14¾ 15	4 6 8	" "	15 1/16	14⅝
70,000	10	6%	Do. 6 per Cent. Preference	15¾ 16¼	15¾ 16½	3 13 10	" "	16⅛	16
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109 112	109 112	3 11 5	May and November	111	110
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	14⅞ 15⅛	14¾ 15	4 13 4	Jan., Apr., July, Oct.	15⅛	14¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	111¼	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104 107	104 107	4 13 6	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103 106	103 106	4 14 4	" "	105⅝	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	103 106	3 15 6	February & August	104	..
180,227	10	1/0	Globe Telegraph and Trust	10 10⅛	9⅞ 10⅛	4 13 10	Jan., Apr., July, Oct.	10 3/16	9⅞
180,042	10	6%	Do. 6 per Cent. Preference	15⅛ 15⅜	15 15½	3 18 8	" "	15½	15
150,000	10	5/0	Great Northern	18¾ 19¼	18¾ 19⅛	4 8 4	Jan., April, and July	19⅛	18⅞
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	105 108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	43 45	43 45	5 11 1	May and November	44¼	..
38,348	10	4/0	London Platino-Brazilian	6 7	6 7	5 14 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	107 110	107 110	5 9 1	March & September	..	..
10,802	8	4/0	Reuter's	7 8	7½ 8½	4 14 1	April and October	7 1/16	7¾
3,381	£100 Cert.	30/0	Submarine Cables Trust 6%	117 121	117 121	4 19 2	" "	117½	..
15,609	10	5/0	West African Telegraph	6½ 7⅛	6½ 7⅛	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	100½	..
30,000	10	2/0	West Coast of America	3 4	2½ 3½	..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	103 107	103 107	7 9 7	June and December	..	..
88,321	10	6d.	West India and Panama xd	1¼ 1½	1¼ 1½	..	" "	1⅜	..
34,563	10	6%	Do. 6 per Cent. 1st Preference xd	10¼ 10⅜	10 10¼	5 14 3	May and November	10⅜	10½
4,669	10	6%	Do. 6 per Cent. 2nd Pref. xd	9 10	8½ 9½	6 6 4	" "	..	..
64,242	15	6/0	Western and Brazilian xd	8¼ 8⅜	8 8⅛	5 5 9	" "	..	..
33,129	7½	1/8	Do 5 per Cent. Cumulative Preferred xd	6 6⅛	6 6⅛	5 15 3	" "	6 7/16	6⅛
33,129	7½	4/6	Do. 5 per Cent. Deferred	2¼ 2⅜	2¼ 2⅜	..	" "	2⅜	2¼
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	105 108	5 11 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	105 108	5 11 1	" "	..	..
$1.336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	3 4 0	..	3 1/16	..
22,800	14/0	1½d.	Consolidated Telephone Const. & Maintenance	½ ⅝	¼ ⅝	6 10 10	May and November	..	..
220,000	£1	4½d.	Oriental (11s. paid)	13/16 15/16	13/16 15/16	7 18 2	Yearly	..	..
438,984	5	3/6	National	4⅜ 5	4½ 5	6 0 0	June and December	4 1/16	4⅜
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 14½	14 14½	4 2 9	" "	14½	14 5/16
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13½ 14	13½ 14	4 5 9	" "	..	..
420,000	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	111 113	111 113	3 19 8	January and July	113	111½
43,000	£10	..	New Telephone, Limited (£2 paid)	3⅝ 3⅞	3⅞ 4⅛	..	..	4 1/16	3 15/16
58,000	5	1/0	United River Plate	2¼ 2⅜	2⅜ 3	..	January and July	2½	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	—	..	—
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	—	City of London Electric Lighting (fully paid)	10½ 11½	10½ 11	..	—	11	10¾
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	..	2¼ 3⅛	..	—	—	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	..	5 5¼	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..	5¼ 5⅜	..	January and July	..	..
30,000	£5	4½% '91	Liverpool Electric Supply (£3 10s. paid)	3 7/16 3 9/16	3 7/16 3 9/16	3 15 9	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 1/16 5 1/16	5 1/16 5 1/16	4 6 9	March	..	..
111,000	5	..	London Electric Supply	5/8 3/4	5/8 3/4	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	..	6 1/16	6⅞
£50,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	104 107	103 105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	—	—	..	..
18,680	£5	2/6	St. James' and Pall Mall	8 8⅛	8 8⅛	—	—	8⅜	..
7,900	£5	7%	Do. 7% Preference	8 8¼	8 8¼	—	—	8¼	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 10 0	—	5⅝	5 1/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1 9/32	Brush Electrical Engineering	3⅛ 3⅜	3 3¼	..	—	3¼	3
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2¼ 2⅜	4 16 0	—	2⅜	2⅛
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼ 5¾	5¼ 5¾	6 7 3	January and July	5⅝	5 9/16
12,139	5	17%	Edison and Swan United	.. ..	.. ..	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..	2¾ 3¼	..	—	..	3⅝
45,000	10	12/0	Electric Construction	3½ 4	3⅜ 4⅛	..	—	4	3⅝
70,000	2	10/0	Elmore's Patent Copper Depositing	1⅜ 1⅝	1¼ 1½	—	—	1 7/16	..
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2¼ 3¼	..	—	3 1/16	2⅝
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½ 22½	21½ 22¼	5 11 1	February & August	21¾	21⅜
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/16 1/8	3/16 1/8	..	..	..	..
78,949	5	2/9⅜	Swan United (£3. 10s. paid)	3¼ 3⅜	3¼ 3⅜	10 4 10	May and November	3 11/16	3½
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July	46½	45⅝
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103 106	103 106	4 14 4	January and July	..	..
—	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..	⅜ ⅝	..	—	—	—
—	£5	8%	Do. Preference (fully paid)	..	2½ 3	..	—	—	—
			RAILWAYS AND TRAMWAYS.						
50,000	£10	½%	City and South London Railway	2½ 3½	3 4	1 5 0	—	3⅜	—

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TELEGRAMS: "INDICES," LONDON.

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WHEATLEY KIRK, PRICE AND GOULTY are instructed by the Trustee, Arthur Clarke, Esq., TO SELL BY PUBLIC AUCTION, on TUESDAY, the 13th December, 1892, commencing at 10 for 11 o'Clock prompt, the ENTIRE CONTENTS of the EAST DOWN ELECTRICAL WORKS, Dermondy-road, East Down Park, Lewisham, S.E.

Comprising:—8-H.P. Vertical Engine and Boiler, by Davey Paxman and Co.; 6 and 14-H.P. Otto, 2-H.P. Stockport, and 2-H.P. Clark's Gas Engines; Six ¾-H.P. Electrical Motors, Brush, Victoria, Elwell-Parker, E.P.S., Siemens, Gramme, Gills, and Plating Dynamos; 4½in. Stroke Shaping, Horizontal Milling, Planing, Drilling, and other Machines; Fly Presses, Shafting; Six Hand Lathes, 4, 5, and 6in. Centres; 6½in. and 8½in. Slide Surfacing and Screw-cutting Lathes; 46 E.P.S. 23L Accumulator Cells in glass boxes; Switches, ½-H.P. Motors, Valuable Marble Standards, Electroliers, Brackets in brass and hammered-iron Canvas Belting, Loose Tools, Utensils, and other effects.

May be viewed on Monday, December 12th, 1892, and Morning of Sale.

For descriptive Catalogues and any further particulars apply to ARTHUR CLARKE, Esq., Trustee, 6, Lombard-court, E.C., or to WHEATLEY KIRK, PRICE and GOULTY, Electrical and Mechanical Auctioneers, 49, Queen Victoria-street, London, E.C.; And Albert-square, Manchester.

Telegrams: "INDICES," London.

THE METROPOLITAN ELECTRIC SUPPLY COMPANY (LIMITED).

NOTICE is Hereby Given that the coupons due December 1, 1892, on the above-named Company's issue of £50,000 Five per Cent. Registered Debentures WILL BE PAID on and after that date at Messrs. Prescott, Dimsdale, Cave, Tugwell and Co. (Limited), 50, Cornhill, London, E.C., or at the Royal Bank of Scotland, 123, Bishopsgate Within, London, E.C.

Coupons must be left at the Bankers' three clear days for examination.

The REGISTERS of DEBENTURE-HOLDERS WILL BE CLOSED from the 24th to the 30th inst., both days inclusive.

By order, E. CUNLIFFE-OWEN, Secretary.

November 21, 1892.

NOTICE is Hereby Given that the TRANSFER BOOKS and REGISTER of MEMBERS of the ELECTRIC AND GENERAL INVESTMENT COMPANY (Limited) will be CLOSED from the 1st to the 15th day of DECEMBER, 1892, both days inclusive, for the purpose of preparing the warrants for the interim dividend declared on the Ordinary Shares.

By order of the Board, J. CECIL BULL, Secretary.

Offices of the Company: Nos. 1 and 2, Great Winchester-street, London, E.C.

November 22nd, 1892.

SITUATIONS VACANT AND WANTED, &c.

ASSISTANT ELECTRICAL ENGINEER WANTED. Write in first instance, stating experience and salary expected. IMPROVER WANTED. Also VACANCY for a PUPIL.—GILBERT & Co., 35, High-street, Kensington.

MAN WANTED to drive steam-engine and take charge of electric light installation at a private country house, near London: a married man with not more than 2 children preferred; cottage provided, and milk and vegetables found.—Apply by letter, stating experience and wages required, to "W. B.," 179, Piccadilly, W.

ELECTRICIAN (21), 5 years' theoretical and practical experience, Draughtsman, used to test-room work, seeks RE-ENGAGEMENT. Highest referenees. Small salary.—"A. J.," 26, Gower-street, W.C.

YOUNG ELECTRICAL ENGINEER desires APPOINTMENT, home or abroad. Good theoretical training; thorough practical experience in wiring and central station work (high tension); last in experimental department of well-known manufacturing electrical engineers. Could introduce capital. Knowledge of French.—Address, "A. X.," Beal and Son, East-street, Brighton.

PARTNER WANTED by an old-established firm of Merchants, who, having made advantageous arrangements with large Continental Works, are about to add an electric light, &c., department to their business.—Address, "N. T.," care Davies and Co., Advertising Agents, Finch-lane, Cornhill.

WORKING PARTNER WANTED in an old-established, though not extensive electrical engineering business, with £300 to £400 at disposal, to buy out two others (sleeping), and assist advertiser in extending business. Works and offices well fitted, and very conveniently situated; good regular trade.—"X. Y.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

OLD SWAN LAMPS.—WANTED, one of the Old Swan Lamps, with a long neck and cardboard sheath, in good condition.—Apply, stating price, to "S. O. L.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

WANTED, SHUNT WOUND DYNAMO, 120—160 volts, 40—60 amperes. Must be cheap.—T. MARCHANT, 60, Verney-road, S.E.

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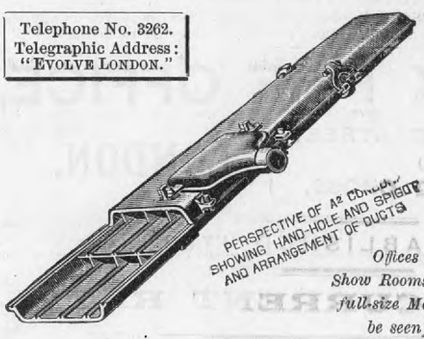

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M. R. MARGESSON, Managing Director.

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The following Statement shows the Financial position of the Company on the **31st DECEMBER, 1891,** *including the business taken over from the Queen Insurance Company for the second half of the year only:—*

Capital Paid up	£366,702	0	0
Fire and other Reserve Funds, including Balance of Profit and Loss	2,981,078	0	0
Life and Annuity Funds	4,546,577	0	0
Total Invested Funds, 31st December, 1891	£7,894,357	0	0

INCOME FOR THE YEAR. . . . £2,230,635

The following Comparative Statement shows the progress of the Company:—

1881	... Life Funds	£2,737,858	... Total Funds		£4,673,299
1886	... „	3,257,609	... „		5,672,041
1891	... „	4,546,577	... „		7,894,357

INCREASE OF FUNDS IN TEN YEARS, £3,221,058.

IMPORTANT REDUCTIONS IN LIFE RATES—see new Prospectus.

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"We have examined all the Securities held here, and have found them correct and in order, and we further certify that the present aggregate Market Value thereof is in excess of the amounts in the said Balance Sheets."

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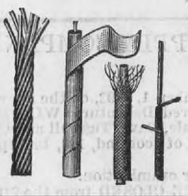

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LIMITED.

ELECTRICAL ENGINEERS,

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INDIA RUBBER AND GUTTA PERCHA MANUFACTURERS.

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GLASGOW .....8, Buchanan Street.	DUBLIN.....15, St. Andrew Street.	
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Only the highest class of labour and Best Materials.

Crompton & Co., Ltd. — *See Important Announcement on page xxvi.*

DAVEY, PAXMAN & CO.,

ENGINEERS, COLCHESTER.

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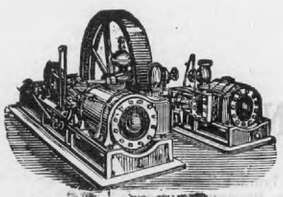
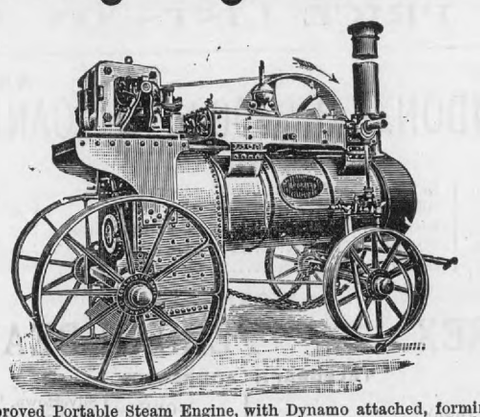


Coupled Horizontal Engine, to 200 H.P. nom.



Improved Portable Steam Engine, with Dynamo attached, forming a portable electric light plant. Single cylinder, 4 to 12 h.-p.; double cylinder, 8 to 25 h.-p.; compound, 8 to 30 h.-p. nominal.

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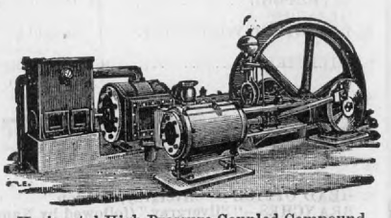

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 758.—Vol. XXX. FRIDAY, NOVEMBER 25, 1892. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

We hear that the action which has been brought against Mr. Graff Baker by the National Telephone Company and arising out of the telephonic disturbances, which the working of the Leeds electric cars is alleged to have caused, will shortly come before the Courts. We trust that electric traction engineers in this country will realise the supreme importance to the future of their industry of a right decision in this action, and that they will not stint their active assistance in aid of the common cause. It was, of course, the bounden duty of the Directors of the National Telephone Company to put this question of "earth" to the test of the law. But sympathy with the victims of the single-wire system does not preclude a desire to see the system itself ended. To string delicate instruments like telephones along "earthed" circuits in a modern city, and then to complain of their being disturbed, seems to us as unreasonable as it would be for an individual with *fin de siècle* nerves to whine about the noise of a busy city into which he had voluntarily thrust himself. We sincerely hope that law and equity will go hand in hand in England as in America.

When we heard in the morning train on Tuesday last that there was nearly a column and a-half in *The Times* on "Wire-to-Wire Electric Lighting," we thought the long-expected revolution had come at last. A Ewing-Parsons generator, a Tesla lamp, and a lampholder so contrived as to raise the frequency to a little more than the cube, and the problem would be solved. Will Mr. Verity or Mr. Binswanger be the first with this lampholder? But in a hasty glance at a poster our fellow-passenger was mistaken, and the discovery proved to be that of "Wire-to-Wire Electric Communication." So much of the information must have been derived from Mr. Preece or from his assistants that it is a pity that the whole of the communication was not written by someone better acquainted with electrical science. Wire-to-wire electric communication means telegraphing without wires. Any electrician can give examples of previous experiments, such as those of the late Mr. Willoughby Smith, which gave rise to some correspondence in our twenty-first volume. Communication has been effected across the Solent, and across rivers in India, while Mr. Preece has made experiments across the Mersey and the Severn, and at several places mentioned in his British Association Paper of 1887, and in yesterday's *Times* Mr. Willoughby S. Smith writes describing a remarkably simple method which has been successfully tried by him off the Needles for the information of the Royal Commission on lighthouse communications.

The problem on which, according to *The Times*, Mr. Preece has been engaged, is electrical communication between the shore and lightships. The three methods which have been proposed are, first, "by running a wire along the shore on light poles for a distance of about a mile, and a second wire from stem to stern of the ship, the two acting upon each other inductively through the intervening space." Why light poles should be used is not evident. We should have thought that along a sea-shore unusually stout poles would have been used, especially as they may be wanted most during a storm. We suppose that ordinary alternating electric currents were used; if so, these wires would probably be earthed at each end, and such effect as was produced might safely be attributed to earth currents.

The second method is "by suspending a short line over the side of the ship, so that it may dip into the sea, in the direction of the end of the shore line, to work by conduction through the sea." We are not told where the other end of this wire goes; perhaps it is screwed firmly into an accumulator in which electric fluid is compressed, and which oozes out at the end. It is thoughtful of Mr. Preece to suggest the proper direction by pointing the free end towards the land line; they do not always take this trouble in liberating carrier pigeons. "And, thirdly, by running out a light cable from the shore to the ship, terminating in a coil at the bottom of the sea, near the ship, but not attached to it, while another coil is placed on board. These two coils are expected to act inductively, and to give ample sound on telephones by means of rapid alternations." This method, we believe, is patented, and very encouraging results on a small scale have been obtained, from which the practical working may be predicted by calculation.

Near Cardiff a shore wire was erected and the lightship was "represented for the occasion by the island of Flat Holme." The line was half a mile long (what a pity the "Great Eastern" is broken up), and was three miles distant. "A powerful generator" was used, and messages were easily sent. "The principle underlying this method is," says *The Times*, "precisely analogous to that which governs the transmission of light itself." And then follows a long account of ether waves, Tesla's experiments, and Prof. Crookes's recent article in the *Fortnightly Review*.

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The latter part of *The Times' communiqué* refers to receivers accurately timed to respond to vibrations of a definite period, but the statement that the connection is made "only by the ether which occupies interstellar space" does not explain whether Hertzian oscillations or ordinary electric currents are used. In the early part of the article alternating currents are mentioned, and the effect, it is said, appears to depend principally upon the distance which separates the two wires. It would have added a scientific flavour if "the square of the distance" could have been brought in without materially interfering with the accuracy of the statement. When the time comes for Mr. Preece to describe his experiments with his usual lucidity, the confusion and ambiguity of this preliminary bit of newspaper science will matter little.

In our Note on the Regent-street fire last week we remarked that our inquiries on the spot had failed to elicit anything in support of the suggestion that the fire was due to electrical causes, but we did not go so far as to state, as Mr. Human suggests in his letter (which will be found in our Correspondence Columns), that the "fire was in nowise connected with the electric installation." We thought it worth while to remark that no evidence had been elicited, since it is to be presumed that Capt. Simmonds had some good grounds for distinctly attributing the fire to electrical causes. If it is the intention of this officer to report that fires are due to "overheat of electric wires" instead of "cause of fire unknown, but premises were fitted with electric light," the sooner the value of these reports is known the better. The utility of such reports would seem to be in proportion to the trouble involved in their preparation. As it is, one large firm of contractors, who are in no way connected with this case, have informed us that this unusual accident, or rather this very unusual report, has distinctly injured their business.

Mr. Human's hypotheses, on the other hand, are worthy of very careful consideration. He puts his arguments very clearly, and his assumptions require, as he says, no great stretch of imagination. We are quite disposed to agree with him that it is time to reconsider the position. We have hitherto refrained from advocating the earthing of the middle wire, because several leading engineers have thought that the time had not yet come for fighting for it. We suppose there will be a fight. It has begun in New York. The Edison Company have earthed their "middle" in a most determined manner, but they have only the insurance offices and a political hybrid, called the Board of Electric Control, against them, and know not what it is to have a Board of Trade. If we understand the present opinion of the Board of Trade, it is this: Take plenty of insulation. Insulation is good, more insulation is better, and so of course the most insulation is the best. This contention, backed by a committee whose constitution may be called an exaggeration of that of the Council recently under discussion, produced the overhead wire rules, and by the same contention the middle wire is, of course, to be insulated. When at last an accident occurs—and we do not admit that this has yet arrived—it will of course be easy to say, "You had not enough insulation. Take plenty of insulation."

While allowing this important question to develop by degrees, we have reproduced in our columns several noteworthy articles which have appeared in foreign journals, but have not commented upon them. Mr. Human's letter compels us to say a word or two, and to do this nothing more is needed than to slightly amplify parts of his communication. Leaks have arisen and must arise *on one pole or the other* of supply companies' mains. To use double-pole switches invariably, is only to introduce complications and risks which are inseparable from such devices when made on a small scale. If a leak is started on one of the street mains, the Company alone, and not the consumers, should be inconvenienced thereby. It is to be presumed that the "middle" would be earthed through an ammeter, and, as a matter of fact, one company, in an unofficial, private, and altogether experimental manner, has thus occasionally used a recording instrument; with an absolutely negative, that is to say, the best possible result. If a leak arises on the "middle," the engineer will discover it in due time, but meanwhile no harm will be done; if it occurs on an "outer," he will be obliged to repair it at once by stress of circumstances which at present have no existence. To those who have not yet given attention to this extremely important matter we recommend a study of Mr. Human's diagram, and of this simple means for providing against the possibility of an accident.

Several of the London Companies who work the direct low-pressure system are congratulating themselves on the great reductions that have been made during the current year in working costs. It is an open secret that a friendly rivalry in economy of working exists between several of these Companies. We hear that in the month of October one of the stations of the Kensington and Knightsbridge Company has beaten the record, the total cost of grinding out the current, to use Mr. Justice A. L. Smith's expression, having been only 1·173d. per supply unit sold to the customer, the coal used being 5·9 lbs. per unit generated, or 6·4 lbs. per unit sold. We hear that the month of November will show still better results, not only in this but in several other stations, notably at some of those belonging to the Westminster Company, where the condensing plant has been recently got to work. We have no information as to the cost per unit at Westminster, but we understand that at Eccleston-place, where they were condensing every day during the heavy watch, the last week's coal account worked out at 5·31 lbs. per unit generated, and 6·23 lbs. per unit delivered to consumers.

Competition is the salt of business; and when the weak are driven to the wall they become socialists and deprecate the battle being for the strong. But to some forms of competition the most brangling demagogue can hardly object, even on what he is pleased to call principle. The Westminster Electric Supply Corporation has its three stations in parallel, and unless we are mistaken there is considerable friendly rivalry between the engineers in charge, as each one wishes to get as large an output as possible. A small difference in pressure at certain feeding points has been found to make a considerable difference in the area which each station supplies.

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Hence we believe occasional complaints and expostulations through the telephone as to the poaching tendencies which each gentleman thinks to be manifested by his colleagues. As a matter of fact it is arranged that, as far as possible, the light load in the day-time shall be taken by Eccleston-place, which is midway between the other two stations. Another, but an incorrect version of the story, is that one engineer kept his pressure a volt or so lower, thus allowing the other stations to supply his district and enable him to boast of a small coal bill.

Beckenham.—The Local Board have decided to apply for an Electric Lighting Order.

Reading.—The Reading Electric Supply Company are applying for an Electric Lighting Order.

Royal Society.—None of the medals of the Royal Society are this year awarded for electrical research.

Inter-urban Telephony.—A telephone trunk wire is to be established between Berlin and Posen, a distance of 170 miles.

The Cheesbrough Patent.—The Cheesbrough (Sawyer-Man) Patent, No. 4,847, of November 28, 1878, expires on Monday next.

Electric Traction in Germany.—A concession has been obtained for the construction of an electric tramway between Altona and Blankenese.

Newington Vestry.—This Vestry has decided to oppose the application of the County of London Electric Lighting Company for a Provisional Order.

Electricity in Mines.—The Marien coal mines in Saxony have recently been provided with an electric power plant by Schuckert and Co., of Nuremberg.

Chagford (Devon).—The streets of this enterprising little town, which has adopted "Hedgehog" transformers and other novelties, are now illuminated with the electric light.

Gibraltar.—The permission for raising a loan not exceeding 900,000 pesetas (about £34,000) for the supply of electricity for lighting and other purposes in Gibraltar has been obtained.

Perth (Western Australia).—The city of Perth (Western Australia) is being canvassed by an electric light company. As gas is 15s. a thousand, the B.T.U. even at 1s. would be a boon.

Proposed Electric Lighting Legislation in Canada.—A Bill is being drafted providing for Government inspection of electric lighting and is to be introduced during the next Session of Parliament.

Post-Office Appointments.—Mr. W. H. Preece, F.R.S., Assistant Engineer-in-Chief and Electrician, to be Engineer-in-Chief and Electrician.——Mr. J. Hookey, Principal Technical Officer, to be Assistant Engineer-in-Chief.

The Blackpool Electric Tramway.—The Town Council have decided to extend the electric tramway to the South Shore. A company is being formed to construct a similar system of tramways between South Shore, St. Annes, and Lytham.

Glasgow.—The electric light works are now going steadily forward. As at present arranged there are to be 106 electric lamps, which, at £20 each, will cost the Lighting Committee some £2,120 annually. The lamps are about 20ft. high.

The late Prof. Dittmar.—A Civil List pension of £75 per annum has been granted to Mrs. Dittmar, widow of the late Prof. William Dittmar, Professor of Chemistry in Anderson's College, Glasgow, in consideration of the distinguished services of her husband.

Paris.—M. E. L. Naze, concessionnaire for the electric lighting on the left bank of the Seine, has deposited the 300,000fr. caution money required by the Municipality, and obtained the necessary capital for carrying out the scheme. Work will be shortly begun.

Lisbon.—In consequence of an accident to the electric lighting at the Opera House, where there is no other means of illumination, the gala performance on Sunday night last in honour of the return of the King and Queen of Portugal from Spain was suspended.

Telephone Wires.—Some telephone wires having been fixed to the steeple of the Church of St. Martin's-in-the-Fields, Trafalgar-square, which is just now undergoing repair, the churchwardens have given formal notice that unless they are removed within a month they will be cut.

The Pacific Cable Scheme.—A Reuter cablegram from Ottawa says that a deputation of influential members of the Ottawa Chamber of Commerce had an interview on Tuesday with a representative of the Canadian Ministry, at which they requested the Government to urge the Imperial authorities to aid the Pacific cable scheme.

The Carnaby-street Station.—At ten o'clock on Friday night last week several calls reached the fire brigade stations for Carnaby-street, Golden-square, where the basement of the premises of the St. James's Company was on fire. Several engines were despatched, and the mischief was restricted to the portion of the premises in which it had originated.

Cable Interruptions.—

Cable.	Date of interruption.
Bolama-Bissao (communication with)	September 9, 1892
Cayenne-Vizeu	September 24, 1892
Para-Maranham.....	October 15, 1892
Ceara-Maranham	November 9, 1892
St. Thome-Loanda.....	November 24, 1892

Société Internationale des Électriciens.—At the meeting of this Society, on the 2nd inst., M. Mascart announced that subscriptions to the amount of 100,000fr. had been received by him towards the new laboratory. In addition MM. Weyher et Richemond had promised a 25-H.P. engine, and M. A. Hillairet had undertaken to supply all the mechanical appliances.

Proposed Electric Cars at Coventry.—The independent deputation of members of the Coventry City Council who left Coventry on Wednesday night last week for Leeds, for the purpose of inspecting the electric traction in use there, have returned with their views very much modified as to the objections, and with a favourable impression as to the advantages of the system.

Finding Faults in Coils.—The Thomson-Houston Company test the insulation of all coils turned out at their Lynn factory by placing them in a powerful alternating magnetic field. The circuit being open there will be no appreciable heating; should a short circuit, however, exist anywhere a heavy current will be generated, and the bobbin will soon become perceptibly warm.

The Merchant Venturers' School.—In view of the large increase in the mechanical and electrical engineering departments of the Merchant Venturers' School the governors have invited Sir J. Fowler to distribute the prizes and medals, and to deliver an address to the students in the departments of science, art, and technology. Sir John has consented to visit the school for this purpose on Thursday, December 8th.

Electric Traction in Germany.—The Bremen overhead trolley line has at present about four miles of road, and it is now proposed to extend it. The number of passengers carried has risen 30 per cent. in the past year.——The Allgemeine Elektricitäts-Gesellschaft are making rapid progress with the Breslau tramway, which is also on the overhead trolley system; about five miles of underground conductor are now laid.

Worcester.—On Friday last, at the meeting of the Watch Committee, it was resolved to recommend the City Council to purchase Powick Mills, on the River Teme, for the purpose of electric lighting, at a cost of £5,000, and to accept an alternative tender by the Brush Company amounting to £23,209. It was stated that by utilising the water power of the Teme for generating the electricity a saving of £1,416 per annum would be made.

The Proposed International Electrical Exhibition in Milan. With regard to this proposed Exhibition in 1894, the Committee are now proposing to offer, in addition to the usual diplomas and medals, a "grand premium" for the most important invention and discovery in the field of electricity, having special regard to the long distance transmission of

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electric energy, and its distribution and transformation for industrial uses.

Cork.—At the last meeting of the Town Council the recommendation of the Special Committee *re* electric light, Oct. 4th: "That the Council refuse its consent to the application of the Cork Gas Consumers' Company for a Provisional Order to enable them to supply electrical energy within the borough; and that should the Company persist in such application, the Council on its own part to apply for a Provisional Order for the same purpose," was deferred for a month.

Proposed Electric Railway from Victoria to Kilburn.—During the ensuing Session of Parliament a Bill is to be promoted with the object of incorporating a Company for the purpose of constructing an underground electric railway from a point on the Vauxhall Bridge-road side of Victoria Railway Station, and passing from thence under Edgware-road to Kilburn. The gauge which it is proposed to adopt on this line will be the ordinary standard gauge adopted on all passenger railways of 4ft. 8½in.

The South Staffordshire Electric Cars.—In view of the success of the electric cars on the South Staffordshire lines, the Chairman of the Birmingham Central Tramways Company, it is stated, thinks it prudent to keep an open mind as to the advisability of using electric instead of cable traction. If overhead wires were permitted, the Central Tramways would, he believes, prove "a gold mine." The Mayor and Corporation of Birmingham are to be invited to visit Darleston for the purpose of inspecting the electric cars.

Lord Kelvin's New Form of Electrostatic Voltmeter for Low Voltages.—The arrangement of the vanes and cells of this instrument are much the same as those of the multicellular voltmeter already described in these columns. The instrument is specially designed for use on switchboards, and has a vertical scale instead of the old plan of reading with a mirror. It is rendered practically dead beat in its action by a small horizontal disc which turns in an oil dashpot below the case. The zero adjustment has been modified by the addition of a torsion head and micrometer screw.

Naval Signalling.—*The Times* states that the battleship "Anson" is to be supplied with the new pattern electric flashing signal lamps on her return to Devonport. Six of these lamps have been ordered for trial in the Mediterranean Squadron, and the "Royal Sovereign" has also been supplied with one. So far the lamp has been unfavourably reported upon. It has been found that flashes cannot be made with the necessary rapidity owing to the fact that light lingers in the carbon. The lamps are of about 100 c.p., and are worked at the masthead by electric wires from the deck.

Coast Communication.—The islands of Scilly, Tresco, Bryer St. Martin's, St. Mary's, and St. Agnes, are now telephonically connected, and the coastguard station at Porthleven has been connected by telephone with the Lizard signal station, a distance of 14 miles, and from the signal station a wire has been carried to the chief officer of coastguard two miles away. There is a wire from the Lizard station to Cadgwith post-office and the Cadgwith coastguard. It is expected that shortly all the lighthouses around the coast, including the Wolf, Longships, Bishops, and St. Agnes, will be connected with one or other of the various circuits.

Hove.—On Saturday last the new supply station at Hove was started, only 90 days after the signing of the contract. The mains were laid and closed in in 60 days, and on the opening day some 1,300 lamps were connected, thus ensuring an income of some £700 or £800 per annum from the commencement. Hove being practically part of Brighton, this town now possesses no less than three systems of electric lighting. The Hove Commissioners have granted the concession to the Hove Electric Lighting Company (Limited) for 42 years. We understand that much of the credit of this smart bit of work is due to Mr. Stevenson, the resident engineer and representative of Messrs. Crompton and Co., who have secured the contract for the whole of the works.

Larne.—A specially-convened meeting of the Town Commissioners was held on Monday evening last. Mr. M'Williams said there had been a good deal of time lost at that Board over the question of electric light. They had been informed repeatedly that the contractors were doing their best to make the light a success, and he believed they were, but so far they had failed to make the light what they all would have desired to see. He would propose:—"That a letter be sent as final to Messrs. Gordon and Co., stating that the present lighting of the town was not by any means satisfactory, and that the Commissioners will not pay for light not received by them, and will deduct what they may consider fair and just out of their account for supplying electric light in future." The motion was passed, all voting in its favour except one member.

The City Lighting.—At Tuesday's meeting of the City Commission of Sewers a letter was received from the City of London Electric Lighting Company relative to the progress made. They stated that out of 515 arc lamps contracted for in the principal streets, 409 had been supplied, some of them three months before the contract time. Of the remainder, the positions of 44 had not yet been definitely fixed, but the list would be completed as soon as the operations retarding them, and for which they were not responsible, such as the repaving of streets, were finished. They were now prepared to go on with the erection of the incandescent lamps in the smaller streets. Mr. Malthouse said the work had been very well done, and speaking from his experience at the Central Markets, the lighting of the City, as experienced during the recent fogs, was a great improvement on gas. Mr. C. T. Harris raised the question whether the Court had ever given the Company power to light the less important streets with incandescent lamps. He contended that this method of lighting was most costly and extravagant, and was equivalent to using perfumed water to turn a mill.

Imperial Institute.—Sir Frederick Abel having acted as proposer to the whole body of Civil Engineers, Mr. Preece is doing the same for the Electrical Engineers. The first privilege set forth in a circular which has been sent to all members and associates of the Institution, is that of attaching "the distinctive designation of 'F.I.Inst.'" after the name of each Fellow. We have recently visited the Institute, under a guidance of a Fellow who was compelled to show a ticket of membership on entering. We understand that the Library is not yet built; the News-Room is well supplied with daily papers, but the Reading-Room has a very scanty selection of magazines and periodicals, besides those connected with trades and Colonial commerce, while the Refreshment Department is arranged in the style of a public refreshment-room at a museum or railway station. The telephone is fixed in one of the offices, and conversation has to be carried on in the presence of a number of clerks. As an Imperial Institute the place may no doubt be well arranged, but it is fair to warn intending Fellows that they must not expect to find the conveniences of a club in the building as at present arranged.

Exports of Telegraphic Apparatus.—The Board of Trade returns are again unsatisfactory so far as regards our exports of telegraphic wiires and apparatus connected therewith. The exports for October were again much below those for the corresponding month last year or the year before, having amounted in the aggregate to but little over £31,000. In April last the value of our exports under this head reached the very large total of nearly £448,000, and had it not been for this exceptionally large movement, the aggregate figures would have been very much worse than they are. As it is, our total exports for the first ten months of the current year are less in value than two-thirds of the exports in the corresponding period of last year. Below we give a statement of the exports for the first three quarters and for last month, in comparison with the corresponding figures, for 1891 and 1890:—

	1890.	1891.	1892.
First Quarter.....	£324,670	£653,081	£96,079
Second Quarter	397,042	331,449	579,756
Third Quarter.....	210,280	342,106	124,605
Nine Nonths	931,992	1,326,636	800,440
October.....	335,064	38,167	31,198
Total ten months...	£1,267,056	£1,364,803	£831,638

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NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 16.)

21. The Cable Ships "Store Nordiske" and "H. C. Oersted."—These two vessels, although belonging to one Company—the Great Northern Telegraph Company—are at work on very nearly opposite sides of the globe. The two portions of this Company's submarine system are situated in the waters of the Far East and northern Europe respectively. The "Store Nordiske" presides over the cables in the Far East, numbering nine in all, or thirteen if counted by sections, besides those of the Japanese Government. These cables principally connect Northern China, Japan, and Corea with the town of Wladiwostok on the eastern littoral of Russian Asia. From this town the great Russian land-line system of 9,000 miles spans the continent of Asia, and communicates with St. Petersburg and the Baltic Sea coast. Thence follows the European cable system of the above Company, connecting Russia with Germany, Sweden, Norway, Denmark, France, and Great Britain, and numbering in all 12 cables in 16 sections. This latter system, running through the North and Baltic Seas, is kept in repair by the steamer "H. C. Oersted." The faults repaired by this vessel in cables crossing the North Sea between Scotland, Norway, Denmark, and Newcastle, are chiefly caused by trawlers in the North Sea fishing fleets. At Shanghai the Eastern Extension Company's system joins that of the Northern Company, and connects China with Australia, India, Africa, and Europe.

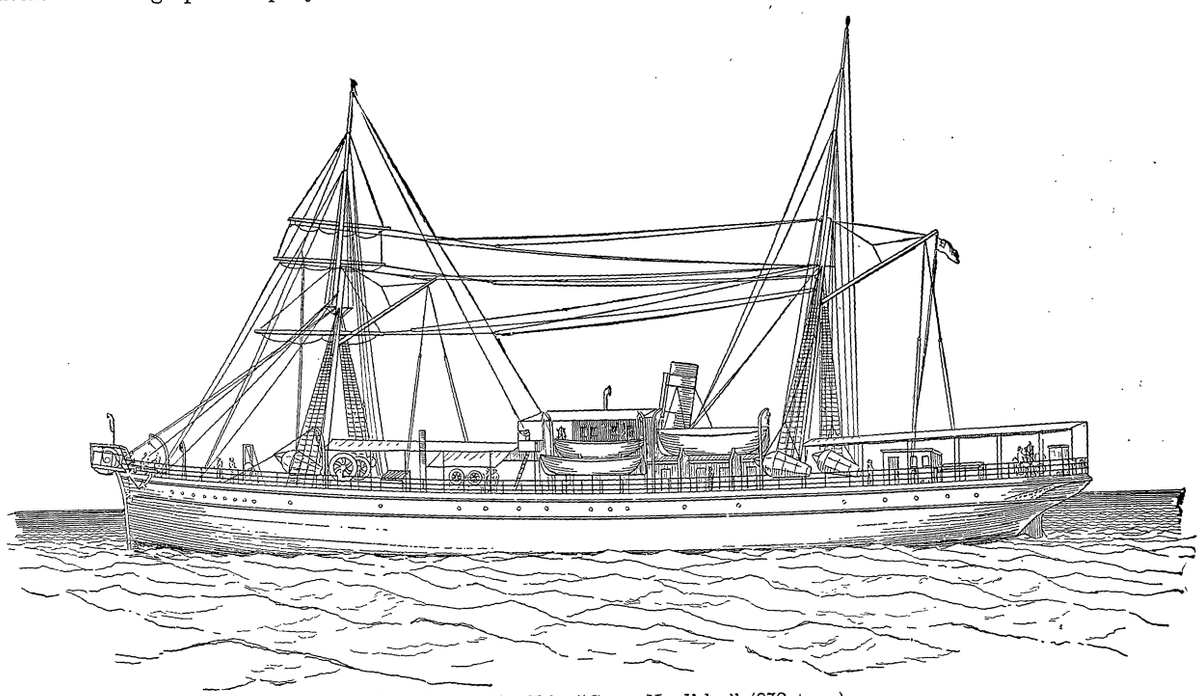

FIG. 78.—Cable Ship "Store Nordiske" (832 tons.)

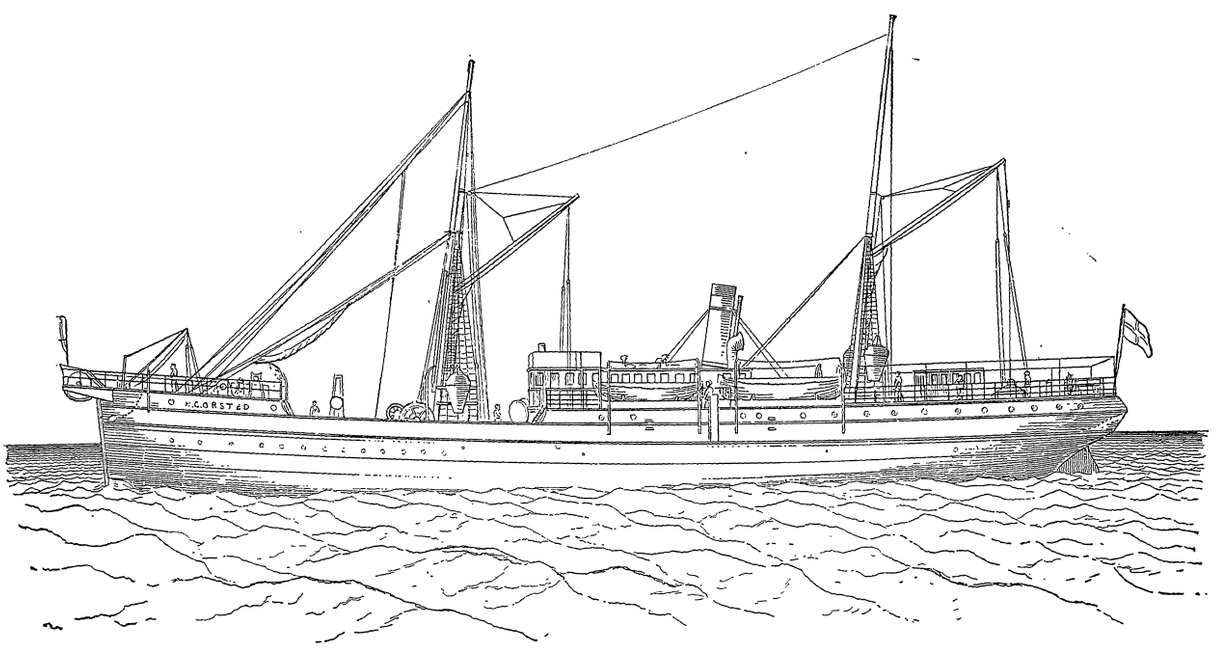

FIG. 79.—Cable Ship "H. C. Oersted" (750 tons.)

The illustrations of these vessels (Figs. 78 and 79) are from photographs kindly lent to the writer by the Great Northern Company, that of the "Store Nordiske" being a very good one, taken at Shanghai by a shrewd John Chinaman. It will be noticed that these vessels are of very compact form, light

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tonnage, and carry no gear aft, being specially fitted for repairing work, all operations being carried out from the bows. The sets of steam gear for picking up and paying out were fitted on these vessels about 11 years ago by the Thames Ironworks Company, to the designs of Mr. W. B. Esson, well known for his more recent contributions to the theory of dynamo design. In Fig. 80 is shown the arrangement of this gear as fitted on board the "Store Nordiske." Steam is delivered to two inclined cylinders with trunk action, driving direct on to pin of crank-disc A. Between this shaft and that of the winding drum there is a second motion shaft driven by spur-gearing, which reduces the speed between the drum and engine shafts in the ratio of 5 to 1. The illustration being a sectional elevation does not take in the drum, but it may be remarked that the large spur-wheel on drum shaft is made fast to the drum itself, the latter having arms and a boss to key on shaft, and the spur-wheel being made up in segments bolted to the internal flange of drum. With this arrangement no strain is put upon the spokes of the drum or spur-wheel, as is the case when the latter is built as a separate wheel, and keyed to the shaft at a little distance from the drum. When so built the strain comes on the spokes and keys, and a torsional strain is put on the shaft, which is avoided by making the wheel one with the drum. As far back as 1863 Mr. F. C. Webb made this improvement in the gear he designed for the cable-ship "Amberwitch," the repairing vessel for the Persian Gulf cables. The brake on main brake wheel B can be set up by weighting the lever S. The hauling-off pulley H is mounted on a separate shaft with clutch and lever for throwing in or out of gear. With the clutch over to one side the pulley is set in motion at a circumferential speed a little in excess of that of the drum, so pulling cable taut away from the latter, as required during picking up. Putting the clutch over to the other side disconnects the shaft from the driving pulley, and couples it to a small brake, E, the tension on which can be adjusted by the lever O to keep cable taut on its way to the drum from the tank, as required in paying out.

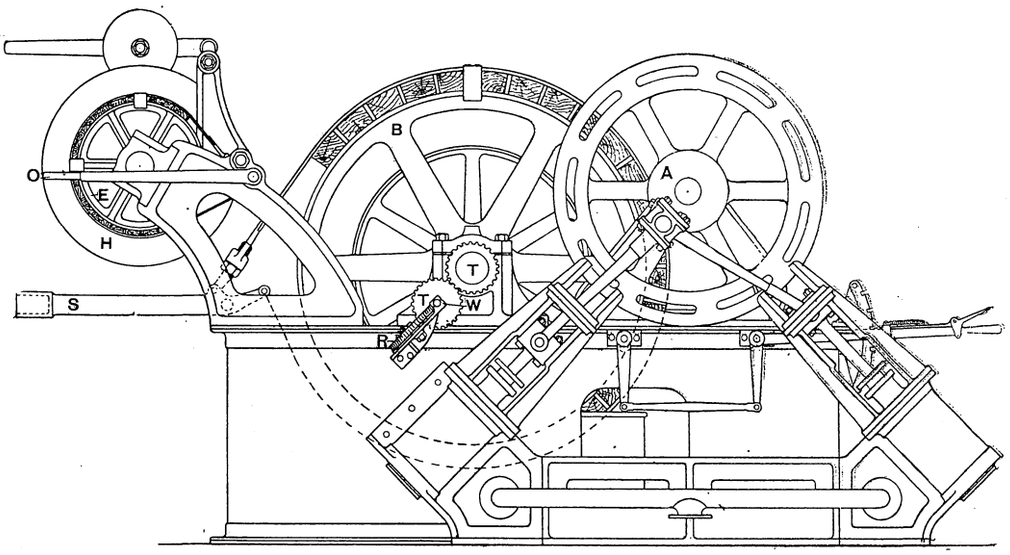

FIG. 80.—Elevation of Cable Gear.

Driven off the drum shaft through the intermediary of the toothed wheels T T, and worm on shaft W, is a very simple form of rotometer for recording the number of revolutions made. The dial R, graduated in revolutions of the drum, is slowly rotated by the action of the worm on its outer circumference, the index hand remaining stationary, and being set to zero at starting. This is read very easily, and there is nothing to get out of order, while, like all rotometers which follow both the forward and backward movements of the drum, it registers the exact length of cable passing between bows and tank during picking up or paying out without calculation.

Two knives for fleeting the turns of cable on drum are fitted on opposite sides of the drum, the forward one for use in picking up, and the other behind for paying out. The former is made moveable as shown, so that when it is required to remove the turns of cable bodily off the drum this knife can be shifted out of the way. This is frequently a necessary operation where there is only one drum as in this set of gear. When the ship, engaged in paying out cable after removal of fault, arrives at the buoy, the drum is required for picking up the buoyed end and consequently the turns of cable then on the drum have to be removed bodily. The cable is therefore stoppered at the bows, first taking off all strain from the drum, then the fleeting knife is moved out the way and the turns of cable slipped off. As picking up proceeds on the buoyed end the ship moves forward a little, and the stoppers on the payed-out end are eased to allow cable to slip through as required. The only objection to this is that the amount of cable so payed out by hand is not measured, or only approximately so. In the first ten years of cable gear construction drums were made with outside bearings so that cable could not be got off without cutting it, and this involved much inconvenience and waste in wrongly judging length at which to cut. The first overhanging drum was constructed by Mr. Webb on the vessel above alluded to in the year 1863, and has since been universally adopted.

22. Regulations Affecting Cable Ships at Sea.—Cable ships engaged in picking up or paying out cable cannot get out of the way of other vessels that may be approaching them, and therefore, in order to prevent collisions, the Admiralty, in conjunction with the Board of Trade, drew up some special rules to be observed by British cable ships when so engaged. These rules were included in the "Regulations for Preventing Collisions at Sea," issued in pursuance of the Merchant Shipping Act Amendment Act of 1862, and were confirmed by an Order in Council of August 11, 1884. In framing these rules it was recognised at the outset that a cable ship engaged in laying or picking up cable at sea was in the same condition as a disabled steamer, inasmuch as she could not get out of the way of other ships in her neighbourhood, and that, therefore, she should fly signals of a similar character. A disabled steamer is required to carry by night three red lights on the foremast head in place of the usual white light, and by day three black balls or shapes, all in a vertical line. If, however, the signals carried by a cable ship were exactly like those of a disabled steamer, passing vessels would bear down upon her to render assistance, and therefore some distinguishing signal was necessary. This was effected as regards night signals by making the centre light of the three a white light, and by day flying red globular shapes at top and bottom with a white diamond-shape between them.

The full text of the three clauses in Article 5 of the "Regulations" is as follows :—

(*b.*) A ship, whether a steam ship or a sailing ship, employed in laying or in picking up a telegraph cable, shall at night carry in the same position as the white light which steam ships

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are required to carry, and, if a steam ship, in place of that light, three lights in globular lanterns each not less than 10in. in diameter, in a vertical line over one another, not less than 6ft. apart; the highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character that the red lights shall be visible at the same distance as the white light. By day she shall carry, in a vertical line, one over the other, not less than 6ft. apart, in front of but not lower than her foremast head, three shapes, not less than 2ft. in diameter, of which the top and bottom shall be globular in shape and red in colour, and the middle one diamond in shape and white.

(*c.*) The ships referred to in this article, when not making any way through the water, shall not carry the side lights, but when making way shall carry them.

(*d.*) The lights and shapes required to be shown by this Article are to be taken by other ships as signals that the ship showing them is not under command, and cannot, therefore, get out of the way.

(*To be continued.*)

OPEN AND CLOSED MAGNETIC CIRCUIT TRANSFORMERS.

BY W. E. AYRTON AND W. E. SUMPNER.

In a Paper read before the British Association on August 5, 1892, and reprinted in *The Electrician* for October 7th, we described a number of tests made to determine the losses occurring in transformers of the closed circuit type under ordinary working conditions. The tests actually published referred to four Mordey transformers of outputs varying from 1·5 to 4·5 kilowatts, but it was stated that numerous experiments had been made on a Hedgehog transformer of 4 kilowatts output, and that these tests showed that neither at no load nor at full load was there any great difference between the power wasted in a Hedgehog and in a Mordey type of transformer of the same output. The details of the tests on the Hedgehog transformer were, however, reserved for later publication, as it seemed desirable to analyse more fully some of the results obtained.

Since that date we have repeated the tests, and by using a slight modification of the method before employed (*see* Fig. 1, p. 615, *The Electrician* for October 7, 1892) have obtained very satisfactory results. As we indicated in the Paper already mentioned, some of the peculiar results previously obtained with the Swinburne transformer were due to its large magnetising current, which prevented the current, as read by the dynamometer, being any measure of the load on the transformers. Corrections had also to be applied owing to the fact that the transformers were working at somewhat different voltages.

The arrangement of the apparatus employed for the recent tests is shown in the figure. The thick coils of a three-kilowatt Mordey transformer M, and of a four-kilowatt Hedgehog transformer H, were put in parallel on low-pressure mains, a Siemen's dynamometer S D being so connected as to measure the current through the coils of H. A Ganz wattmeter G W measured the power supplied to the combination of M and H. A third transformer T had its primary on the mains, and its secondary in series with the fine coils of M and H, these latter coils being connected so that their voltages opposed each other. A Swinburne wattmeter S W measured the power given out by the secondary of T, and an Ayrton and Mather electrostatic voltmeter V was arranged to measure the voltage on the fine coil of either H or M. In all the tests the fine coil of H was adjusted to 2,000 volts, and the transformer T was so arranged that H transformed down. In some of the tests a reflecting dynamometer, measuring up to two amperes, was placed fn the high-pressure circuit, in which case the dynamometer S D was dispensed with. The sum of the readings of the two wattmeters measured the total power wasted in M and H, and, as the losses in M were known from the previous tests for all frequencies, voltages and currents, those in H could be found.

In testing with alternate currents it is most necessary to ensure that the currents in the leads do not affect the readings of the dynamometers and wattmeters employed. The only effectual way of doing this is to twist together the two wires which lead up to and away from each instrument. Moreover, as suggested by us in connection with Mr. Swinburne's Paper on "Electrical Measuring Instruments," read in April last at the Institution of Civil Engineers, it is of particular importance in testing *open* magnetic circuit transformers to take great care that the stray alternating field does not act directly on the measuring instruments. To make sure of this we have found it necessary to place the measuring instruments several yards away from the Hedgehog transformer.

The following is a sample of tests made at a frequency of 100 ∿, with the dynamometer in the fine-wire circuit :—

Volts in Hedgehog transformer	2,000	2,000	2,000	2,000
Volts in Mordey transformer	2,000	1,960	1,950	1,880
Amperes in fine-wire circuit	0	1·32	1·53	1·84
Sum of watts read by two wattmeters	275·0	339·5	362·5	391·5
Watts lost in coils of Mordey transformer	0	40	54	78
Watts lost in iron of Mordey transformer	106·5	105·5	105·0	96·0
Watts lost in copper and iron of Hedgehog transformer	168·5	194·5	203·5	217·5
Watts lost in copper of Hedgehog transformer	0	28·2	39·5	55·0
Watts lost in iron of Hedgehog transformer.	168·5	166·3	164·0	159·5

For convenience of tabulating, the numbers under the head of copper losses do not include the constant part of the copper losses, viz., that due to the magnetising currents, and this latter is included in the numbers under the head of iron losses. The watts lost in the iron of the Mordey transformer diminish as the load is increased owing to the fact that the voltage at which it is worked diminishes as the current increases, the alteration being shown by the numbers in the second row of figures.

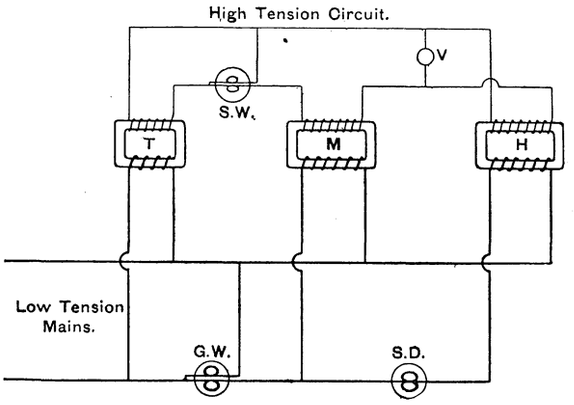

Diagram of Connections.

Shortly before these tests were made the Ganz wattmeter was tested to see whether it read correctly. The open-circuit losses of M and H were tested separately, and were, respectively, 105 and 163 watts. The sum of the two losses was also tested and found 271, which is sufficiently near 268, the sum of 105 and 163, to show that the inductive nature of the load introduced no appreciable error in the wattmeter readings.

The losses occurring in coils of the Hedgehog transformer were tested with both direct and alternating currents, and found to be 65 watts at 40 amperes.

Complete sets of experiments were made not only at frequencies of 100 ∿, but also at 150 ∿ and 200 ∿. It will be sufficient, however, to add a sample of the results at a frequency of 200 ∿.

Volts on Hedgehog transformer	2,000	2,000	2,000	2,000	2,000	2,000
Volts on Mordey transformer	2,000	1,820	1,775	1,695	1,645	1,600
Amperes in thick-wire circuit	0	19·2	20·35	24·10	25·6	28·1
Sum of watts read by two wattmeters	192	234	228·2	241·0	256·0	270·0
Total copper losses in watts...	0	41·3	46·5	65	73·5	88·5
Total iron losses	192	192·7	181·7	176	182·5	181·5
Watts lost in iron of Mordey transformer	80	73	71	68	66	64
Watts lost in iron of Hedgehog transformer	112	119·7	110·7	108	106·5	107·5

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The open-circuit losses at different frequencies were also separately determined, and the mean of a large number of tests gave the following numbers for the Hedgehog transformer :—

160 watts	at a frequency of	100 ∿
131 „	„ „	150 ∿
117 „	„ „	200 ∿

and these numbers, when expressed as a fraction of the full load of 4,000 watts, give 4·0 per cent., 3·27 per cent., and 2·92 per cent. Whereas, as stated in our British Association Paper, the open circuit losses for a transformer of the Mordey type, expressed at a fraction of full load, were only 3·2 per cent., 2·8 per cent., and 2·36 per cent., at frequencies of 100, 120, and 160 ∿ , and, of course, still less at a frequency of 200 ∿ .

From the results given in this communication, we obtain as the efficiencies of the Hedgehog transformer at the full load of 4,000 watts, 94·38 per cent., 95·10 per cent., and 95·45 per cent., at frequencies of 100, 150, and 200 ∿ respectively.

ON THE POSSIBLE OCCURRENCE OF TORSION CURRENTS IN THE CORES OF TRANSFORMERS.

BY FRED. T. TROUTON, M.A., SC.D.

At the British Association last year I described some rather peculiar results I had then obtained while endeavouring to experimentally investigate the rate of propagation of magnetic disturbances in iron.*

An interference method was adopted in these experiments. A large iron ring (about 12ft. in circumference) made of iron wires had placed on it a coil through which alternating currents were sent. There was a second coil on the ring connected with a telephone which could be moved round the ring. The experiments were intended to ascertain if, at very high rates of alternation, the waves of magnetism sent round the ring in opposite directions would interfere and produce places of silence, and these were to be observed by means of the telephone.

Places of silence or nodes were found to occur round the further half of the ring from the alternating coil, provided the alternating coil was placed in certain positions. Each of these latter positions lay between places where nodes were to be found for some other position of the alternating coil. The nodes on the whole were at nearly equal distances apart, but did not alter their position with the rate of alternation, thus precluding all idea of wave interference. Yet, in spite of this, it was found that the vibrations on either side of a node were in opposite phases, as they should be, supposing the phenomenon due to stationary waves, produced by interference as in an organ pipe. This was ascertained by employing two coils connected in series with the telephone. On placing them at equal distances to either side of a node the induction currents interfered and produced silence in the telephone.

After much investigating it was found that this phenomenon, which in such a remarkable manner simulated a magnetic wave interference effect, was due not to any magnetic effect at all, but was due to the iron being in some peculiar state at certain places round the ring, which, when the alternating coil was at one of them, caused a current to flow in the iron at *right angles* to the plane of the inducing alternating coil. And then again it was due also to this current flowing round the ring and in converse order inducing currents at *right angles* to its own direction in the coil connected with the telephone, provided it also was placed at positions on the ring in this peculiar state, between these positions the nodes occur. Further, it was found that this peculiar state was due to twisting of the iron of the ring, which resulted from the tendency a large coil rewound from a smaller one has to twist up into fairly regular lengths, succeeding sections of which are twisted in opposite directions. These lengths are separated by portions of untwisted iron. When special precautions were taken in making a ring to prevent this twisting it was found that the phenomenon did not occur.

* *Electrician*, Vol. XXVII., p. 520.

Direct experiments were undertaken with the view of further investigating this subject. An alternating coil was placed on a rod of iron, to the ends of which a telephone was connected up, or conversely the alternating current was passed through the rod while the telephone was connected with the coil. In both cases, if a permanent twist had been given to the bar, induced currents were evinced by sound in the telephone. The relative direction of these induced currents depended on the sign of the twist given. Subsequently to this I learnt that Prof. Hughes had some years since, in connection with the Inductive Balance, most completely investigated these effects produced through twist in iron.*

Most of the specimens of iron I experimented with were found, even while in the original state, to be in a condition to afford, to a greater or less extent, these induced currents, which, however, could always be neutralised by a suitable twist being given to the iron. An interesting question arises thereby with reference to the iron in the cores of transformers. Should the iron used in the cores of closed circuit transformers happen in some way during manufacture to gain the necessary twist, currents will be induced in this way which may prove a source of heating in the iron and thus entail loss of energy. In open circuit transformers such loss could be prevented, but will ordinarily occur should parts of the iron of the core be differently twisted from others and be uninsulated, or should there be short circuit through other parts of the apparatus. It has been doubted by some observers whether the heating in the cores of transformers can be fully accounted for by the calculated values of Foucault current and hysteresis. These Torsion Currents may in part account for the alleged discrepancy.

LIFE AND EFFICIENCY TESTS OF INCANDESCENT LAMPS.

BY CLARENCE P. FELDMANN.

It is a well-known fact that in the course of its life a glow lamp slowly decreases in candle power and efficiency, the latter being taken in its proper meaning, *i.e.*, candle-power per watt. The object I had in view in undertaking these tests was to determine the character of this decrease, especially for the so-called "low watt" incandescent lamps. For that purpose, from three to ten lamps of each make were taken, their candle power and energy consumption determined at the normal working pressure of 72 volts, and they were then run at the laboratory of the Cologne central station, measurements being repeated every 50 and in the beginning every 25 hours.

In this way I tested 106 lamps of 21 different makes. I will first refer to the results obtained with de Khotinsky lamps, as they best show the characteristic features of well made "low watt" lamps. There were in all 17 lamps, labelled 72 volts and 16 c.p., and some, in addition, $2\frac{1}{2}$ watts (per candle). The energy was measured with a Ganz wattmeter, and the candle-power with a Bunsen photometer, using the amylacetate candle as unit. With respect to their initial efficiency, using the term in its ordinary signification, they were divided into three groups :—

Group	I. :	lamps giving	20·9	candles	and taking	1·72	watts	per candle.
„	II. :	„	16·66	„	„	2·76	„	„
„	III. :	„	16·0	„	„	3·32	„	„

The curves I., II., and III., in Figs. 1 and 2 show respectively the decrease in candle power and the increase in watts per candle for Groups I., II., and III.

Table I.

Group I.

2 lamps were	broken	after	16	hrs.	1 lamp was	broken	after	246	hrs.
1 lamp was	„	„	45	„	1	„	„	302	„
1	„	„	130	„	1	„	„	370	„
1	„	„	176	„	1	„	„	1,130	„

Group II.

1 lamp was	broken	after	110	hrs.	1 lamp was	broken	after	281	hrs.
1	„	„	212	„	1	„	„	400	„
1	„	„	246	„	1	„	„	1,080	„

Group III.

1 lamp was broken after 370 hrs.	2 lamps lived still after 1,500 hrs.

* *Proc.* Royal Soc., Vol. XXXI.

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We see, therefore, that even lamps of low initial energy consumption may reach a high number of burning hours, but that towards the end of their life they have lost so much of their initial candle-power that it is practically impossible to run them out. Practice requires a certain minimum amount of candle power, say 50 per cent. of the initial candle-power, and this limit must be taken as a measure for the *practically useful life* of the lamps. The life, defined in this way, was :—

About 110 hours for the lamps of group I.
„ 325 „ „ „ „ II.
„ 1,050 „ „ „ „ III.

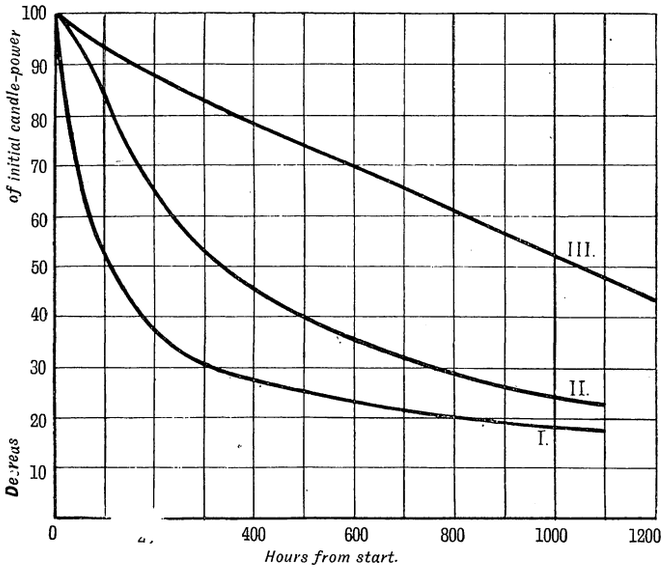

FIG. 1.—De Khotinsky Lamps.

But the lamps of Group III. are better than the other ones in other respects also. The curves of Fig. 2 show that after 130 and 170 hours respectively they reach equal efficiency with those of Group I. and II. respectively, and that for a higher number of hours they work much more economically than the latter.

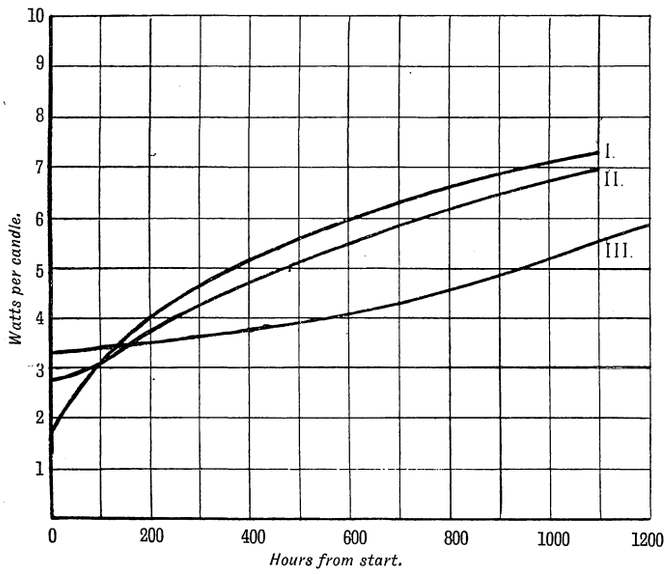

FIG. 2.—De Khotinsky Lamps.

These properties are common to all well-made lamps, not only to those of de Khotinsky. But I shall not give all the curves obtained, and I only mention (Table II.) those of the Venloo lamps, manufactured by Pope, because they show some characteristic features.

Table II. and Fig. 3 both show that the "low watt" lamps of this manufacture are better than the de Khotinsky lamps with respect to constancy of candle-power, but worse with respect to the durability of the filaments. This is especially shown by the lamps of Group E, of which

3 lamps were broken after			23	hrs.	1 lamp was broken after			108 hrs.
1 lamp was	„	„	48	„	1	„	„	112 „
1	„	„	56	„	1	„	„	163 „
1	„	„	63	„	1	„	„	320 „
1	„	„	90	„				

One single lamp, Group D, shows an increase of candle-power a few hundred hours after start. A similar phenomenon has been observed by Ch. Haubtmann, who found for a 16-c.p.

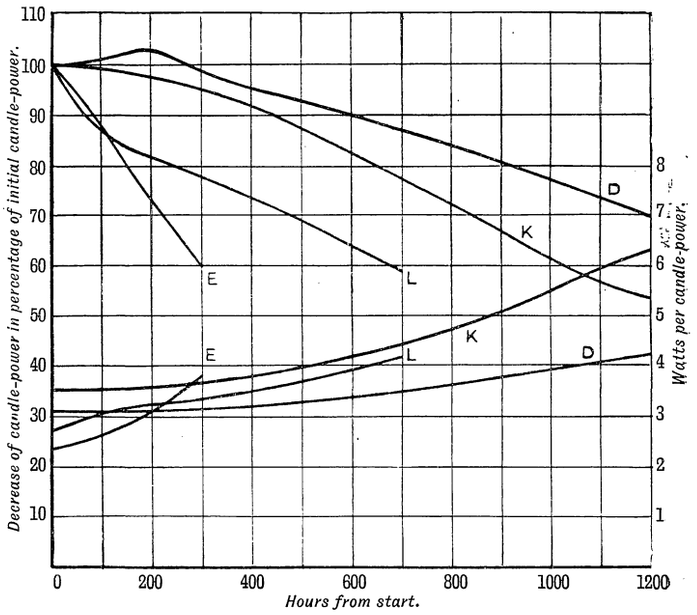

FIG. 3.—Venloo Lamps, manufactured by Goossens, Pope and Co.

Gérard lamp 6·5 per cent. increase after 250 hours, and for a 10-c.p. Zürich lamp (manufactured by Mr. Stearn) 17 per cent. increase after 100 hours, and by Prof. Thomas and Messrs. Martin and Hassler, who found for the lamps marked C, D, and P, an increase of 9, 1, and 7 per cent. respectively. Fig. 4 contains the characteristic curves for all these lamps.

Table II.—*Test of Venloo lamps, manufactured by Messrs. Goossens and Pope.*

Decrease of candle-power.					Increase of watts per candle.				
Hours from start.	E.	L.	D.	K.	Hours from start	E.	L.	D.	K.
	%	%	%	%		%	%	%	%
0	100	100	100	100	0	2·36	2·75	3·1	3·56
100	87·7	86·4	101	99	100	2·60	3·1	3·1	3·54
200	73·0	82·0	103	98	200	3·1	3·22	3·1	3·6
300	60·3	78·0	98	95·5	300	3·8	3·36	3·2	3·6
400		73·7	95·5	91·8	400		3·50	3·2	3·8
500		68	93·4	87·3	500		3·73	3·3	4·0
600		63·7	90·7	82·2	600		3·93	3·4	4·2
700		59	87·0	76·7	700		4·20	3·5	4·5
800			84·0	72·3	800			3·6	4·73
900			80·5	66·7	900			3·8	5·08
1000			76·8	61·2	1000			3·9	5·55
1100			73·0	56·7	1100			4·1	5·93
1200			69·7	53·5	1200			4·22	6·3

All burnt out. All out. All burnt out. All out.

Taking the values of all the tests which Thomas, Martin, and Hassler, and afterwards Haubtmann made, together with the results of my own measurements, I have calculated Table III., which contains mean values for more than 500 lamps, taken from 28 different factories, and representing 49 different types.

The values given in Table III. are plotted down in Figs. 5 and 6. It may seem strange that the lamp with the highest initial consumption per candle-power is, with respect to constancy of light, worse than that taking 4 watts per candle; but this irregularity may be due to the fact that these 4·5 watt lamps, which were all of American manufacture, are some-

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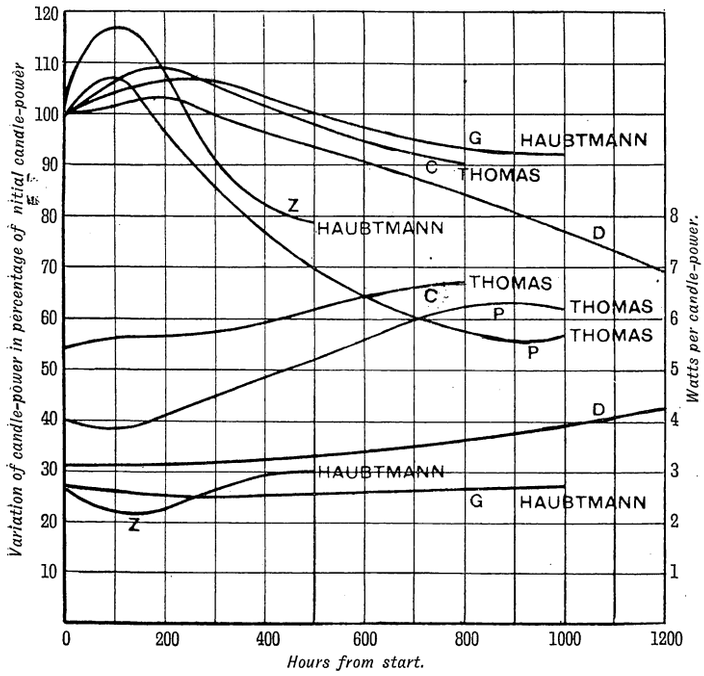

FIG. 4.—Various Lamps.

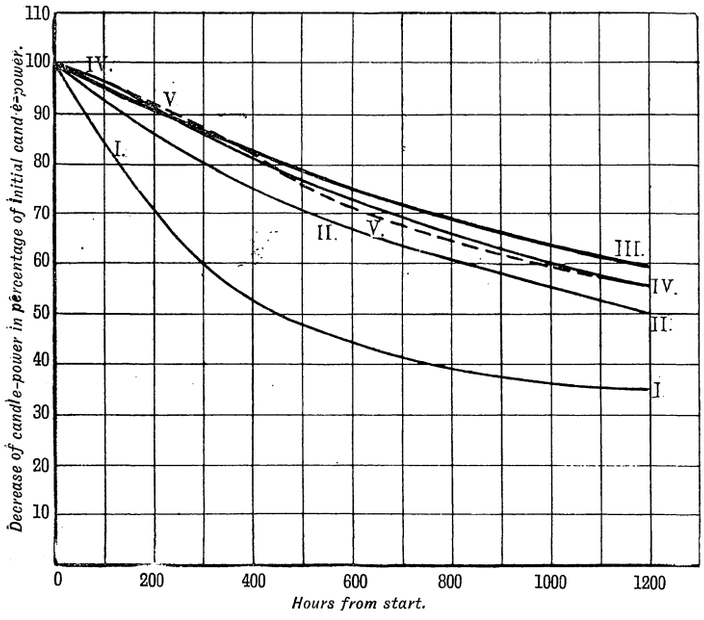

FIG. 5.—Modern Glow Lamps.

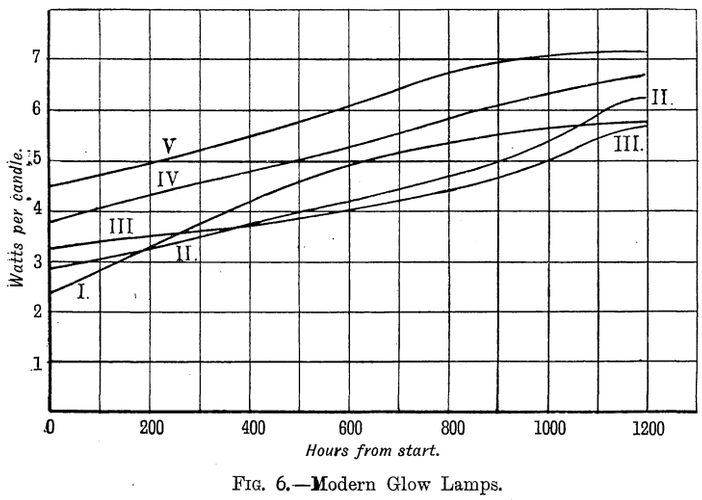

FIG. 6.—Modern Glow Lamps.

what worse than good modern lamps ought to be. What I want to emphasise, however, is that these Figs. 5 and 6 evidently show the 3·5 watt lamps (curve III.) to be the best among the modern ones, a fact which has been felt instinctively by many, but which had not, to my knowledge, yet been ascertained by exact measurements. Indirectly, these measurements, which were made with an alternating current of 50 ∽ per second, corroborate the results of Profs. Ayrton and Perry's tests, which showed that there existed no difference in the efficiency of incandescent lamps fed with continuous and alternating current.

Table III.—*Average Candle Power and Efficiency of Modern Glow Lamps at different periods of their lives.*

Hours after start.	Initial consumption 2·0—2·5 watts per c.p. I.		2·5—3·0 watts per c.p. II.		3·0—3·5 watts per c.p. III.		3·5—4·0 watts per c.p. IV.		More than 4·0 watts per c.p. V.	
	C.P. in per cent.	Watts per c.p.	C.P. in per cent.	Watts per c.p.	C.P. in per cent.	Watts per c.p.	C.P. in per cent.	Watts per c.p.	C.P. in per cent.	Watts per c.p.
0	100	2·4	100	2·9	100	3·3	100	3·8	100	4·5
100	84	2·8	93	3·0	95	3·4	96	4·1	96	4·7
200	70	3·3	85	3·3	91	3·5	91	4·3	92	4·9
300	59	3·7	81	3·5	88	3·6	86	4·5	87	5·2
400	53	4·2	76	3·8	84	3·7	81	4·7	82	5·4
500	48	4·6	71	4·0	79	3·9	77	5·0	75	5·8
600	45	4·8	67	4·2	76	4·1	73	5·3	72	6·1
700	41	5·2	64	4·4	72	4·2	69	5·6	68	6·4
800	39	5·3	62	4·7	69	4·4	66	5·9	65	6·8
900	38	5·5	59	5·0	67	4·7	63	6·1	62	6·9
1,000	37	5·7	56	5·3	64	5·0	60	6·3	60	7·0
1,100	36	5·7	53	6·0	62	5·4	58	6·5	58	7·1
1,200	35	5·8	50	6·3	59	5·6	56	6·7	56	7·1

THE PROBLEMS OF COMMERCIAL ELECTROLYSIS.

The following is an abstract of the adjourned discussion of Mr. Swinburne's Paper on "The Problems of Commercial Electrolysis," which took place on Thursday last, Nov. 17th, at the Institution of Electrical Engineers. Speakers whose remarks are prefixed by an asterisk have returned the same revised. Owing to the large number of blanks in the report which we received from the Institution of Electrical Engineers, where chemical or other technical expressions have been omitted, we have had unusual difficulty in filling in these omissions in the abstract.

Mr. G. L. ADDENBROOKE agreed with Mr. Swinburne that the methods of reduction of aluminium were simply due to the heat of the arc, and not to any chemical action. The price of aluminium six months ago was brought down to 1s. 9d. for large quantities ; it has now gone up again to 3s., and his impression was that it would continue to rise, but probably within the next 25 years aluminium would not be very much more expensive than copper, and as it was a very good conductor, since for equal weight it had double the conductivity of copper, it was not improbable it might play a very important part in the electrical industry.

Mr. LLOYD said that plating was a comparatively old industry, and that on that account Mr. Swinburne might have wasted time if he had introduced it in his Paper. Nevertheless, he thought that electro-plating with alloys was a distinct advance. He placed on the table a number of samples of alloys, and called attention to some samples of silver alloyed with cadmium, the amount of cadmium being comparatively small. He thought that palladium plating would probably come into considerable use in future, when the non-oxidisability of this metal, and the high temperature that materials coated with it would stand, became known.

*Mr. E. J. BEVAN said, with regard to Mr. Falconer's remarks, that there was nothing remarkable in the formation of chlorates ; indeed, the manufacture of potassium chlorate was one of the processes referred to by Mr. Swinburne. It depended entirely on the conditions. If they suited the conditions to make magnesium chlorate they could make it in abundance, and if they took care that these conditions did not obtain they got very little chlorate. It was interesting to note that within the last week or so Dr. Hopkinson had published a Paper, in which he stated that the cost of a kilowatt should not exceed 0·33d, which was not very far from Mr. Swinburne's figure. Mr. Swinburne assumed that a current density of 3 volts was all that was necessary. He only wished it were so ; it would reduce the cost of power very considerably. As a matter of fact, they could electrolyse sodium or any other chloride with about 2½ or 3 volts, but it would be necessary to have an exceedingly large plant to work at that voltage. In practice he had found that from 4 to 4½ volts was economical. With regard to evaporation, Mr. Swinburne said that the evaporation of the caustic liquor could be effected at such a price as would not raise the cost of the caustic more than a

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shilling or two per ton. He did not see how it was possible. For every ton of caustic produced they had to manipulate and get out in solid form several tons of salt, which, of course, was a very considerable matter in the operation of evaporation. This could be got over by precipitating the alkali as bicarbonate, allowing the precipitate to settle, pouring off some of the salt solution, and re-electrolysing that. In the Le Sueur system of electrolysing caustic the anodes were ordinary gas carbon, and an arrangement was made by which these anodes as they gradually wear away could be brought down close to the cathode, the diaphragm being between. As to the commercial uses of the soda produced, Mr. Swinburne said that the presence of salts would not interfere with the action of the alkalies; he ventured to think he was somewhat in error. He had made a number of determinations some years ago with the view of showing that the purest form of caustic was the most economical form, and he found the addition of, say, 10 per cent. of salt to caustic, which was not apparently a very large amount, seriously impaired the efficiency. The results were recorded in the *Journal of the Society of Chemical Industry*. He was of opinion that the electrolytic reduction of soda would pay very handsomely.

* Mr. A. P. TROTTER, alluding to electric tanning, thought that it had been decided by Dr. Rideal that there was practically no electrolysis in that process. The suggestion of Prof. Thompson as to the effect of the electric current on osmosis in some way not yet properly understood might have extremely important effects upon industries in which electric treatment has not yet been even attempted. In the Paper by Dr. Rideal and himself, which they had communicated to the Society of Chemical Industry, nothing in the nature of a theory was put forward, but they examined various theories on electrolysis from the time of Grotius up to the present date to find one which would fit with their observations, and perhaps the most plausible was that of Clausius, who suggested that the molecules are always changing partners, and dissociation was always present to some extent, and the effect of electromotive force was to give direction to the movements already going on. In that way there is no real expenditure of work necessary, it was merely directive, and molecules were encouraged to go in one particular direction. Mr. Swinburne alluded to dyeing, or rather to the electrolytic production of dyes. The process of dyeing seemed not at all unlike that of tanning, and he threw out the suggestion that this sometimes difficult process might perhaps be facilitated by electrical treatment. Mr. Swinburne alluded in his Paper to the fact that a process ought to be remarkably good on paper before they could expect anything at all from it in practice. He would say it should be not only remarkably good on paper, but also remarkably good in the laboratory before it was fit to put in practice. He had been connected some years ago with a process which was first electrolytic and after merely chemical—the decortication of rhea fibre. The first process consisted of the electrolysis of a rather disgusting mixture of organic substances. The rhea fibre subjected to this treatment in the laboratory in small bundles was remarkably encouraging. Stuff like dried bean stalks produced hanks of a fibre very like white floss silk, but afterwards putting it on a large scale, as soon as they tried a hundredweight or more at a time it came out a tangled mass. The machinery was clogged and nothing could be done with it.

Mr. GABRIEL ANDREOLI said that he wished to take up a point in Mr. Swinburne's Paper which has already been discussed both last week and this evening. It was the point in which he says that the only difficulty in the production of alkaline is in the anodes He says that platinum is too expensive, that carbon is destroyed, and that peroxide of lead is attacked by the hydrochloric acid which is formed in the electrolysing chloride. Mr. Fitzgerald told us what peroxide of lead will do in the form of lithanode. If ordinary peroxide of lead would serve for anodes, they need not go any further. In Prof. Bartoli's researches on the action of carbon in a solution evolving oxygen, the carbon was destroyed, disintegrated, and malitic acid is formed; but it was not generally known that if they used denser solutions less oxygen was given off, and the carbon was not nearly so much attacked. If they went on reducing the solution they got chlorine only and very little oxygen, and the carbon was hardly attacked at all. The idea of replacing the ordinary bleaching process by using electrolytic bleach presented so many difficulties that it had been practically given up. There was such a large bulk of liquor to use that they lost a large amount of salt, and to avoid this loss they had to use weaker solutions which gave off oxygen, and if they used carbon anodes the carbon was destroyed. If they used weaker solutions, they decomposed the water, and had a loss of current, because they used their current up by decomposing this water, and that diminished their yield. He was interested in the question of ozone. Ozone could be applied in very many instances, more particularly to bleaching molasses and sugar. It was a very powerful disinfectant; it kills bacteria, and was used in hospitals.

Mr. COOPER said that in nearly every instance which Mr. Andreoli had mentioned they had found the difficulties which he stated, but they had got over those difficulties some years ago, and he was prepared to prove that at the present moment on the Continent they were replacing in mills bleaching paper, pulp, cotton, and yarn, the equivalent of 3,000 tons of bleaching powder per annum.

* Mr. BLOUNT referred to the production of copper from the ore or from the matte direct. The refining of copper was quite a different thing from the winning of it, either from the matte or from the ore itself. Although the refining of copper from crude copper cast into suitable anodes was very hopeful, still greater advances would be made when the ore itself, or, if that be impracticable, the matte, was treated directly with commercial success. The whole difficulty in the Höpfner process seemed to be the one indicated by Mr. Swinburne in the electrolytic production of alkali, that was the question of an anode. The anode was always to trouble us—an anode might be excellent in every way, but either it would not stand, or if it would stand, it would not conduct.

* Mr. SWAN (in a communication read by Mr. Mordey) asked for further information regarding the cost of a kilowatt at a farthing an hour. He alluded to a detailed description which appeared in the *Scientific American* of plating large pillars with aluminium. Dr. Hopfner's process was: Instead of electrolysing sulphate of copper-solution, Dr. Hopfner employs a solution of cuprous chloride ($Cu_2 Cl_2$) as the electrolyte, and after the partial deposition of the copper and raising of the cuprous chloride to cupric chloride ($Cu Cl_2$), he reproduces the cuprous chloride by treating the cupric chloride with ore obtaining sulphur at the same time. In connection with the question of the electrolytic extraction of zinc, he might remark that there was great room for improvement on the ordinary process of zinc smelting. There was a loss of 20 to 30 per cent. of the metal. The inducement to effort to improve this process by electrical or any means was very strong. Among the electrolytic processes, one of the most recent and perhaps one of the most hopeful, Burghardt's was not named. Burghardt proposed to deposit zinc from a solution of zincate of soda.

* Mr. MORDEY, referring to the troubles experienced with carbon electrodes, said that in making class experiments on the electrolysis of water, using acidulated water and carbon electrodes, he found the mixed gases did not explode. He found this was due to the evolution of CO_2. In the Paper written in June, 1833, Faraday pointed out that CO_2 and CO are given off abundantly when water is electrolysed with carbon electrolysed—a fact that did not appear to be generally known

Mr. RICHARDSON described a process of bleaching which was being used in connection with a paper mill. They found that carbon disintegrated at a very rapid rate under certain circumstances. But its disintegration did not by any means preclude its application to the particular purpose of decomposing salts. It had been remarked that the carbon came off in a very fine, almost an infinitesimal division. Nothing of the kind: sometimes it came off in lengths of one-eighth of an inch, sometimes one-sixteenth of an inch, and sometimes almost half an inch, as though there were something relative to its conductivity.

* The PRESIDENT said that the question whether Mr. Mordey's experiment depended on electro-chemical or an electrolytic action seemed to be one of very great importance. If it was only a chemical action, it was simply heating the cell; then it was like any burning and was not of importance. If it was really an electrolytic action, then he had decomposed water and formed carbon di-oxide. Of course the heat of combustion of hydrogen was greater than the combustion of an equivalent amount of carbon, and therefore an amount of energy was required to produce that process. If they took a substance which when oxidised had a less heat of combustion than carbon, then if what Mr. Mordey had found was really an electrolytic process, it would be possible to obtain electrical energy by the combustion of carbon, an easy method for doing which is the one thing which so many of them had been seeking for a long time. It would mean, therefore, that they would then have an electric cell in which the positive substance would be carbon. He could hardly hope for such an easy solution of the process. The President then described the application of an electric current to overcome the "sickening" of mercury in the extraction of gold. Hydrogen was produced at the surfaces of the mercury which cleaned the mercury and so exposed a fresh surface to the gold. He had made experiments with similar tubes of mercury, and put similar particles of gold on the top, and then sent a current for a certain number of hours through one tube, and no current at all through the other. In the morning, or the day after, he analysed the layers of mercury in each of the two vertical tubes, and in the case of the one without current the mercury at the bottom was pure, and in the one with current the mercury at the bottom contained a good deal of gold, showing that the mere passage of current conveyed gold down to the bottom of the mercury. He described experiments, made with Prof. Perry, to see if it was not possible to produce a voltaic cell—a primary cell—by using this idea of transference of one material through another, so as to produce these effects without any electrolysis at all. That particular cell was a sell in two senses of the word. The observed effects were probably due to difference of temperature. Still, he thought it might be possible to really get E.M.F. without electrolysis, because they certainly seemed to be able to do the converse by means of the current—to pass one substance through another without any electrolysis in the ordinary sense of the word.

Mr. ALEX. SINCLAIR had sent a communication, which was read. He found himself at variance with Mr. Swinburne as to the cost per kilowatt-hour, which he placed so low as 0·25d. Mr. Swinburne assumed generally that one kilowatt was equal to a certain amount of electrolytic work, so it was, but, unfortunately, that kilowatt contained E.M.F., a constantly varying quantity, according to the materials used as electrolyte or electrodes. The electrolytic treatment of zinc suffered very much from insoluble anodes and high power. What was required there was a good anode, homogeneous deposit, and a means to prevent a decomposition of water and consequent loss of power. Under the most favourable circumstances 400 kilowatt-hours are required to deposit one ton of copper, which, taken at ½d. per kilowatt, would be 16s. 8d. Again, the fact of having to roll the copper to a quarter or three-eighths of an inch thick and then cast to shape cost from 15s. to £1 per ton, these items in themselves come to more than the price given; probably some three to four times that figure would be the better value, and even on to that must be added the after treatment of the copper and bullion recovered. Some of the problems required to be overcome were—The production of a really good insoluble anode; the discovery of a good diaphragm, which will stand the test of time; the prevention of the formation of a back E.M.F. when insoluble anodes are used; the prevention of decomposition of water; the production of pure deposits from impure materials; the combinations and effects of such impurities on the resistance of the electrodes; and the means to reduce the resistance of electrolyte so as to minimise the quantity of power required.

* Mr. SWINBURNE, in reply to the discussion, said that Mr. Falkenstein had pointed out in the beginning of his remarks that tan liquor was colloidal, and then he went on to say that the tanning was due to electric

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osmosis. These statements did not seem to agree very well. A colloid could not work by osmosis. He read to the meeting the following estimate of cost of running a plant continuously day and night :—

Output 1,000,000 watts. Engine and dynamo combined efficiency 85%.

Coal, at 2lb. per I.H.P. per hour, at 10s.	£5,850
Oil, waste and sundries	700
Three shifts of engineers at 35s., and two shifts of three stokers at 24s.	657
Interest at 3% and depreciation at 5% on £20,000	1,600
	£8,807

Coming to 0·241d. per kilowatt hour.

He was afraid he did not put the matter clearly enough about the anodes, and thought there had been considerable confusion. An anode in an alkaline solution was one thing and in an acid solution quite another. He thought that Mr. Fitzgerald's experiments of producing hypochlorite by means of lithanode might overcome a difficulty in bleaching liquid, but had no bearing as far as he could see on the manufacture of caustic soda. Mr. Falconer had mentioned that the platinum was attacked when used as a connection to his lithanode. He thought the mere fact of platinum being attacked showed that the anode was trying to give off chlorine and not hypochlorite. He was glad to get some information from Mr. Bevan about the E.M.F. he considered necessary in working chloride solutions. He said 3 volts. Of course, if they used a weak solution their plant account became large ; that is to say, they had very little output for very large vats. Those who had calculated it were probably surprised to find the size of vats necessary to give a ton of caustic per day. Again, if they ran a high current density with high volts, they lost power by losing the E.M.F. of course, and that would tend to disintegrate the anode, so that the whole question became one of compromise. As to the theory of tanning, Mr. Trotter ought to have found fault with the theory he advanced before saying there was not a theory. He would only refer to the President's remark as to the possible use of carbon. If the burning of the carbon in the CO_2 does help the E.M.F., of course they could not make ordinary cells with carbon plates, carbon to zinc, and so on, but they always used carbon on the depolariser side, and not on the other side.

DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The fourth annual dinner of the Institution of Electrical Engineers took place at the Criterion Restaurant, Piccadilly, on Friday evening last, Prof. W. E. Ayrton, the President of the Institution, presiding. Amongst those present were the Right Hon. A. J. Mundella, M.P., President of the Board of Trade ; Sir Courtenay Boyle, K.C.B. ; Mr. Latimer Clark, Mr. W. H. Preece, Major-General C. E. Webber, C.B. ; Prof. W. Crookes, Mr. C. E. Spagnoletti and Prof. D. E. Hughes, Past Presidents ; Dr. William Anderson, F.R.S., President of the Institution of Mechanical Engineers ; Sir James Sivewright, K.C.M.G., Commissioner of Public Works, Cape Colony ; Sir Thomas Blomefield, Bart. ; Prof. G. F. Fitzgerald, F.R.S., President of the Physical Society ; Dr. W. J. Russell, Past President of the Chemical Society ; Sir Robert Rawlinson, K.C.B., Vice-President of the Institution of Civil Engineers ; Prof. James Dewar, of the Royal Institution ; Prof. W. C. Unwin, Dean of the City and Guilds of London Central Institution ; Mr. W. H. M. Christie, Astronomer Royal ; Mr. J. C. Lamb, C.M.G. ; Sir H. Trueman Wood, Secretary of the Society of Arts ; Sir Henry Mance, C.I.E. ; Sir David Salomons, Bart. ; Mr. A. Siemens and Mr. R. E. Crompton, Vice-Presidents of the Institution ; and the following members of the Council : Prof. S. P. Thompson, Prof. J. A. Fleming, Sir Albert J. L. Cappel, K.C.I.E. ; Colonel R. R. Jackson, Mr. Mordey, Mr. Swinburne, and Prof. Perry, and Mr. Webb, secretary.

The toast of "The Queen" having been drunk, the toast of "The Learned Societies," coupled with the name of Prof. Fitzgerald, was proposed by the CHAIRMAN, who said that some difficulty had been felt in the wording of the toast list. It was thought that to have two toasts, "The Learned Societies," "The Engineering Societies," might suggest that the latter were not learned ; but the inference would be entirely wrong. There was no "and" in the matter.

Prof. FITZGERALD, in response, thought that the learned societies were never in a more flourishing condition than they were at present. He was quite sure they felt that they owed much to such electrical engineers as Gilbert, Galvani, Volta, Oersted, Ampère, Gauss, Weber, Faraday, and Maxwell. The co-operation of theory and practice had already produced great results, and he ascribed nearly all the material advances of the nineteenth century to that co-operation. There was plenty of room for further development, however. It had been calculated that the amount of energy received from the sun would be sufficient to supply the energy required by five people living upon every square yard of the earth's surface ; and though such a large population would find it very close quarters he was afraid, they thought that with these enormous stores of energy at their disposal there was a great future for its proper distribution and utilisation. The small advances that had been made hitherto had been effected by the co-operation of a comparatively small section of the community, and they might look to far greater advances in the future when the whole community conspired together to advance the material prospects of mankind to their utmost by the combination of theory with practice.

Mr. LATIMER CLARK (past President) proposed "The Engineering Societies." He thought their importance was liable to be very much under-rated and overlooked. He felt that the engineering societies had a grievance against the politicians. He ascribed the credit for the extreme prosperity of the country to the efforts of the engineers, but politicians seemed to think it was due to political measures. The facilities for communication and transport which had been provided by engineers had made England the richest nation in the world.

Dr. WILLIAM ANDERSON, in responding, referred to the definition of engineering as the art of directing the great sources of power in nature to the use and convenience of man, and said this capacious definition would include every work and every art. In the Government factories of which he was the head, they called upon every art to assist them in preparing munitions of war, and the members of their Institution played a very important part in the preparation of those delicate electrical fuses constituting the apparatus for exploding submarine mines. They were now able, in consequence of the extraordinarily small intervals of time which could now be measured by electrical means, to determine with considerable success the relations between velocity and space in regard to the bore of guns, from which it would be possible to derive velocity curves, and from them the pressure curves, telling them with exactness what took place in the bore of cannon, and this could only be effected by electricians, physicists, and chemists combining together. Then the mechanical engineer came in, and taking the calculations of the mathematician to work upon, evolved ponderous cannon with an exactness that might be fairly expected from mathematical instruments alone.

The CHAIRMAN then proposed "Our Guests," with which he joined the name of Mr. Mundella, President of the Board of Trade, who exercised a sort of parental supervision over the actions of electric lighting engineers. Sometimes, he admitted, there was a little uneasiness and irritability between them, and this year sparks had been seen flying between a town in Essex and Whitehall-place, sparks which the Meteorological Society had put down as unusual electrical disturbances. As those who had taken exception to some of the Board of Trade rules were exactly those with whom electric cooking had found most favour, it might be imagined that the objections were made in order to assert the right of every freeborn Briton to fry himself electrically on the high pressure overhead wires, but he was told that was not really the ground of their contention, but that it was because the "undertakers" had been required to bury their wires. It had been contended that some of the wires were out of town, and must therefore be regarded as non-resident members of the machinery for the distribution of electricity, but to that the Board of Trade replied that only those who were thin-skinned could experience pain at their rules. As a matter of fact, the point could only be felt by those, the thickness of whose electrical epidermis, expressed in inches and fractions of an inch, was less than the number obtained by dividing the pressure to which the Board of Trade had been subjected in volts by ten times the number of the members of their Institution. The question really was as to the relative durability of insulating material and the lasting power of Board of Trade regulations. Whatever might be their feeling about the regulations, however, there was no question as to their regard for the head of the Board of Trade.

Mr. MUNDELLA, in response, said that whatever the grievances of engineers might be against politicians, at least he could say that his withers were unwrung. In the short time during which he was at the Board of Trade in 1886 he had learnt that the Act of 1882 was altogether too restrictive, that it impeded enterprise, and that it had done much to delay the development of electrical engineering in this country. At that time, however, they were not so well prepared for an extension in electrical enterprise, and if it had delayed for a time the development of electric lighting, yet during that time much had been done to perfect their methods and improve their practical experience. As to the grievance referred to by Mr. Clark, he thought if politicians and engineers divided the credit for the prosperity of the country there would be a little more fairness in the appropriation to each of the merit which was their due. They all knew what the country owed to engineering. In a little musuem at South Kensington might be seen one of the most interesting collections in the world, including such curiosities as Watt's steam engine, and Stephenson's Rocket, but it must not be forgotten that it was Sir Robert Peel and the free traders who gave free play to the energies of these men, and if we had now the greatest mercantile marine, and had become the carriers of the world, it was partly owing to that free play. He felt it very difficult to speak on that branch of engineering of which they were the great masters. They were a comparatively young Institution, and for many years, probably centuries, they would continue to grow in importance and power. The Board of Trade owed much to the members of their Institution who had co-operated with them in fixing electrical standards. They had made a report which for ingenuity and ability was one of the most remarkable which the Department had ever had to deal with. This report would have to be embodied in an Order in Council, and submitted to Her Majesty for approval, and if approved would form the standard of electrical measurement for all future time. They owed a great deal to Prof. Helmholtz and the German Government for their co-operation with the English committee, and practically their standards would be the same. He was afraid, however, that he should find a difficulty in lucidly explaining, if called upon in the House of Commons or the Privy Council, what was so

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learnedly set forth in these recommendations. For example, if he were asked about alternating amperes, here was his answer, in one sentence with no punctuation :—"An alternating current of one ampere shall mean a current such that the square root of the time average and the square root of its strength at each instant in amperes is unity." Did anybody doubt it? Any man who called that in question could know nothing at all about the subject. However, they had helped the Board to fix an admirable standard for electric measurement in this country, and which would, he hoped, result in an international agreement upon a common standard. To secure the universality of electric lighting they had to show that they could give the shareholders a reasonable dividend ; when they had done that, there would be no lack of enterprise and no lack of money to carry it on. A marvellous change had been wrought in commerce by the introduction of the electric cable, which to-day equalised prices throughout the world, and they were making great advances in other directions. There was a Royal Commission, on which some of the members of that Institution were sitting to consider the utilisation of electricity for the saving of life at sea by connecting lighthouses and lightships with the electric system on our coasts, and he might congratulate them on the fact that one distinguished member of their body had been that day appointed to serve on that Commission—he referred to Mr. Preece. They might hear occasional grumbles about Board of Trade regulations, but these were only the expression of their desire for safety, and it was a creditable thing that the loss of life in this country in connection with electric lighting since its introduction was exceeded every year in some American towns. They had adopted, he believed, a sound system of regulations, the result of which would be a career of prosperity and success for their enterprise, which neither he nor his colleagues on the Board of Trade had any desire to harass. They would be glad if in the application of electricity, as in every other science, England held her own against the rest of the world.

Sir JAMES SIVEWRIGHT, K.C.M.G., in proposing "The Institution of Electrical Engineers," said they all wished well to the Institution. In South Africa telegraphic engineering, with which he had been connected all his life, was playing a very important part to-day. When Mr. Rhodes returned to South Africa a few years ago with the Royal Charter which had been granted to him by Her Majesty's Government of that day, and when they were considering how, according to the terms of the charter, they might best develop the country, Mr. Rhodes had asked what he thought they should start with. He replied, push a telegraph line right into the heart of the country. The estimated cost was £100,000 ; they had undertaken that work, and were now stretching a line, which would compare favourably with lines in any other part of the world, 1,800 miles into the heart of Africa. They had been studying the navigation of the Zambesi and Shire waters, and had now finally decided to extend that line 300 miles further into the interior, so as to place Mr. H. H. Johnston and others in telegraphic communication with the civilised world. Their efforts in these distant corners of the empire were the fruit of the improvements effected in the means of communication by electrical engineers in this country. He would like to put in a word for the telegraphic engineers—the practical men who were doing this work in South Africa, and it should be remembered that the Institution of Electrical Engineers had its first beginnings in the old Society of the telegraphic engineers. They were very proud of the body to which they belonged, and that body need not be ashamed of the men who were upholding the name of the Institution. Mr. Mundella had said that the electrical engineers, as a body, would increase in importance—it might be for centuries ; he would go further, and say that they would so increase as long as England continued to be England. He was sure there would never be a lack of men connected with the Institution competent to uphold the reputation it had already acquired.

The PRESIDENT briefly responded, and the proceedings then terminated.

GAS-ENGINE EXHAUST.*

BY P. SIMON.

Engines in general and gas engines in particular exhaust in a rather noisy way, and the result is a good deal of bother in the way of complaints from neighbours, legal actions, &c. I undertook a series of investigations into this matter, which I may, perhaps, make public some day. However that may be, it may prove of interest if I now point out a method which I have tried and adopted for the purpose of putting a stop to, or at any rate mitigating, as far as possible, the noise produced.

First of all, I should point out that the noise is of two kinds. There is firstly a blow at every escape, and secondly, a note given out by the escape of the gases under pressure ; a note which is always given out, be the exhaust spasmodic or regular. As a matter of fact the shocks are mitigated by regulating the flow of the gases by means of exhaust chambers, which play the same part as the air chambers of double-acting pumps. Unfortunately, this remedy is limited by the danger of filling large receivers with gases which may have escaped combustion in the cylinder and thus give rise to dangerous explosions. Moreover, this method of regulation involves a back pressure, and it cannot, therefore, be carried far without diminishing the useful effort of the engine. This remedy has, therefore, a limited range of action.

What is wanted is a gradual and insensible diminution of the average velocity of the exhaust gases. The variations of pressure and consequently of volume would thus be rendered very small, and the violence of the blows would be diminished, whilst the exhaust gases having a lower velocity would no longer give a noisy note. A system of very acute angled conical tubes has been tried by myself and others. The insensible increase of cross-section produces a gradual diminution of velocity. Unfortunately, when the diameter approaches a certain value, the velocity of the gases is no longer the same over any given section, owing to the friction of the walls, and the result is a series of whirls which make the tubes quiver, thus producing an effect the reverse of what was intended.

I have substituted for these cones a single straight pipe, split for a distance of about two metres. The opening, very narrow at the bottom, widens out until it attains a width equal to the diameter of the tube. The effect produced is remarkable when it has been possible to give an appropriate width to the cut by trial and error. It is not an easy matter to split a tube in this way by means of ordinary tools, and alterations are a lengthy job. I have considerably simplified matters by giving the tube a long longitudinal saw cut ; the two halves are then drawn apart and kept apart by wedges and rings. The puff of exhaust gas spreads out in a fan, and the passage from the tube to the open air takes place very gradually.

Such is the method, at the same time simple and cheap, which I have employed to my own great satisfaction, and especially to that of my neighbours whose rest was disturbed. Applied to a non-spasmodic escape of steam, this simple split tube has reduced a strident noise to very modest proportions.

* From *L'Électricien*.

BOOKS, &c., RECEIVED.

"Campo Elettrico Rotante e Rotazioni dovute all' isterisi Elettrostatico." By R. Arnó. (Rome : Academia dei Lincei.)

"Proceedings of the Royal Society." Vol. LII., No. 316. (London : Harrison and Sons.)

"Electric Traction on Railways and Tramways." By A. Reckenzaun. Illustrated. (London : Biggs and Co.) 400 pp. Crown 8vo.

"Direct Electric Tramway Traction." (London : F. G. Wynne.)

"First Report of the Bureau of Mines, 1891." Printed by order of the Legislative Assembly of Ontario.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 25th.

PHYSICAL SOCIETY.

5 p.m. Paper to be read :—"Experiments in Electric and Magnetic Fields, Constant and Varying," by E. C. Rimington and E. Wythe Smith.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read :—"The Telephone," by Howard Little.

MONDAY, November 28th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture. I., 2, "The Generation of Light from Coal Gas," by Prof. Vivian B. Lewes.

TUESDAY, November 29th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion :—"The Manufacture of Small Arms," by John Rigby, M.A.

WEDNESDAY, November 30th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read :—"The Copper Resources of the United States," by James Douglas.

OLD STUDENTS' ASSOCIATION.

8 p.m. Meeting at Finsbury Technical College. Presidental Address, "Human Dynamics," by Ll. B. Atkinson.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Conversazione at St. James's Hall Restaurant.

THURSDAY, December 1st.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be discussed :—"Experimental Researches on Alternate Current Transformers," by Dr. J. A. Fleming, F.R.S.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting. Paper to be read :—"On the Formation of Orcinol and other Condensation Products from Dehydracetic Acid," by J. Norman Collie.

FRIDAY, December 2nd.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Ordinary Meeting. Paper to be read :—"Water-tube Steam Boilers," by Harry Fraser.

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The Electrician.

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SCIENCE IN SCHOOLS.

In these days of hurry, competition, and democracy there is little time for culture and little heed for refinement. Men who from their youth are driven into commerce or trade, occasionally snatching an hour or two for exercise of the body and to rest the brain, have no leisure worthy of the name, and it is not surprising that, with the consequent neglect of literature, marked changes are to be found in education. A generation or two ago, a successful cheesemonger would give his son a literary education "to make a gentleman of him," with the idea of giving the lad something which the father did not possess. But now, in the race for that which is called social success, money plays so important a part that it is found Latin and Greek do not work the spell, and these being, therefore, "useless," boys have to be taught something "useful." To supply the want, a modern language or two, a trifle more mathematics, and history in its most dreary form are taught on the "modern" side, together with a smattering of science, and though generally disfavoured by the clerical element which still pervades the better class of English schools, science has made its way. Little or no pretence is made as to its educational value, and it is indeed idle to discuss an ideal system of education when not one parent in five hundred would venture from the conventional path. Whether the teaching of science to boys under eighteen is desirable or no does not concern us at present. It is taught, and will be taught, and it remains for those who are interested in it to justify the practice as well as they can.

The progress made in schools in the teaching of science has been mainly determined by the growing importance of the subject from an industrial point of view. Its advancement

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has been mostly retarded by the system of oral instruction to which school teachers are addicted, and the restriction of it to subjects which have been most important in their own student days. But schools, although naturally very conservative, are keenly sensitive to competition. The newer schools, like the newer universities, have found that to lay stress on the development of a modern side will pay them best, and sooner or later most of the older ones will be compelled to follow their example. The distinct propensity of the time is to specialise, even at school. For many reasons this may be regretted, yet the division of the upper forms into classical, commercial, and scientific classes has been rendered necessary by the increase in the number of subjects of recognised importance, and the excellent excuse is put forward that a boy can spend his time on studies which bring out his brighter faculties, rather than waste a large part of it on comparatively vain efforts in other directions. Were it not for this bias towards specialism it would be impossible, during the brief school hours, to devote more time to science than is needed for the merest smattering of it. No doubt to over-specialise is bad, yet it cannot be worse than the endeavour to acquire a mass of superficial knowledge at a rate which does not admit of a proper expenditure of thought. The hitherto abstruse and mysterious aspect of science has been one of the great obstacles to its introduction into schools. It appeared to stand apart from the feelings and ideas of everyday life. To fit up a physical laboratory with apparatus, purchased entirely from instrument makers, requires more money thay any but an exceptionally endowed school can afford; and the ordinary master, whose training at school and university has been chiefly oral, does not possess the manual skill needed for supplementing a few good instruments with a number of cheap home-made pieces of apparatus. This difficulty is gradually disappearing with the introduction of manual instruction into schools, and with the improvements in the physical laboratories possessed by various colleges. Moreover, the abstract appearance of science is being quite changed owing to the increase in the number of its commercial applications. Of all the sciences, electricity and magnetism are the two which in the popular estimation are most enveloped in mystery, yet so many illustrations of them can now be drawn from everyday experience that the elementary facts of these sciences have no longer the aspect of propositions in Euclid, but are becoming generally familiar as tangible things. With so-called technical education we are not here concerned, we have on several occasions objected to the inclusion of the teaching of a trade under the name of education, whether at Cambridge or at Kensington. In its proper place this secondary education or technical instruction is, of course, invaluable, and an abstract of a very interesting article upon this subject, by Mr. Henry Cunynghame, will be found in another column.

The rate at which the teaching of science is progressing cannot be properly realised unless it is remembered that thirty years ago there was hardly a physical laboratory in the kingdom. Teaching was confined to lectures containing a great deal of mathematics but very little experimenting, and to a course of unintelligent "test-tubing." The teaching of physics was subordinated to that of chemistry, and was in many cases placed in charge of a chemist. In modern days we can boast the possession of many fine laboratories set apart for physical science alone, and in these not the professor only with a few favoured helpers, but the ordinary student also may be now seen at work. The agitation in favour of technical education has in late years caused large sums to be expended on the erection of good laboratories, although we are even now a long way behind the Continent in the provision of space and apparatus for individual work. Schools, such as those at Manchester and Birmingham, have been erected exclusively for the teaching and applications of science; and in America, where the average undergraduate is but slightly older than the boys in the upper forms of English colleges, such schools are common enough. The science examinations at the London University are attended by candidates from all parts of the kingdom, and form a good criterion of the progress of science teaching in this country. We notice that the number of successful candidates at the Intermediate and Degree examinations in science has quadrupled during the last ten years, and that of these candidates one out of every seven was a lady. Physical science cannot indeed claim to be exclusively masculine, and several ladies' colleges could be cited where the provision for science compares very favourably with that found in similar institutions for men. The science examinations just referred to are supplemented with practical tests. The candidates in the Intermediate examination are required to show familiarity with the use of physical apparatus, and in the final examination a more searching test is applied. These practical tests have been instituted only within the last three or four years, and we understand that the average proficiency of the candidates has shown a marked improvement during that space of time. An official announcement of this University has lately been made with reference to the entrance or matriculation examination, to the effect that candidates "will find it an advantage to have obtained some elementary instruction in the practical use of apparatus." This seems to foreshadow that a practical test will eventually be applied even at matriculation. This departure can hardly fail to have influence in improving the science teaching of schools. Every candidate for a degree is obliged to pass the matriculation examination, whether ultimately pursuing science or not, a great number of schools sending up as many candidates as possible for this test, since the passing of the examination is regarded as a certificate of a good school education. These regulations are significant, because such examinations are the standard by which English high schools judge their own efficiency, and in this respect have a more important influence upon the public schools than that exercised by the older universities.

THE GENOA CONTINUOUS CURRENT TRANSMISSION.

Mention has frequently been made in these columns of the 6,000-volt continuous current transmission plant laid down by MM. Cuenod-Sautter, of Geneva, for the purpose of supplying power to the dynamos of the Société Génoise d'Électricité, and to other concerns. The following details, however, from *L'Electricien*, are of interest:—

Power is derived from the Ferrari-Galliera aqueduct at a point some 16 miles from Genoa. Three turbines each drive two separately excited Thury 1,000-volt 45-ampere dynamos; the speed of the turbines and the current of the machines being automatically kept constant. The line, which is of bare wire, is carried on oil insulators, and runs underground on entering the town. The positive lead is protected as it leaves the generating station by an Elihu Thomson electro-magnetic arc-breaking lightning guard. The return lead, on the other hand, was until recently provided merely with an ordinary saw-tooth lightning protector, with the result that the earths on the intermediate stations caused persistent arcs to earth.

At Genoa the current is fed into three Thury motors belt-coupled to a countershaft, from which four low-pressure machines are run. These dynamos supply current to a three-wire 230-volt system. As the low-pressure machines are of the ordinary constant-potential constant-speed type, the con-

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stant-current motors have to be kept running at a rigorously-constant speed whatever the load, and this is effected by an automatic regulator acting on the field excitation of the motors.

The main excitation of the motors is supplied by a large number of series coils in the usual way. The additional excitation required as the motor load is increased is furnished by pairs of coils arranged on diametrically opposite pole-pieces. The + and − ends of these coils are connected to a regulating switch S, as shown in Fig. 1, the main exciting coil being taken

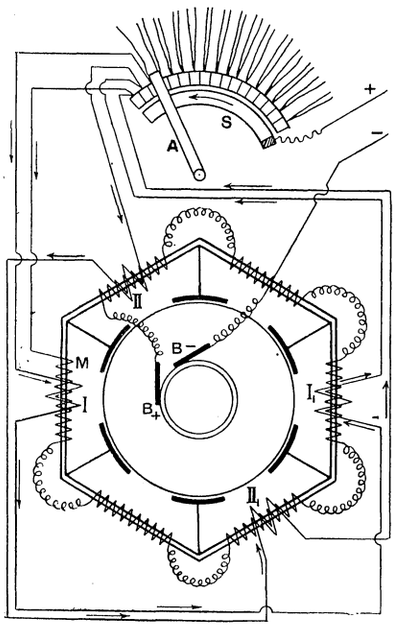


FIG. 1.

to the left-hand segment. The current from the line comes to the strip S, passes across the revolving arm A to the additional excitation coil I, thence to I_1, back to the switch, thence through the additional coils II and II_1, again back to the switch, and thence through the main coils M to the brush B+, through the armature to line by the brush B−. The revolving arm A is rotated by the motions of a centrifugal governor. A toothed disc D (Fig. 2), formed by the juxtaposition of two truncated cones, is placed on the same shaft as the governor balls. Above and below this disc are two mitre wheels, W_1 and W_2, having on their axes the pinions w_1 and w_2, gearing with a toothed wheel, which transmits its motion by an endless screw (not shown) to the revolving arm A.

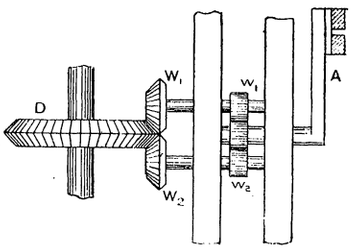


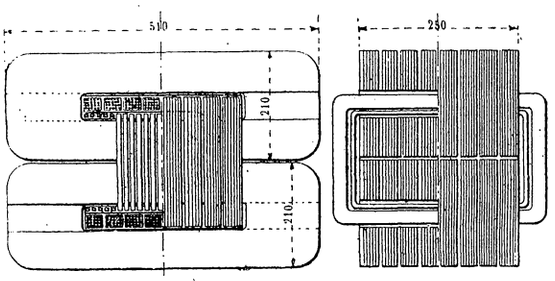
FIG. 2.

When the speed is normal the disc D is in contact neither with W_1 nor with W_2; but as soon as it increases above or falls below the normal, the disc engages with one or the other of the mitre wheels, and the arm A is suitably rotated.

By its agreement with the Société de l'Aqueduc Ferrari-Galliera, the Société Génoise d'Électricité has to pay a fixed charge of 300fr. per horse-power year demanded, so that it is obviously to the advantage of the Electric Light Company both to keep down the maximum amount it has to demand and to make the maximum use of the amount actually demanded. Secondary batteries are, therefore, made considerable use of in Genoa, and in order that the dynamos may be able to supply the mains at the same time as they are charging the cells, the battery voltage of 310 to 320 volts is kept down to the proper amount by a compensating dynamo placed in series, its field being regulated as required. The ordinary regulation of the voltage of the cells is carried out automatically by means of electro-magnetic devices for switching cells in and out.

THE PATIN TRANSFORMER.

The Patin transformer, says M. F. Guilbert in *La Lumière Electrique*, has the shape of a rectangular parallelopiped. The secondary is next the core, the primary, which consists of eight coils, being wound in rectangular tubes of insulating material. The core consists of U-shaped stampings insulated from each other with paper, and arranged side by side in two groups, as shown in the accompanying figure. The stampings are com-



Patin Transformer. End View and Lateral View.

pressed by end plates and bolts, the upper plate carrying the terminals, cut-outs, &c., &c., on a slab of marble. Owing to the manner in which the stampings are arranged there is a sort of thin chimney between the two groups. The primary fuses are long glass tubes with expansions at regular intervals, containing a fuse wire soldered to the terminal metal caps. The tubes are fitted with an ebonite handle in the middle to facilitate their being placed in position. The following data relate respectively to a 4-unit and an 8-unit Patin transformer:—

Primary.			
	4,000 watts.		8,000 watts.
Voltage	2,400	...	2,000
Current	1·7	...	4
Wire (turns and diameter)	1,080 turns 16/10	...	1,540 turns 22/10
Length	885m	...	—
Weight	17·4kg.	...	21kg.
Resistance	7·04ω.	...	—
Volts lost at full load	12	...	—
Secondary.			
Voltage	100	...	110
Current	40	...	72
Wire	45 turns (3 layers) 43/10	...	30 turns (5 layers in parallel) 40/10
Length	42m.	...	—
Weight	16·8kg.	...	15kg.
Resistance	0·046ω	...	—
Volts lost at full load	1·84	...	—
Core Plates.			
Thickness	4/10	...	4/10
Number of plates	564	...	684

TECHNICAL EDUCATION: "WHAT IT IS."*

BY HENRY CUNYNGHAME.

The object of general education is to train up good, wise, and useful men, sound in mind and in body. The object of technical education is to make good industrial workmen.

If we inquire what are the qualities which go to make up a good workman, whether he be the manager of a business, or an operative, we find they may be grouped under two heads—moral and technical. The former are, perhaps, the more important to success. But these do not come within the scope of our present inquiry. The technical qualities are five in number:—(1) Inventive or constructive power. (2) Artistic feeling. (3) Knowledge of the principles of science and art. (4) Knowledge how to apply

* Abstract from "Cassell's New Technical Educator."

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these principles practically. (5) Hand, or manipulative skill. Of these, the first two come mostly by nature, but they can be immensely improved by training. Englishmen possess them both to a remarkable degree, for the people of Great Britian are very inventive, and have naturally considerable artistic gifts, especially in their taste for colour.

If, on the one hand, art and invention are natural gifts, on the other scientific knowledge is the reward of industry. The poet may be born, but the orator is made, and so far as knowledge is concerned, resolute perseverance generally counts for more than the most brilliant gifts. The German nation is an excellent example of this. They have not displayed of late years any very shining ability in art, poetry, literature, or mechanics; and yet by sheer work they have acquired a first-rate place in almost all branches of knowledge and industry.

The use of the knowledge of principles, as compared with the mere routine of the workshop, cannot be overrated. It is this which distinguishes the true mechanic from the mere factory hand. It is this that makes work a pleasure instead of a drudgery, and it is only by knowledge of principles that inventions can be made.

In olden days trades were chiefly in the hands of privileged bodies of men, and the right to practise them could only be obtained after a long and wearisome apprenticeship. The old apprenticeship system has, however, broken down, and there appears little probability of its restoration. The causes of this are partly the spread of trade secrets by means of printing, partly the disorganisation of our social life by means of railways, partly increased facilities for emigration, and partly the introduction of machinery, and the consequent development of the factory system. The result has been bad. In spite of our great improvements in knowledge and invention, the workman has not kept pace with the time. Boys are far too soon liberated from the healthy control of their parents or foremen, and they are far too anxious to earn immediate wages, rather than to look to more distant but higher remuneration.

If this movement continues, the effect will be to drive from England all the trades requiring high knowledge or delicate skill, and to leave us in possession only of those which are conducted by a highly educated body of foremen or engineers, directing labour of a dull and unintelligent order. This would be deeply regrettable, and would also infallibly end in the lowering of wages. It is, therefore, highly necessary, not only for the general prospects of manufacture in Great Britain, but also for the prospects of our workmen, that some effort should be made to replace or supplement the apprenticeship system by means of technical education.

Learning of all kinds may be pursued from one of two motives, either from the pleasure it gives and its ennobling effect, or else as a means of gaining money. In the very materialistic age in which we live, when each successive year shows a decreasing desire for ideals, and an increasing desire of all classes for comforts and luxuries, when philanthropy, legislation, and politics are directed principally to increase our material welfare, when, in fact, the age is almost wholly dominated by epicurean philosophy, it is not to be expected that the working classes will escape these tendencies. On the contrary, materialism is almost the sole end of the socialistic or democratic movements of the day. Hence, then, it will be found in general in technical schools that those branches of study are most pursued which end in improved wages. This, though it may be regrettable, is to a great extent inevitable, and is not nearly as great an evil as at first sight appears. The best commencement for a young workman is a thorough understanding of the principles of his own trade. If ever he is to rise to higher things, it will not be by passing his own trade over, but through it and by means of it. The fortunate man whose lot lies neither in being a mere quill-driver on the one hand, nor a mere factory hand on the other, into whose life a little invention or art can enter, whether it be the laying out of a garden, the decoration of a room, the planning and laying on of gas and water, or any other trade that involves responsibility and thought, is surrounded with the mysteries of nature. They hem him in on all sides, and he can make no one step forward in any detail of his trade without having the opportunity of self-culture.

It remains only to add a few words upon the relation of technical schools to art. The art teaching of this country, which has been established among us for nearly half a century, has upon the whole been productive of great benefit, but our design is still very imperfect. Much—very much has been done in pottery, and much in fabrics and wall papers; a few really beautiful patterns are to be seen in almost every shop; but our silver work, our metal work, and our glass are, as a rule, beneath contempt from an artistic point of view, and our furniture is very poor. An especially hideous description of art seems to pervade all our cast work, whether in iron or brass; knockers, door-knobs, lamps, balustrades, chandeliers, gas brackets, tea and coffee pots, exhibit a wild jumble of Egyptian, Assyrian, Gothic, Greek, or Rococo, put together without taste or judgment. It is perhaps not quite so bad as the terrible specimens of a like nature which come from America, but s hopelessly inferior to similar art in France. The great work of our art classes in technical schools should be to remedy these defects; not to aim at high art as they almost invariably do, but to get out simple household articles of beautiful and ingenious patterns.

In the present days great efforts are being made in England to encourage the formation of technical institutes. Three or four new ones of large size have been established in London, and there are now few large towns which do not contain some kind of technical school. But it is of no use that these schools should be founded if those for whom they are intended do not take advantage of them. It is the duty of parents to see that their sons do so, and it is no less the interest than the duty of the employers to afford facilities to their apprentices to study in the evening. When one reflects how certain and large an increase of wages results from technical study, and how speedily those who pursue it rise in their trades, one can only be astonished at the folly and apathy of those who, for want of a little self-denial, throw away such solid and permanent advantages.

EXPERIMENTAL RESEARCHES ON ALTERNATE-CURRENT TRANSFORMERS.*

BY J. A. FLEMING, M.A., D.SC., F.R.S.

1. So much has been already written on the theory and performance of real and imaginary transformers that some excuse might seem necessary for venturing to add to the literature of the subject; and yet, when we come to review that which is absolutely accepted as settled truth with regard to transformers, we find acknowledged authorities were no long time ago, and perhaps are now, in entire disagreement with each other on matters which seem vital and fundamental. At the time when the investigations described in the following Paper were commenced, the matters in high dispute involved such practical questions as the relative superiority or advantages of open and closed magnetic circuits, the relative magnitude of the core losses at full and at no load, and the most trustworthy experimental methods of determining these transformer losses. During the many months that these experiments have been in progress, important contributions have been made to the solution of these question in Papers by Dr. Hopkinson, Prof. Ayrton, and Dr. Sumpner. Applying their own particular methods, they have reached conclusions on some of these points which it will be seen are similar to those arrived at in the following pages. As my own experiments, which were almost complete before these Papers appeared, have been made with apparatus and instruments obtainable in most electrical workshops, and have not been limited to one or two special transformers, but have been made with stock sizes of many different kinds and types of transformers, it seemed likely that they might have sufficient independent value to justify me in bringing them before you.

These experiments had their origin partly in my own desire for definite and trustworthy facts as to actual transformers in use, and partly arose out of an invitation of Mr. Swinburne to examine his "Hedgehog" transformer, and compare its performance with that of some closed magnetic circuit transformer of equal size. They have, however, gone beyond that last-mentioned aim; and it forms no part of my purpose to draw comparisons between transformers from a commercial point of view, but simply to record facts of observation and leave them to speak for themselves. As a matter of fact, it is a very difficult thing to institute exact comparisons between commercial transformers as made by different makers. In the first place, they take different stock sizes, and they design their instruments for different frequencies. Hence, if we procure stock sizes for experiment, they are not directly comparable. In the second place, if special sizes of equal output are specially made, the maker cannot generally do himself justice unless he has *carte blanche* as to price, and from a commercial point of view price is everything; and, lastly, as such experiments cannot be done all in a minute, but generally take many months to complete, the experimentalist finds himself often, when all is said and done, met by the progressive manufacturer with the placid remark, "Yes, but the transformer you have been testing is our *old* pattern; you have not seen the one we are making now." One of the objects of this investigation was to arrive at some definite certainty on the best practical method of quickly testing transformers in actual use and *in situ*. The particular methods employed by Dr. Hopkinson and Prof. Ayrton and Dr. Sumpner involve the possession of two transformers of equal size. These methods are in principle an extension to transformers of Dr. Hopkinson's method of measuring the efficiency of dynamos, and they are based upon the obviously right method of measuring directly the quantity we desire to know, viz., the power lost in the trans-

* Abstract of a Paper read before the Institution of Electrical Engineers on November 24, 1892.

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former—rather than measuring it as the difference of two very much larger quantities, viz., the power going in, and the power coming out. These methods, as well as others which depend upon the graphic description of the current and electromotive force curves, have the disadvantage that it is often impossible to apply them, because only one transformer is at disposal, or because the observer has not access to the dynamo, and accordingly the first matter which engaged attention was an examination of the degree of accuracy to be reached by the simple direct methods which can be applied under such conditions as can generally be obtained in practice and when using the commercial instruments to be found or obtained in every testing laboratory.

I.—*Methods of Measurement Employed.*

2. In order that an opinion may be formed as to the confidence to be placed in the quantitative experiments described, it may be well to give, in the first place, some details as to the methods adopted for measuring the potential differences, currents, &c., and processes of calibrating the instruments used. These instruments were then employed in measuring the power taken up by transformers with open, or loaded, secondary circuits. As single transformers only of each type were at disposal, we entered on a preliminary investigation on the degree of accuracy to be obtained when using such methods as the three-voltmeter, the three-ammeter, and the two-circuit electro-dynamometer watt-meter of various constructions.

In order to avoid tedious repetitions, it may be observed once for all that when mention is made of "the current," or "the potential difference" of such and such an amount, the *effective* value is meant, or the square root of the mean of the squares of the equidistant instantaneous values, unless otherwise stated. The letters P.D. are used as an abbreviation for *effective* potential difference.

Mr. Swinburne placed at my disposal four of his electrostatic torsional voltmeters, and also two of his dynamometer watt-meters, and there were also at hand a sufficient supply of Kelvin current balances and electrostatic voltmeters and other appliances for the calibration of the above instruments. Since these Swinburne electrostatic voltmeters proved useful in much of the work, it may be advantageous to point out their good and bad points, and also to say how they were improved, calibrated, and used in these experiments. As they have been sufficiently described by their inventor, suffice it to say that they consist of two tiers of semi-cylindrical metal boxes, B (*see* Fig. 1), insulated from each other. A vertical metallic axis carries two semicircular aluminium "needles," set at different levels, so that one is enclosed in the upper pair of boxes and the other in the lower. This needle is strung at the top and bottom by a round phosphor-bronze wire 0·003 or 0·004in. diameter, and the top end of the upper wire is held by a torsion head, T, the indicating needle of which moves over a graduated scale. In most of the experiments these voltmeters were used as idiostatic voltmeters, and the "needle" and one pair of semi-cylinders formed one terminal of the instrument, and the other pair of semi-cylindrical boxes the other terminal. When a definite potential difference is made between the two terminals, the needle is displaced from its normal position, and the semi-circular needles attracted into the semi-cylindrical enclosing boxes, which are at a different potential. The upper torsion head is then turned until the needle comes back to its initial position. This is accurately determined by affixing a mirror to the axis of the electrometer needle. The image of the filament of an incandescent lamp is then thrown on the mirror by a lens, and, after reflection, received on a paper scale about one metre away. By a simple reference point on this scale it is easy to bring back the line of light accurately to its original position. In first working with these instruments we were greatly troubled by electrical discharges passing across from the "needle" to the cylinders and destroying the suspending wire by the resulting current. The simple remedy for this was found in enclosing each semi-circular aluminium disc of the "needle" between two thin sheets of mica which projected slightly over the edge of the sheet of metal. The instrumental utility of the voltmeter was not at all impaired, whilst at the same time discharges between the needle and enclosing boxes were prevented, and much labour thereby saved. The sensitiveness of the voltmeter was such that when used to read an alternating potential of 2,400 volts, a difference of 3 or 4 volts was easily detected, and with sufficiently steady potential there was no difficulty in taking the reading of about this number of volts to one-quarter per cent. accuracy. The great defect of the instrument as it stands is the large moment of inertia of the needle, and this, in the absence of any effective damping arrangement, creates a great waste of time in getting readings.

The instruments were provided with an electro-magnet intended to be used for creating a magnetic damping field. This, however, proved to be ineffective. A far better plan when such a heavy needle is employed is to damp out the oscillations by a suitable mica vane dipping in oil or water.

3. In calibrating these voltmeters, the first step was to prepare a standard inductionless resistance capable of carrying, without sensible heating, a current of at least a quarter of an ampere, and which could be subjected to an alternating pressure of 2,000 to 3,000 volts without risk of short-circuiting. This was formed by winding double silk-covered platinoid wire (No. 36 B.W.G.) round a wooden frame. The wire windings were each kept separate by being wound in serrations, or teeth, cut in the edge of varnished slate slips fixed at the top and bottom of the frame. The frames were about 37in. long and 14in. wide, and the wire made 56 turns round the frame, each turn of wire being separated by about a quarter of an inch from its neighbours. The length of wire on each frame was about 126 yards, measuring some 1,600 ohms. Six of these frames were provided, giving us, therefore, about 9,600 ohms resistance in the form of a wire perfectly insulated in every part and between every turn. This wire was capable of carrying about one-quarter of an ampere without any very sensible heating, and about three-quarters of an ampere without exceeding safe limits. Every part of the wire was accessible, and exposed to the cooling action of the air. The six frames were fastened up to the ceiling of the laboratory and arranged so that the direction of the wire windings was alternately right and left. The resistance of all these coils was measured when at 15°C., and found to be as follows :—

Coil 1	1,607·2	ohms.
„ 2	1,505·5	„
„ 3	1,525·5	„
„ 4	1,649·0	„
„ 5	1,610·1	„
„ 6	1,645·7	„
Total	9,543·0	„

On coil 1 two terminals were placed, one at a distance of 394·7 ohms from the end, and one at a distance of 1212·5 ohms from the end. By taking leading wires from these points it was possible to divide the whole resistance of 9,543 ohms into two sections, having in one case resistances in the ratio of 23·175 to 1, and in the other case a ratio of 6·87 to 1. This divided resistance was a practically

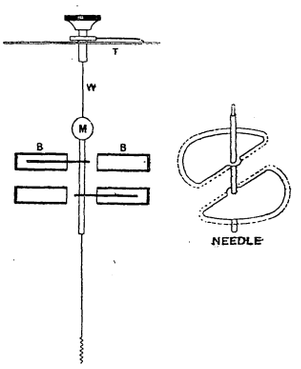

FIG. 1.—Diagram of Swinburne Voltmeter.

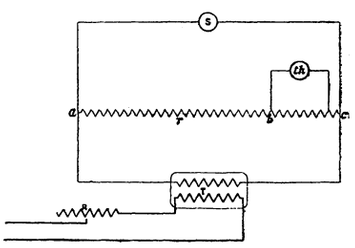

FIG. 2.—Plan of Connections used in Calibrating Swinburne Voltmeters.

non-inductive resistance of about 10,000 ohms, divisible into two sections in the ratio of 23 to 1 or 7 to 1. If a measured alternating pressure of 2,400 volts was applied to the ends of this resistance, the wire came to a steady temperature of about 20°C. to 25°C. above the atmospheric temperature (15°C.), as nearly as could be judged by a thermometer. Taking the coefficient of change of resistance with temperature for platinoid as equal to 0·021 per cent. per degree, it will be found that at 40°C. the whole coil would have a resistance of 9,591 ohms, and hence, if truly non-inductive, the current through the coil would then have a value of 2,400/9,591 ampere = 0·250 ampere. The actual current, carefully measured by a Kelvin deciampere balance, was found to be exactly 0·250 ampere, thus showing that the resistance was, for all practical purposes, non-inductive.

In all subsequent experiments it was therefore taken that when an alternating pressure of 2,400 volts was applied to this resistance, it passed a current of 0·25 ampere and absorbed 600 watts. This resistance will be hereafter called the "No. 1" resistance for reference. By the aid of this divided resistance the Swinburne voltmeters were easily calibrated.

A 24 to 1 transformer, T_1 (*see* Fig. 2), was connected to 100-volt mains through a rheostat R, so as to raise the pressure and enable it to be regulated within limits. The above standard divided resistance was placed across the high-tension terminals, and a Kelvin multicellular electrostatic voltmeter, Th, and a Swinburne electrostatic voltmeter, S, connected respectively to the small section and to the whole length of the resistance, as shown in Fig. 2.

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By taking the readings of the Kelvin electrostatic voltmeter corresponding to various pressures and multiplying these readings by 24·175 we obtained values for the P.D. at the terminals of the Swinburne voltmeter, and hence the true values of the instrumental readings of the last-named instrument. For each Swinburne voltmeter a calibration curve was then prepared in which the horizontal abscissæ were the torsion-head readings, and the corresponding ordinates the true P.D. in volts at the terminals of the instrument. This curve (Fig. 3)* was found to be a very exact parabola. Having proved this to be the case by many experiments for each of the four Swinburne voltmeters, we subsequently adopted for each voltmeter an instrumental constant, the product of which by the square root of the torsion-head reading gave the terminal P.D. on the instrument. These constants were determined for each instrument at the beginning and end of every set of experiments.

In addition to the above standard resistance, another set of six similar coils was provided, each coil of which consisted of No. 32 B.W.G. platinoid wire wound in the same open manner on a frame. Each of these coils had a resistance of about 500 ohms, and each coil could carry comfortably, without any very sensible heating, about half an ampere. These last six coils were specially intended to be used for current measurement, as follows :—The coils were arranged either two, four, or all six in parallel, and the current to be measured passed through them. The P.D. at the ends of the compound resistance was measured by a Kelvin electrostatic voltmeter. The arrangement was standardised as an ampere-meter by passing known currents through the coils, measured by a Kelvin ampere balance, and then observing the P.D. at the ends of the compound resistance. In this way the true resistance of the coils grouped in various ways when carrying currents was found, and at any subsequent time the mere reading of the P.D. at the ends of the resistance gave the current passing through the coils. The reason for employing an electrostatic voltmeter and resistance in this way to measure current was that we thereby obtained an inspectional ampere-meter much more convenient in many experiments than an ampere balance or dynamometer. It will be seen, therefore, that all the measurements were ultimately referred to one Kelvin electrostatic voltmeter and one Kelvin deciampere balance. These instruments were found to agree with one another. Any other instruments, such as Siemens's dynamometers or an Ayrton and Perry twisted strip ammeter, sometimes used, were standardised and referred to the above-mentioned Kelvin balance, which was one specially constructed for alternating-current measurement.

This last-mentioned set of six resistance coils will be hereafter spoken of as the "No. 2" set. We frequently employed the No. 1 and No. 2 resistances in series, giving us a practically non-inductive resistance of about 12,000 ohms. The No. 1 resistance was also employed as an absorber of power. For if the six coils, each of about 1,600 ohms, were arranged three in parallel and two in series, we obtained an effective resistance of about 1,100 ohms, and this, when placed across a 2,400-volt circuit, passed a total current of rather more than 2 amperes, and absorbed about 5,000 watts. We found it very convenient to employ this resistance in this manner as a standard non-inductive power-absorber for obtaining the constant of various forms of wattmeter. Although using the No. 1 resistance in this way to absorb nearly 7-H.P., the current passing in each single wire was not more than two-thirds of an ampere, or well within the safe limits.

II —*Experiments with the Three-Voltmeter Method of Measuring Alternating-Current Power.*

5. Having the necessary instruments all calibrated and compared, a series of experiments was made with three or four of the Swinburne voltmeters, using them in accordance with the well-known method, for measuring the power taken up in transformers on open secondary circuit.

Two 5 H.P. transformers were arranged with low-tension coils in parallel on a 100-volt circuit, and high-tension coils (2,400 volts) in series (*see* Fig. 4). The current through the low-pressure coils could be varied by a rheostat, *f*, and hence the P.D. at the high-tension terminals of the transformers given any desired value from 2,400 volts downwards.

In the diagram (Fig. 4) T is a transformer in which the power taken up is to be measured; T_1 and T_2 are the 5-H.P. pressure transformers just mentioned. The torsion voltmeters. V_1, V_2, V_3, were arranged as shown; V_1 being across the terminals of the transformer to be measured, V_2 being across a non-inductive resistance, *r*, put in series with the primary coil of the transformer T, and V_3 used to measure the total P.D. between the outside terminals of the two pressure-producing transformers, T_1 and T_2. Since T_1 and T_2 were identical transformers, it was generally quite sufficient to measure the P.D. between the terminals of one transformer, T_1 or T_2, and to take double this P.D. as the value of V_3, except in cases where the total P.D. exceeded the limits of safety for one voltmeter, and then two voltmeters were used, one across the terminals of each transformer. Under these circumstances, as is well known, the power, W, taken up in the transformer, T, under test is given by the formula,

$$W = \frac{1}{2r_1}\left\{V_3^2 - V_2^2 - V_1^2\right\}.$$

In applying this method we had several difficulties to overcome before we could get any satisfactory results. In the first place, the transformer to be tested must have the potential difference, V_1, between its primary terminals always exactly maintained at the normal pressure, which, in all our experiments, was 2,400 volts. In the second place, the potential difference V_2 must always be made as nearly equal to V_1 as possible, in order to obtain the condition of greatest probable accuracy of measurement—that is, to obtain the condition in which given small percentages of error in the several voltmeter readings produce the minimum percentage error in the calculated power. In the third place, the resistance r_1 must be practically non-inductive, and must be capable of being varied in amount as required to fulfil the condition of making V_2 equal to V_1. We met these conditions in the following manner :—In cases in which the transformer T was not loaded on the secondary circuit, and in which, therefore, the current flowing through its primary circuit was not greater than could be comfortably carried by the No. 1 10,000-ohm standard resistance, we employed that resistance, arranging all six coils in series. In series with this we placed some or all of the coils of the second resistance, arranged in series or in parallel, and we placed a Kelvin voltmeter to read the fall in volts down one of these last coils. In other cases, when the transformer T was loaded up on its secondary circuit, and when, therefore, a larger current was flowing through its primary circuit, we employed a series of 24 50-c.p. 100-volt incandescent lamps, or several series of lamps in parallel, adjusted as required to obtain the requisite resistance. When these lamp resistances were used, the second (No. 2) set of resistance coils, arranged with 2, 4, or 6 in parallel, as necessary, were placed in series with the lamps. By measuring the fall in volts down this known wire resistance by a Kelvin electrostatic voltmeter, *th*, and the fall in volts over the lamps and resistance taken together by means of one of the Swinburne voltmeters, V_2, we were able to determine at any instant the value in ohms of this non-inductive resistance from the readings of two electrostatic voltmeters and the known value of the wire resistance across the terminals of the Kelvin voltmeter.

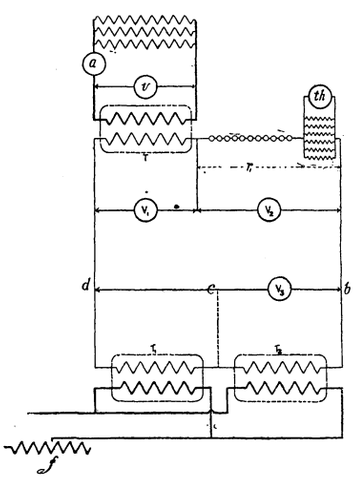

FIG. 4.—Plan of Connections for Three-Voltmeter Method.

The process of getting a reading was this : The resistance r_1 was varied suitably until the value of the P.D. V_1 was as nearly as possible equal to the value of the P.D. V_2. The feeding transformers T_1 and T_2 had a rheostat in their common low-pressure circuit, which was then varied until the P.D. V_1 came to the value 2,400 volts, and it was constantly maintained at that value. The reading of the other two voltmeters was then noted, as well as that of the Kelvin voltmeter Th. If we call A the ampere value of the current flowing through the primary coil of the transformer T, and, therefore, also that through the resistance *r*, it is obvious that the value of *r* is determined at once from the value of the P.D. V_3 and the value of the current A. A is, of course, known by the previous calibratiou of the Kelvin voltmeter and associated resistance as a non-inductive ampere-meter. Hence, if V_1 is constantly maintained at the value 2,400 volts, we see that the power W, taken up in the transformer, is given by the formula,

$$W = \frac{A}{2V_2}\left\{V_3^2 - (2{,}400)^2 - V_2^2\right\}.$$

If it had been possible to make V_2 also always exactly 2,400 volts, the formula would have been still more simplified.

* *See* original Paper.

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It will be observed that we used a row or rows of 24, or less, 50-c.p. incandescent lamps as our non-inductive resistance, and determined the actual resistance at any instant by observing the terminal P.D. of the row of lamps, and the current flowing through them as measured by the fall in volts down a small known non-inductive resistance placed in series with them. We found this to be a better method than using any form of ammeter in series with the lamps—firstly, because we were more sure of not introducing prejudicial inductance into the lamp circuit; and, secondly, because we found we could obtain greater accuracy in the measurement of the current than by any other ammeter suitable for the purpose. The justification for using such a row of lamps as a practically non-inductive resistance is that if an incandescent lamp is placed in series with a dynamometer suitable for measuring both alternating and continuous currents, and if the terminal P.D. on the lamp is adjusted, say, to 100 volts as measured by an electrostatic voltmeter, no sensible difference can be found in the current as measured by the dynamometer, whether that current is alternating or continuous.

It will be seen that when the transformer under test is loaded on its secondary circuit, in addition to the ammeter and voltmeter measurements necessary to estimate the secondary load, we have four, and sometimes five, other voltmeter measurements to make simultaneously in order to get one observation of the power absorbed in the transformer. In dealing with the mere theory of an experimental method, nothing is easier than to say "Let V be a constant P.D."; but in actual practice, and when working off the mains of existing public electric supply companies, this ideal condition is very difficult to realise, and the observers have their patience strained often almost up to the safe working limits to obtain any results worth having at all. We found that the multiplicity of readings to take simultaneously constituted a very great drawback to the utility of this voltmeter method. Having the apparatus, however, set up, and the instruments all calibrated, the method was applied to measure the power absorbed in a number of transformers with open secondary circuits, and in one or two cases the power taken up in the transformer corresponding to various secondary loads was also taken.

6. The results of some of these observations are given in the fourth column of Table I., in which the determinations of the power-absorption of various transformers at no load obtained by different methods are collected. In this table the first column gives the maximum output in watts of the transformer; the second gives the "magnetising current," or primary current, at no load; the third the primary volts, or P.D. at the primary terminals; the fourth, fifth, sixth, and seventh columns give various power determinations; the eighth gives the "apparent watts" absorbed at no load, or the numerical product of magnetising current and primary volts; and the ninth column gives a number which it is convenient to call the *power-factor* of the transformer at no load—it is the ratio of the *true* to the *apparent* watts. If the currents and pressures were simple sine functions, then the power-factor in that case would be the cosine of the angle of lag of primary current behind the primary terminal potential difference.

In criticising these results, it must be borne in mind that several of the transformers were intended to be used at a frequency of 100, and not at 83, and that therefore comparisons between the resulting numbers are not to be instituted without regard to this circumstance. As an example of a series of voltmeter tests, the details of the observations on a series of transformers at no secondary load are given in full in Table II. of the Paper.

7. The application of the three-voltmeter method to closed magnetic circuit transformers, or transformers with large power-factors at no load, showed that it was possible with care to obtain very fairly good power determinations agreeing well with one another; although the number of instruments to be read rendered it exceedingly difficult, unless the pressure was absolutely steady, to get the benefit of the full possible individual accuracy of each instrument. The moment, however, that we turned attention to transformers with small power-factor, such, for instance, as the Swinburne "Hedgehog," the difficulty of obtaining very consistent results was considerably increased. The reason for this is fully explained in a Paper by Prof. Ayrton and Dr. Sumpner, "On the Measurement of the Power given by any Electric Current to any Circuit" (*Proc.* Roy. Soc., London, Vol. XLIX., p. 434, 1891).

Assuming currents and potentials to vary harmonically, they show that if the same percentage error, e, is made in reading each voltmeter, the percentage error in the calculated power will be

$$\sqrt{\frac{2+4(1+\cos\phi)^2}{\mathrm{Cos}^2\,\phi}}$$

times e, where cos ϕ may be approximately taken to be the same quantity as that which we have above called the *power-factor*. Hence, if $e=1$ and cos $\phi=0{\cdot}75$, the multiplier is found to be 5; but if $e=1$ and cos $\phi=0{\cdot}06$, then the multiplier is 40. In other words, a uniform error of 1 per cent. in the voltmeter readings makes only 5 per cent. error in the power when operating on a closed-circuit transformer; but a 1 per cent. voltmeter error means a 40 per cent. error in the power when testing a "Hedgehog." Hence, unless the very greatest constancy in the alternating pressure can be obtained, the three-voltmeter method will not give good results when applied to an open magnetic circuit transformer. In order to show the extent of variation of the power determinations from the mean value, when applying the three-voltmeter method to a "Hedgehog" transformer on open secondary circuit, the individual values obtained on different occasions are grouped together in Tables III. and IV.

Power in watts absorbed by Swinburne "Hedgehog" transformer (3,000-watt) at no load. Taken by the three-voltmeter method. R=3,297 ohms; power-factor, 0·088; apparent watts taken up at no load, 1,752.

Third Set. Frequency = 83·2 ∿; magnetising current, 0·765 ampere.

Voltmeter Readings.			Power absorbed in watts.		R.
V_1.	V_2.	V_3.			
2,400	2,342	3,436	90	Mean value = 85	3,069 ohms.
2,400	2,372	3,447	80		3,080 ,,
2,400	2,372	3,472	87		3,069 ,,
2,400	2,361	3,441	82		3,078 ,,
2,400	2,354	3,441	87		3,069 ,,

Table I.—*Power absorbed by various Transformers with Open Secondary Circuits at a Frequency of 83 ∿.*

Transformer.	Maximum output in watts from secondary.	Magnetising current in amperes.	Primary volts.	Power in watts absorbed at no load.					Power-factor, $\frac{W}{W'}$.
				By voltmeter method.	By ammeter method.	By dynamometer wattmeter, W.	By Swinburne wattmeter.	Apparent power, W'.	
	1	2	3	4	5	6	7	8	9
Ferranti (1885 pattern)	1,875	0·18	2,416	288	—	—	—	432	0·66
,, (1885 pattern)	3,750	0·337	2,400	540	580	549	511	808	0·68
,, (1885 pattern)	7,500	0·25	2,435	444	—	—	—	600	0·74
,, (1885 pattern)	11,250	0·34	2,447	578	—	—	—	816	0·70
,, (1885 pattern)	15,000	0·57	2,389	1,019	—	—	—	1,368	0·75
,, (1885 pattern, rewound)	3,750	0·11	2,400	--	—	233	220	264	0·88
,, (1892 pattern)	7,500	0·075	2,400	—	—	138	—	180	0·77
,, (1892 pattern)	11,250	0·076	2,400	—	—	148	116	182	0·81
,, (1892 pattern)	15,000	0·112	2,400	—	—	228	195	269	0·85
,, (1892 pattern, rewound)	11,250	0·103	2,400	—	—	228	—	247	0·92
Swinburne "Hedgehog"	3,000	0·74	2,400	112	111	112	74	1,775	0·063
Westinghouse	6,500	0·05	2,400	93·5	97	95	95	120	0·79
Morley-Brush*	6,000	0·076	2,400	126	—	140	106	182	0·77
,,	750	0·0317	2,392	61·5	—	—	—	76	0·81
Thomson-Houston	4,500	0·083	2,400	—	—	108	83	199	0·54
Kapp	4,000	0·145	2,400	—	—	152	112	348	0·61

* The power determination by the three-voltmeter method, viz., 126 watts, was made on one transformer, No. 1,952. The power determination by the dynamometer, viz., 140 watts, is the mean of four values obtained on another transformer, No. 1,868, one value of which is also 126 watts.

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In the first set of observations (Table III.) R was kept constant and the values of V_1 varied slightly; in the second and third set (Table IV.) V_1 was kept absolutely constant, and R was adjusted to make this the case. In the third set the conditions for greatest accuracy were best obtained, V_1 being kept constant, and V_2 made as nearly as possible equal to V_1 by varying R as required. The mean value of the power absorbed by the open-circuit "Hedgehog" in these experiments was respectively 155, 101, and 85 watts at no load. The mean of the means is 114 watts. The mean of all the 30 determinations made with the three-voltmeter method is 112 watts. This is, therefore, the mean result for the power in watts absorbed by the 3,000-watt "Hedgehog" transformer on open secondary circuit when worked at a frequency between 83 and 88. The greatest value of the watts is 171, and the least 64; and the greatest deviation from the mean is 49 watts, or, roughly, 50 per cent. The transformer was marked by the maker to be worked at 100 periods per second. We used it at 83 to 88. It appears, therefore, that, owing to the low power-factor of this transformer, it is a bad subject for the three-voltmeter method, and that even with the greatest precautions considerable deviations from the mean may occur in making a series of power measurements in its case. Nevertheless, it will be shown later on that there is reason to believe that the mean value so obtained of the power absorbed at no load, viz., 112 watts, is not far wrong.

8. As regards the three-voltmeter method itself, considered as a practical method of measuring alternating-current power, the following conclusions were impressed upon us:—(1) It is only applicable in cases when a very steady alternating pressure can be obtained of the requisite amount, and it is therefore unsuitable in general for working as a workshop method, or off commercial alternating circuits. (2) Owing to the number of instruments to read, it is difficult to carry it out as a practically useful method without the assistance of several observers. (3) It is especially difficult, if not impossible, to get good results with it when applying it to test transformers of open magnetic circuit type, and having, therefore, a small power factor. (4) Unless all the conditions for maximum accuracy can be secured, owing to the nature of the formula for the calculation of the power, the results will not be very trustworthy.

9. In applying the method to measure the power taken up in the primary circuit of a transformer when the secondary circuit is loaded up, the non-inductive resistance R must be capable of passing the full primary current required, and yet be capable of being so adjusted that at each stage of the load the fall of volts, V_2, down this resistance, is approximately equal to the pressure, V_1, on the terminals of the primary of the transformer being tested. It is essential that this last condition shall hold good, or else we do not obtain the same probability of accuracy in the calculated value of the power given to the primary circuit at all loads. It was found, therefore, that the most convenient arrangement to employ for the non-inductive resistance was one or more parallel series of incandescence lamps. We employed one series of 24 50-c.p. 100-volt lamps, and two series of 24 16-c.p. 100-volt lamps, the three series being arranged in parallel when required, and any required number out of the 24 lamps in each series taken. In order to measure the resistance at any instant of this bank of lamps, the second set of six non-inductive resistance coils was arranged in series with the lamps, and the drop in volts down this known resistance measured with the Kelvin electrostatic voltmeter. This gave us the current flowing through the lamps, and the Swinburne voltmeter gave us the P.D. over lamps and resistance. Hence, knowing the terminal P.D. and the current, we have the value of the non-inductive resistance r_1 at any instant given by the inspection of two voltmeters. In making the full test at all loads of a transformer by this method, the power given out from the transformer was taken up on a bank of incandescent lamps, and the current and terminal volts measured by a Kelvin balance and Kelvin multicellular electrostatic voltmeter. The results of a double series of observations on a Ferranti 5-H.P. 1885 (old form) transformer, and those on a Swinburne 3,000-watt "Hedgehog," are tabulated in Tables V., VI., VII., and VIII.

In these tables the first three columns give the volts, current, and watts output, W_2, of the secondary circuit; the fourth column gives the primary current; the fifth, the value of the inductionless resistance in series with the primary; the sixth, seventh, and eighth columns give the values of the voltameter readings, V_1, V_2, and V_3; the column headed W_1 is the calculated value of the power given to the primary circuit; the last two columns give the value of $W_1 - W_2$, or the total power in watts absorbed in the transformer, and the ratio W_2/W_1, or the efficiency, expressed as a percentage. The values of $W_1 - W_2$ are the total power in watts dissipated in the transformer, partly as copper frictional losses (C^2R losses), partly as iron losses (eddy-current and hysteresis), and in any other way, such as eddy currents in the copper circuits by which internal work is being expended.

Table V.—Ferranti Transformer (1885 *pattern*).—No. 747. Power=5-H.P. Secondary volts=100. Frequency used, 81·7 periods per second. Average final temperature of transformer, 212°F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=12·50 ohms at 212°F. Secondary circuit resistance=0·0252 ohm at 212°F.

[Table V. shows that the primary amperes rose from 0·336 to 1·516. The secondary amperes rose from 0 to 30·07, the secondary volts fell from 100·4 to 99·2. The total power taken up in the transformer rose from 516 to 571 watts.]

Table VI.—Ferranti Transformer (1885 *pattern*).—No. 747. Power=5-H.P. Secondary volts=100. Frequency used, 84·8 periods per second. Average final temperature of transformer, 212°F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=12-50 ohms at 212°F. Secondary circuit resistance=0·0252 ohm at 212°F.

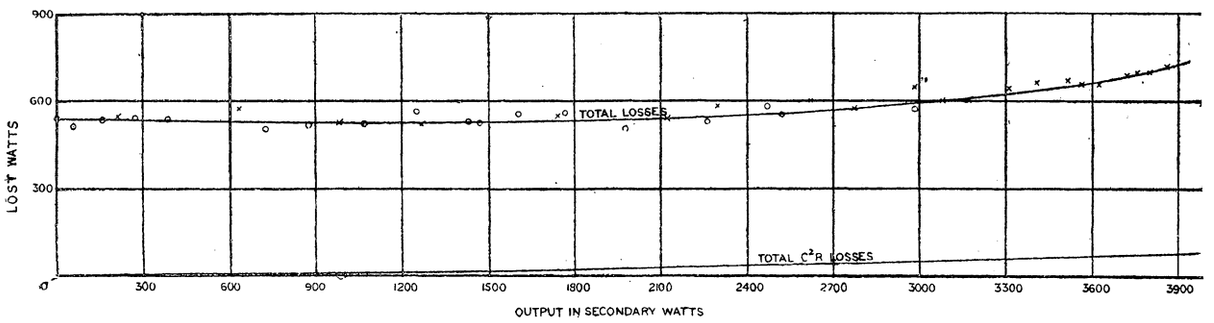

FIG. 5.—5-H.P. (1885 Pattern) Ferranti Transformer. Losses by Three-Voltmeter Method.

[Table VI. shows that the primary amperes rose from 0·329 to 1·9. The secondary amperes rose from 0 to 39·19, the secondary volts fell from 100·9 to 98·5. The total power taken up in the transformer rose from 509 to 720.]

Table VII.—Swinburne "Hedgehog" Transformer.—No. 342. Power=3,000 watts. Secondary volts=100. Frequency used, 83·7 periods per second. Average final temperature of transformer, 147°F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=24·00 ohms at 145°F. Secondary circuit resistance=0·051 ohm at 145°F.

[Table VII. shows that the primary current rose from 0·738 to 1·578. The secondary amperes rose from 0 to 30·1, and the secondary volts fell from 102 to 99. The total power taken up in the transformer varied between 81 and 209.]

Table VIII.—Swinburne "Hedgehog" Transformer.—No. 342. Power=3,000 watts. Secondary volts=100. Frequency used, 82·3 periods per second. Average final temperature of transformer, 145°F.

[Table VIII. shows that the primary amperes rose from 0·76 to 1·566. The secondary amperes rose from 0 to 29·93, and the secondary volts fell from 102·1 to 98·8. The total power taken up in the transformer varied between 0 and 237.]

In Fig. 5 is shown a curve representing the values of $W_1 - W_2$ for the Ferranti 5-H.P. transformer, taken from the results in Tables V. and VI. The secondary output of the transformer in watts is set off on the horizontal line, and the vertical ordinates of the upper curve are the corresponding values of the "total lost watts," or total power losses in the transformer at these various loads. The lower curve is the curve of total copper (C^2R) losses, taking both primary and secondary together. The difference between the ordinates of the upper and lower curves represents the power lost in the transformer in iron losses and eddy-current

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copper losses, if any. It is seen that the upper curve keeps roughly parallel to the lower curve, and that, therefore, as far as these observations go, there is no indication that the core losses get less as the output increases; on the other hand, they seem to get slightly greater. It is much more convenient and instructive to plot out in this way a "total loss curve" for the transformer than to plot an efficiency curve, for if an accompanying $C^2 R$ curve is drawn it shows us at once what is the magnitude of the total eddy-current and hysteresis losses to be accounted for. The values of $W_1 - W_2$ for the Swinburne "Hedgehog" given in Tables VII. and VIII. are found, when plotted, to lie so irregularly that an exact determination of the total loss curve by these tables is impossible. The power-factor of the "Hedgehog," even at full load, is still small, and we were not satisfied with the general nature of the results given at all loads by the three-voltmeter method for this transformer. In the case of the Ferranti 5-H.P. transformer (1885 type), the determinations of the power taken up at no secondary load were fairly consistent. The mean value is 520 watts. The mean of all, corresponding to a frequency of about 83, is probably close to 540 watts, as given in Table I.

(To be continued.)

ELECTRIC MOTORS IN FACTORIES.*

BY R. H. HOUSMAN.

The problem of obtaining the power for driving machinery at the least possible cost is one which meets with solutions varying with the circumstances of each particular case and the taste of each particular engineer.

The case most favourable to economy may be typified a Lancashire cotton mill, in which the whole work is concentrated in a single building, and the demand for power being nearly constant it is supplied by a single large engine working under the most efficient conditions, and distributed to the machinery by gearing, ropes and belts, with a minimum of loss on the way. It seems hardly possible to improve on such a system as this except in detail. Directly, however, these ideal conditions are departed from by distributing the work amongst a number of buildings there is a considerable choice of methods for distributing the necessary power. In certain cases the buildings may all be connected by rope or other gearing, and so be driven from a single engine, but in many cases this is impracticable. It then becomes necessary to have a separate engine in each building supplied with steam, either from a central battery of boilers or each from its own boiler, and here the loss of economy begins.

When steam has to be carried considerable distances, however carefully the pipes may be lagged, not only is there the direct loss due to condensation, but also a further loss from the decrease of efficiency of the engine induced by the supply of wet steam, which loss may reach 20 per cent. or so. On the other hand, where each engine has its own boiler, the efficiency of labour is much reduced by the employment of a separate stoker, whose time is only partly occupied.

There is a further loss due to variation of demand for power, causing the engine to be alternately over and underloaded, and the chance of this increases as the building becomes smaller.

Added to all this is the comparative inefficiency of smaller engines, which are most likely to be worked non-condensing when scattered about promiscuously. Under these unfavourable conditions the cost of power may be many times greater than in the first case.

Electric Plant.

We will now consider what degree of economy is attainable when one or more large engines are used to drive dynamos generating the current which is distributed by copper conductors to motors which supply the necessary motive power. It is evident at first sight that the combination of a dynamo, a conductor, and a motor is rather an expensive form of coupling, which would not be employed in a cotton mill to take the place of ropes or gearing except by a most enthusiastic student of electrical engineering. It is, however, the peculiar advantage of the electrical system of distribution that it makes very little difference to the cost of power whether the work is all concentrated in a single building or scatterred over an area of several acres, so that it is possible under the most unfavourable conditions to keep the cost of power delivered to the machinery within measurable distance of the corresponding cost in a cotton mill.

In order to approach as nearly as possible to this high standard of efficiency, the condition of the working of a large mill engine must be applied to the generating plant as closely as possible. The most essential points are:—

1. Concentration at a single centre, so as to economise the labour of attendance and stoking as much as possible. It may be taken that in a properly designed generating station not more than one attendant to each thousand horse-power is required, since the main point is vigilance to detect incipient trouble, and it is difficult to find the men work enough to keep them on the alert. At the same time, the machines must not be so crowded together as to obstruct free passage or free view from one to the other. Where belt-driven machines are used the engines and dynamos should be kept on different sides of the station, and not mixed up together. In most cases, however, direct-driven dynamos are far preferable.

2. Working of the plant at or near its full capacity. It is on this account generally necessary to abandon the ideal simplicity of one large engine and one large dynamo, since the amount of power required may vary from time to time with the state of trade, &c. It is not, however, necessary to subdivide to the same extent as in an electric lighting station, and if the total power is divided among three or four equal-sized sets it will in general enable the load to be kept within the economical limits. The effect which partial loading has on efficiency will be noticed later on.

Variation of Load.

Since the efficiency of the system depends to a great extent on keeping the plant fully loaded, it is necessary to consider within what limits the load may from time to time vary.

In the case of a shop containing a large number of machines, such as lathes, for example, the power required will only vary slightly from minute to minute, since the number doing actual work at any moment is on the average nearly constant.

The ratio of the maximum demand for power, and that required to run the machines light, depends a great deal on how hard you can persuade the men to work. There is a notable difference when they are on piece-work or some profit-sharing system, instead of being employed by the hour. Under favourable circumstances the useful work may reach 70 per cent. of the whole, but it is often much less. It may therefore be taken that for work of this kind the ratio of maximum to minimum load will not exceed 3 to 1.

Sudden Variations.

There is quite another class of work represented by such operations as rolling, tube-drawing, lead-squirting, &c., in which the fluctuations of load are very violent, and the ratio of maximum to minimum may be as high as 20 to 1.

In cases where the maxima are of short duration (not exceeding half a minute or so) the excessive demand may be supplied by a fly-wheel of suitable capacity, without any great variation in the current supplied to the motor, which should be designed to slow down about 30 per cent. between no load and full load, so as to allow 50 per cent. of the energy stored in the fly-wheel to be utilised. In this way, during the intervals between the heavy loads, the motor is profitably occupied in increases to speed of the fly-wheel up to a certain limit that it cannot pass, and thus, on the average, works under fairly economical conditions.

When the maximum demand for power is of greater duration than about half a minute, it is no longer practicable to depend on fly-wheel storage, and the motor must be capable of meeting the heaviest of the load without injury. In this case, the full variation of load falls upon the generating plant, but is only troublesome when the latter is working close to its maximum output, or when the variation is a large fraction of the whole load. Under either of these circumstances ample fly-wheel capacity on the engine is of great assistance; but it must very much exceed the usual allowance to be of any use. If the mean velocity of the rim is 100ft. per second, each hundredweight of metal in it only stores about $\frac{1}{2}$ H.P. min. (17,000ft.), and as the speed should not vary more than 5 per cent, only 10 per cent. of this energy is available; thus each ton can supply 1 H.P. min. without exceeding the given variation of speed.

A more perfect but less simple way of dealing with sudden variations of load is by using a battery of secondary cells in parallel with the generating dynamos, so as to supply current as soon as the volts fall a little below the normal. The main objection to this is the trouble and expense that at present hang round a battery; perhaps some day this objection will vanish.

Efficiency of Engines.

It is now generally realised that overloading an engine is much less prejudicial to its economy than underloading it. It was once thought that automatic expansion secured economy for small loads; the fact is, however, that at a certain point initial condensation counterbalances the gain due to increased expansion, and the writer often proved by experiment that large compound-condensing engines take at least 20 per cent. more steam when running light with instantaneous cut-off than with moderate expansion and low steam chest pressure, and this is independent of the increase of

* Paper read before the Mason College Engineering Society.

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indicated horse-power due to high initial stresses and of the superheating due to throttling. In fact, automatic gear is valuable, chiefly because it allows the *overloading* of an engine at times of excessive demand—that is to say, for increase of output rather than of economy.

Efficiency of Motors.

It is now necessary to consider the efficiency of motors when fully and partially loaded. Taking the case of a shunt-wound motor of most approved design, giving 40 B.H.P. at 600 revolutions, the various losses in it are as follows :—

Magnet excitation	1·5%	of full load
Hysteresis and Foucault current	2·5%	„ „
Sum of constant loss	4 %	„ „
Loss in armature full load	2 %	
Total loss at full load	6 %	

or commercial efficiency = 94% at full load.

At half load constant losses	= 8 %	of half load
Armature loss at half load	= 1 %	
Total loss at half load	= 9 %	

Commercial efficiency = 91% at half load.

At quarter load constant losses	= 16 %	of quarter load
Armature loss	= ½%	
Total loss at quarter load	= 16½%	

Commercial efficiency = 83½% at quarter load. At no load the waste is only 4% of full output.

These figures, though higher than those usually attained, are quite practicable. The efficiency of smaller motors is lower and of larger ones slightly higher than the above. It may therefore be taken that 90 per cent. efficiency is easily realised under working conditions, provided that the motors are of fair size.

Willans' Experiments.

Without attempting to go over the whole ground covered by Papers which every engineer should study in the original, the results which bear most on the subject of the present Paper are that a good non-condensing engine consumes about one-third of the steam when running light as when loaded to a mean effective pressure of 45lb. per square inch, that for a given ratio of expansion each additional horse-power coils the same amount of steam. If the same engine is used, condensing the consumption at no load is reduced to about one-half, but each additional horse-power still coils the same amount as when non-condensing. Thus, the chief gain in condensing is for small loads, though it is still 15 to 20 per cent. at full load. The figures given are for high-speed Willans' engines, in which the cylinder condensation is comparatively small, but the same general law applies in all cases.

In some experiments made by the writer on a 200 H.P. compound-condensing engine of usual type, running about 800 revolutions, the consumption when running light was fully one-fourth of that at full load ; but each additional horse-power cost the same amount of steam when the cut-off was kept constant and the pressure varied by throttling, which in this particular proved to be the most economical form of governing, since the latest cut-off obtainable (about one-third in high-pressure cylinders) was the most economical for all loads. The writer has also found the same law to apply to an Otto gas engine, the consumption when running light being about one-fifth of the maximum, and the B.H.P. can be accurately measured by counting the explosions per minute and subtracting the number required to run light.

Efficiency of Generating Plant.

As the advantages of direct driving of the dynamos are so great as to practically exclude any other method where space is of any value, and as it is only with this class of plant that any accurate systematic tests are made, the figures obtained in every-day trials of Willan's engines combined with dynamos of various types may be taken as a standard. According to these, with engines of 100 H.P. and upwards, 15lb. of steam per 1 H.P. at full load, with 150lb. pressure, and condensing is easily obtained. At full load about 85 per cent. of the 1 H.P. appears as E.H.P., and at half load 75 per cent. ; under working conditions 80 per cent. may be taken as a fair average ; of this a certain amount is lost in the conductors connecting dynamos and motors, and there is a further loss in retransformation in the motors ; but unless the distance to which the current is conveyed is great, or the motors are of small size, this loss should not exceed 12 per cent. Thus, about 70 per cent. of the original H.P. appears as B.H.P. on the motor shafts ; this represents a cost of between 21 and 22lb. of steam per B.H.P. hours.

General Requirements of Factory Motors.

In order that the full benefit of concentration may be obtained it is absolutely essential that the motors should run without attention or "nursing" of any kind. It is, therefore, necessary that no adjustment of the brushes should be required with varying load. Perhaps the simplest way of attaining this is by the use of carbon brushes either alone or combined with copper ones, but even this is not sufficient to counteract the effects of bad design. A machine that will not keep its commutator smooth should have no place in a factory, as it is a constant source of trouble and expense.

Another difficulty often experienced with motors is the speed that they run at, often 1,000 revolutions and upwards. This means generally either an extra countershaft or a very small pully. It is evident that a 3ft. pully running at 300 revolutions is much better for the belt than a 1ft. pully running at 900 revolutions. It is about time that these slower speeds became more general, since they are quite practicable with multipolar machines.

In conclusion, it may be said that the general advantages of electrical distribution are, first, the ease with which power can be applied at any point required over a wide area at a cost not much exceeding the cost of power in a Lancashire mill, and secondly, the flexibility of the system which enables it to meet great variations in the power required without loss of economy. The main drawback is that as a means of merely transmitting power the first cost is high (compared with rope transmission, for example), but in many cases where other methods of transmission from a single centre are impracticable, the difference in the costs of labour and fuel of the "scattered small engine system" would very soon pay for the cost of electrical plant.

A PACIFIC CABLE.

[From *The Times*, November 18.]

In November, 1872, public banquets were held in London, Adelaide, and Sydney in celebration of the completion of the grand electric chain which united the capitals of the Australian colonies with the rest of the British Empire. Twenty years later proposals have been submitted, in a form which seems to imply serious business, to construct an alternative service to Australasia, *viâ* the Pacific. The idea has, of course, been long mooted. Queensland has never been reconciled to the construction of the land line of 2,000 miles through the heart of Australia by the splendid enterprise of South Australia, which, at a cost of nearly half a million sterling, connected Adelaide with Port Darwin, the terminus of the Eastern Extension Company's cable system. Queensland was ambitious to construct the land link with the Company's cable, *viâ* the eastern coast and Cardwell, to the Gulf of Carpentaria. But the energy of South Australia, combined with the ignorance which prevailed as to the route from Port Darwin to the Roper River, induced the Company to give the preference to the project of the southern colony.

The idea of an alternative cable, *viâ* the Pacific, has long exercised a fascination over the minds of certain enterprising gentlemen in Canada and England. The Pacific Telegraph Company was accordingly registered, with a nominal capital of £2,000,000. Though this was not subscribed then or since, the Company submitted proposals to the Colonial Conference which assembled in London early in 1887 for the construction of a cable from Vancouver Island to Australia, touching at Hawaii, Fanning Island, Samoa, Fiji, and New Zealand ; and, in return for a guarantee from the Governments of Great Britain, Canada, and the Australian Colonies, of traffic to the amount of £75,000 per annum for 25 years, they agreed to grant a cable rate of 4s. per word for both Government and public messages, and to make further reductions if the estimates of increased traffic were realised. A general assent was given by the Conference to the importance of cable communication between Australia and Vancouver, but the proposal has not advanced much beyond the region of discussion. Mr. Sandford Fleming, C.M.G., of Canada, has been one of the strongest advocates of the alternative line, largely on the ground that it would pass mainly through British possessions.

But the proposals which are now made, and which seemed destined to bear fruit, are of French origin. The negotiations with the Colonial Governments consulted have been conducted through Captain Audley Coote, who, on behalf of the Société Française des Télégraphes Sous-Marins, has undertaken to lay, within 18 months, a cable establishing communication between Queensland and New Caledonia. In making his proposals to the Hon. T. Unmack, the Postmaster-General of Queensland, Captain Coote distinctly declared that the new line would be the first section of the main Pacific Cable that Queensland and Canada were so anxious to have completed. The two colonies which must primarily benefit from the construction of the line to New Caledonia are Queensland and New South Wales, the former being only 900 miles distant and the latter having already extensive commercial relations with the French penal settlement. The Governments of these colonies appear to have readily acquiesced in the proposal that they should each guarantee the French Company £2,000 a year on condition that the French Government guaranteed

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£8,000 a year for 30 years; the Company, in their turn, undertaking to lay, maintain, and work the line, allowing the guarantors the free use of the section for Government messages up to the extent of their guarantee in each year of the period referred to. It was further agreed that the working expenses should not exceed £2,400 a year, and that the receipts over and above that amount should go towards the annual reduction of the guarantee of £12,000, to be shared at the rate of one-sixth for Queensland, one-sixth for New South Wales, and two-thirds for the Government of France. The cable rate between Queensland and New Caledonia will be 6s. for a ten-word message and under (including address and signature), and 6d. extra for every additional word. Though the matter has been kept decidedly quiet, considering the magnitude of the political and commercial interests involved, confirmation has been obtained in Paris of the accuracy of the above details. The French Government admit that they are parties to the contract, and it is anticipated that the guarantee of £8,000 a year will be ratified by the Chamber of Deputies next month, and very possibly the Submarine Company will receive other help from them besides. But in any event the Company have sufficient faith in their enterprise to proceed with it whether the French Government assist them or not. Indeed, they have authorised Captain Coote to announce their willingness to continue succeeding sections of the main Pacific cable with all possible dispatch. They are even ready to begin to lay the Fiji section at the same time as the line to New Caledonia if a guarantee can be arranged, and also to couple up the Hawaiian Archipelago. With commendable foresight, Captain Coote, when he first thought of constructing a Pacific cable, arranged with the Hawaiian Government to grant him an annual subsidy of $25,000 for 15 years, provided communication were established between Honolulu and "some point on the North American continent or elsewhere" not later than the first day of January, 1894. Presumably that agreement can be modified, as also that by which Malietoa, King of Samoa, in 1884, granted Captain Coote the exclusive right for 21 years to lay cables into and out of that archipelago, for 21 years from the time the cables are first landed. Much has happened to Malietoa Pupu since he signed that agreement, and possibly the protecting Powers would require to be consulted before it would be recognised.

It was at first thought that either Sandy Bay or Cape Moreton would have proved a convenient starting-point for the Queensland end of the Pacific cable, but it has been found that neither of these positions offer such advantages as the Burnett Heads, which supply a sheltered position and a good landing. Though it is hoped that Vancouver will prove to be the other terminus of the cable, there is nothing so far to prevent San Francisco, or any other point on the North American continent being decided on. So far as the wider scheme is concerned, it is open to doubt if the French Government can be considered in any sense parties to it. They have long felt the inconvenience and danger of being isolated from so important a colony as New Caledonia, and are willing to pay handsomely to have the want supplied; but they would probably open their eyes if they were asked to commit themselves to the heavy additional responsibilities which must be faced by some Governments before the main Pacific cable is likely to be constructed. Colonial statesmen are not blind to the disadvantages incidental to the cable touching at French territory, but they seem disposed to pass them over. The Hon. T. Unmack, when referring to the subject before a recent inter-colonial conference, said he did not think they need trouble themselves much about that question, because, first of all, they had seen how territories frequently changed hands, and as far back as 1884 they would find a treaty of nations by which they bound themselves that all cables in time of war should be considered as neutral. The route, according to Mr. Unmack, would be first through New Caledonia, then Fiji, Samoa, Honolulu, the Fanning Islands, and probably either Vancouver or San Francisco; but, whatever route was adopted, he pointed out that the line must pass through some countries where the British Government was not supreme.

LEGAL INTELLIGENCE.

Hopkinson v. The St. James's and Pall Mall Electric Lighting Company (Limited).

The hearing of this action was resumed on Tuesday last before Mr. Justice Romer, in Chancery Court III.

After a brief further examination by Mr. FINLAY, Mr. J. D. F. Andrews was cross-examined by Sir RICHARD WEBSTER: Witness stated that he was first asked about his supposed anticipation of the three-wire system about four weeks ago by a gentleman who called on him from Messrs. Siemens Brothers, whose name he did not know. He drew the diagram (J.D.A. 1, see *The Electrician*, November 11th, p. 47) on Saturday afternoon, November 5th. He was quite alone. He drew a preliminary one himself, which was not in Court. He was a patentee of an improvement of the three-wire system. Between leaving the works at Glasgow and his recent conversation he had never drawn or described the Glasgow wiring to anybody. The gas engine was, to the best of his recollection, of eight-horse. He would undertake to say that it was not two-horse nominal, working up to 3½-horse actual. If all the lamps shown in diagram were in use at the same time, more than 2½ H.P. would be required. There were never more than 20 lamps on. There were gas fittings all over the shop for gas lighting. The workmen's benches were lit by gas in the ordinary way. He never finished a glow lamp there fit for sale. He was the patentee or inventor of an improved arc lamp—a "plate" lamp. His experiments at Glasgow did *not* consist partly in trying to run two "plate" lamps in series. The trials with "plate" lamps in series were at Siemens Brothers. If the Glasgow machine had come to him with the circuits parallel, he could not have got the double voltage. It came to him with the coils in series.

Sir RICHARD WEBSTER: I think you are mistaken. Just listen to your own letter:—"We were sorry to find the two circuits of the W. 3 you have just supplied us were connected in opposition, and so neutralised each other, and this caused us some delay in our experiments, it being necessary to take out the armature and reconnect it. It also proved that the machine could not have been tried before leaving your works."—That letter was written under a misapprehension, and I discovered it soon after I post d the letter.

Whatever it was, as a matter of fact, did you desire to have a machine in series?—I did.

Was not the object of having the machine in series that you would have, we will call it, positive at one terminal and negative at the other terminal, so that you could get a less voltage by using one-half of the machine independently?—Yes, that was the case.

Do I understand you to say that you always knew that you had used this three-wire system publicly in Glasgow?—Yes, always.

Did you yourself apply to Dr. Hopkinson for a licence under this very patent for the three-wire system?—Yes I did.

Do you represent to my Lord that when you applied for this licence under Dr. Hopkinson's patent you knew at the time that there had been a public user of it?—Yes, I did.

Did you endeavour to get the best terms you could to be sole licensee of Dr. Hopkinson's patent?—Yes, of a certain application of it.

Did you see both Mr. Belfield and Mr. Scanes, and I think Mr. Baldwin?—Yes, I saw those gentlemen on the subject.

WITNESS, continuing, stated that the patent referred to was for putting three conductors round one another with insulating material in between. He had not advertised it, but had announced it publicly.

Sir RICHARD WEBSTER: Did you see Mr. Belfield, Mr. Scanes, and Mr. Baldwin, and did you say to all those gentlemen that unless you could get a licence under Dr. Hopkinson's patent your patent would be worth nothing?—I think I did. It is very likely that I would.

After reading some correspondence which had passed between Mr. Andrews and Dr. Hopkinson and the Westinghouse Company with reference to a licence, Sir Richard Webster, continuing his cross-examination, said: Did you at that interview with Mr. Belfield, or Mr. Scanes, or Mr. Baldwin make the slightest suggestion that the Hopkinson patent was invalid?—Yes, I did.

What did you say?—I said I knew of instances where the three-wire system had been used.

Where?—In Blackpool.

Did you say a word about Glasgow?—No.

You, I suppose, used that in order to try and get better terms?—No, I did not.

Why did you do it, then?—We were having a general conversation—a pleasant conversation.

You asked the Westinghouse Company to help you to bring out a company, I think?—Yes.

WITNESS, continuing, said he had no desire in 1882 to get Mr. Graham, Mr. Rankin Kennedy, Mr. Bottomley, or Lord Kelvin to assist him, or to assist his Company, in bringing out new electrical inventions, or in promoting other business. These gentlemen came and inspected the workshop, though he did not recollect seeing Mr. Rankin Kennedy there in the early part of 1882. He did not know whether Mr. Rankin Kennedy ultimately purchased the plant that was in that place, nor remember the number of the dynamo.

Sir RICHARD WEBSTER: On the last occasion, you know, you said that you bought it back from the Company in the year 1883. You said that positively, and now to-day you say you are waiting proof of it. Now we have investigated this matter, and I put it to you, is it not a fact that Mr. Rankin Kennedy bought that dynamo, and worked it at the Woodside Works, the adjoining premises to you, to your knowledge?—I do not know that it is a fact.

WITNESS, continuing, stated that the voltage of the dynamo was 220 when it was double, and 110 when it was single. He never himself noticed the men put a bradawl or a bit of metal across the two wires. He did not believe the lamps went out when this was done. It would be a very foolish experiment to try. There was no difference in the size of the wires used. He was well acquainted at that time with that particular wiring, the three-wire system. What they had used at Siemens Brothers was *virtually* the three-wire system as they know it now.

When you say that you had used the thing over and over again at Siemens, was not the thing that you had used the use of a third wire as a common return?—We gave it that name, but we knew that it did not carry the whole of the current.

Were not the currents on the outside of like polarity?—They were not.

Witness then drew a diagram (J.D.A. 4) of what he said was used at Messrs. Siemens. The return wire was not larger than the others. The

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middle ring in the larger Siemens' machine was of double size. After having bought the plant, he installed it at Messrs. Russell and Company's shipyard at Greenock.

Re-examined by Mr. FINLAY, witness stated that he had no idea of contesting the validity of Dr. Hopkinson's patent at the time of his interviews. He intended to uphold it if it could be upheld. With regard to the short circuiting tricks, he had since heard that the men used to play tricks while he was experimenting with his "plate" lamp in order to put it out, and he believed they succeeded in putting it out, and at the time he did not know why it went out. They also played a similar trick in order to put the other lights out. If by a tool being put across one branch the other lamps went up, it would show it was not the three-wire system. He was quite certain that this third wire was connected. He connected it himself. The third wire in certain cases at Messrs. Siemens was not confined to acting as a common return, but acted as a safeguard in the event of one arc lamp going out.

Mr. WILLIAM CLARK MUIR, examined by Mr. FINLAY, stated that he was one of the Directors of the National Electric Company in 1882. The user of the Siemens' dynamo and the installation were in no way secret. The installation was primarily for the purpose of assisting in the manufacture of an incandescent lamp. Other (Maxim) lamps were put up in the workshop for the purpose of lighting the shop.

Mr. GEORGE FORREST, examined by Mr. FINLAY, stated that he was an electrical instrument maker and was now in the employment of Messrs. Siemens. In 1882 he was foreman at the National Electrical Company's Works. He went to the Glasgow Works either at the end of January, 1882, or the beginning of February, and continued during the whole of 1882. He remembered the alternator referred to by Mr. Andrews being put up in the early days of March; he remembered distinctly three terminals on the machine. To the best of his belief the machine was connected with three wires, one to the outer circuit and a common terminal wire which went to the middle of the three terminals. The wires were led from the machine to the other end of the shop where there were two or more frames for the manufacture of incandescent lamps. There was also an arrangement at the corner where the flashing of lamps took place. In addition to that they had some leads laid off for lighting the shop when they were not using the current at the other end. They used a common return wire for both frames, having one frame on one side and some balance of lamps on the wall, and the other frame on the other side, or something of that kind. Previous to going early in May, 1882, to the Crystal Palace, he did not think he had ever seen Mr. Rankin Kennedy on business at the workshop. After his return from the Crystal Palace Exhibition early in June, Mr. Rankin Kennedy was at the workshop two or three times a week.

Cross-examined by Sir RICHARD WEBSTER, witness stated that all casual observers would see of the installation would be wires. He did not think Mr. Rankin Kennedy came to the workshop as early as April or May, 1882. Maxim lamps were used for lighting the shop. It might have been later than August that the Maxim lights were used. He knew of no putting of a connection across when the incandescent lamps were in question at all. He remembered the short circuiting of one side of the machine when Mr. Andrews was experimenting with his "plate" lamps. That would be confined to the period from March up to July.

Re-examined by Mr. FINLAY, witness stated after his return from the Crystal Palace Exhibition most of their time was occupied in perfecting the Kennedy lamp. Between March and July he did not think much use was made of the dynamo in connection with any installation of electric lighting.

Mr. JAMES McKELLOP, examined by Mr. FINLAY, stated that he was employed as tool maker and engineer at the Glasgow factory by the National Electric Company in 1882. He left at the end of November. He observed three wires, and that they went from the dynamo to the other end of the workshop. Between March and July, 1882, the dynamo was in use for lighting the workshop. The Maxim lamps were put up before he left for the Crystal Palace on May 5th. The alternator had three rings, three brushes, and three wires. He was not able to say from recollection how these wires were connected to the dynamo.

Cross-examined by Sir RICHARD WEBSTER, witness stated that he was an engine fitter, and had never had any electrical experience at all. As to voltage of the dynamo or of the Maxim lamps, he was perfectly ignorant of them.

Mr. CHARLES HUNTLEY TOWN, examined by Mr. FINLAY, said that he was now in the employment of Messrs. Mavor and Coulson, of Glasgow, as wireman. He had been in the employment of the National Electric Company from February to November, 1882, as instrument maker. He could not tell anything definite as to the connections; but three wires came from the dynamo, along the side of the shop, to the end of the shop. Maxim incandescent lamps were burnt, put up between March and May. He assisted in putting up the wires.

Cross-examined by Sir RICHARD WEBSTER, witness stated it was not the fact that up till the middle of 1882 whatever lighting there was by electric lighting was experimental.

A statement, signed by witness, and made by him to Mr. Owen ten days since, was then read over. It stated that, "Except some telephone work and dynamo brushes, the work at Sauchiehall-lane was of an experimental character. Nobody came about the place except those who had to do with the business. Although there were a few incandescent lamps about the place from time to time experimentally, the place was never lit for working by incandescent lamps. Gas was the real light we worked by." He had some recollection of three wires roughly fastened along the wall, but did not remember how far they went. On one occasion a man put a bradawl to the wires near the well-hole, and all the lights that were on went out. Mr. Andrews never had anything to do with the incandescent lamps.

Prof. SILVANUS THOMPSON, examined by Mr. WALLACE, stated that the alleged novelty of the patent was the bringing of the third wire back to the dynamo. The advantage of connecting the third wire with the dynamo was that, although they had the additional expense of copper in bringing that wire back to the dynamo, they could now turn out lamps one by one instead of two by two. Witness then read extracts from contemporary prints, showing the meaning attached in 1882 to the word "distribution." There was no special meaning of the word "distribution" known at that date. It had been suggested in the Court that "distribution" had a special technical meaning, and was confined to distribution in parallel; that was not the case. Witness then explained what he held to be the advantages of the Alexandra Palace "user." At the Paris Exhibition of 1881 the steadiest arc lamps of all were those of Mr. Gülcher, which were run at about 67 volts, all in parallel with one another. The suggestion that feeders were inapplicable to arc lights was absurd. They were in use every day for arc lights. Witness then gave his opinion as to the merits of the Inchicore arrangement. Between the diagram of Mr. Andrews relating to his workshop in Sauchiehall-lane, and the diagram of Dr. Hopkinson, there was no difference, saving that Dr. Hopkinson showed specifically two separate dynamos united in series, and the diagram that Mr. Andrews produced showed only one dynamo, presumably the one that he described with the two sets of coils. The Hopkinson system would not work with alternate currents without modifications. Witness then explained the mutual action of the two coils of regulator when alternate currents were used. It would not act efficiently without bringing to bear upon it subsequent knowledge.

Mr. JUSTICE ROMER: Really I ought not to take upon myself the examination of the witness, but I will ask him this question. [To the witness]. Will you look at the words, "A system of conductors for an electric supply at a fixed potential." Does that phrase show that, electrically, the system arrived at must be one where the parallel system alone is used?—No, certainly not. It included all cases whether of simple parallel or of parallels with series in them—all cases where the supply is a fixed number of volts.

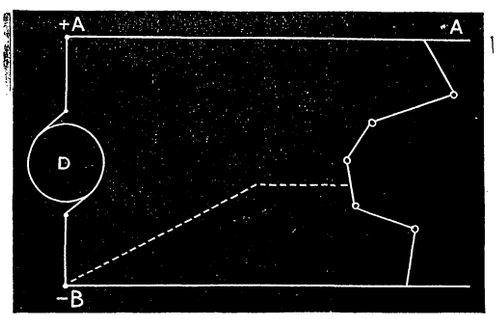
Speaking as an electrician, and only as an electrician, are there any electrical expressions here in this specification which, in your opinion as an electrician, point solely to a system of parallel lighting?—No, certainly not.

Cross-examined by Sir RICHARD WEBSTER at length upon diagram J.H. 1, witness said it was one way of arranging multiple parallel.

Sir RICHARD WEBSTER: Will you kindly draw me a system of conductors for supply at various points at a fixed potential which is *not* on the parallel system?

Mr. JUSTICE ROMER: That is exactly what I wanted.

The witness produced a diagram which was marked S.P.T. 3.



S.P.T. 3

Sir RICHARD WEBSTER: Now, you have there only got one bridge?—I have one bridge only.

And that is the only case which you can explain in which a distribution at many points—distribution of electrical supply—is to be at a fixed potential that is not parallel?—It is the only possible case.

The moment you put other bridges across you must have a fixed potential at all the points?—The moment you put other bridges across you have a system of parallel; they are in parallel one with the other.

In this S.P.T. 3 there will be both fixed current as well as fixed potential?—In that particular case, yes.

But let me point out to you you cannot make a number of bridges on the parallel system without having fixed potential.—They would not work well.

Kindly tell my Lord any passage in the specification or drawings which would lead a workman to apply the three-wire system to arc lights in series only.—In series only there is nothing whatever.

You have no doubt that Fig. 5 is an instance of multiple parallel bridge?—Certainly it is.

Now in fairness to this miserable patentee, to this ignorant man, will you kindly tell my Lord a single word that would lead the honest electrician to set to work to make arc lights in series and apply the three-wire system to that?—There is nothing to lead him to it, but there is nothing to prevent him doing what was done already, namely, using arc lamps instead of incandescent on his mains.

You have no doubt whatever that the indicator is only useful in the system of constant potential and varying current?—The regulator is distinctly for that purpose.

Does not that involve not only parallel bridge but multiple parallel bridge?—It involves the use of parallel bridges, but it does not say anything as to whether there shall be one, two, three, four, or five lamps in each bridge. It does not exclude that case.

The Court then adjourned until Wednesday.

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WEDNESDAY, NOVEMBER 23RD.

On the hearing of the action being resumed, Prof. SILVANUS THOMPSON was recalled and further cross-examined by Sir RICHARD WEBSTER with reference to diagram S.P.T. 3. In the system as it was drawn one ordinary dynamo which produced sufficient voltage and sufficient current would do. It was only when they desired to burn two lamps separate from two others that any question of divided dynamo would come in or any question of another wire. Assuming that kind of dynamo to be used, the third wire would be useless. If a return were connected as shown by dotted line, it would break down the two lamps. If they had a constant voltage, and they cut out the extra lamps, the result would be that the remaining lamps, if glow lamps, would be broken down. With arc lamps the extra voltage might make them burn with longer arcs, but it would not break them down. Witness was next cross-examined with regard to diagrams illustrating his lecture delivered at the Crystal Palace in March, 1882. Witness admitted that in none of the diagrams did he, as a matter of fact, show a third wire taken back to a compound or double dynamo. A single dynamo of the proper kind would work perfectly well in any one of those systems.

Sir RICHARD WEBSTER: Can you point to any enunciation of the value of the three-wire system even in general, prior to Dr. Hopkinson's specification—in any text-book or printed book you can refer me to?—The nearest one I think I can refer you to is a description of dynamo with three terminals, with a middle terminal, suitable for this.

Where is that to be found?—At page 290 of Vol. I. of "Electric Illumination."

What time in 1882?—I think the date of the publication was August.

But that is not before Dr. Hopkinson's specification?—It was in August, 1882.

Have you ever actually tried the Inchicore or tried a system upon it with two bridges upon one side and three upon the other, or one upon the one side and two upon the other?—No.

Do you know that in order to get the lamps to burn equally you have to put in resistance to equalise the resistance on the two sides?—I should not have thought so.

What is there in this specification to lead people *not* to couple alternate dynamos rigidly?—There are no instructions as to coupling at all, and the practice was not to couple dynamos rigidly.

Do you suggest that a competent electrician dealing with this specification would not know that they must keep step?—I know of a case where they were coupled, simply each one to its own engine—no mechanical coupling between the two at all.

Cross-examination being continued, witness said he had never made an indicator according to Claim I. He would not undertake to say there was no case in which it could be made to work. He did not know of anyone on behalf of the defendants who had ever tried an indicator made according to Claim I. to see whether it would act or not. The passage on page 4, line 44, of the specification—"The application of this instrument to an extended system of electrical supply with a network of distributing mains is important. For each machine I prepare a pair of feeders of a size appropriate to the current they are to carry, but independent of the distance they have to go. Each pair of feeders goes to and is connected to some part or other of the system of distributing mains, and by the use of my invention I am able to keep the difference of potential constant at or near the point where the feeders join the distributing mains"—properly described a system of many bridges where the feeders took the current of constant potential to the place where the bridges were to be lit up. And it did *not* properly describe a system of one series where they had one main wire going out and another returning, and all the lamps in series on that.

Re-examined by Mr. FINLAY, witness stated that the use of the third wire had advantages in other cases than a system of parallel distribution. It had advantages in all cases of distribution save one, that was where the dynamos that were used—two together—were constant-current dynamos. In that case the middle wire could never have anything to do. He had looked at the part of the final specification which had been disclaimed relating to the use of meters and other things. As far as the meter was concerned, it would be applicable to all cases whether of parallel or series, or single working motors or arc lamps or incandescent lamps, saving only one case, that just referred to of constant current.

Mr. JAMES SWINBURNE, examined by Mr. FINLAY, stated that every arc lamp he knew of in 1882 would have worked in parallel. He found nothing in the specification confining it to a system of parallel distribution, only to a system of constant potential. The word "distribution" did not in 1882 refer particularly to distribution in parallel; it referred also to distribution in series. Taking the disclaimed portions of the specifications, they were in no way confined to parallel lighting. Witness then gave his opinion with regard to the advantages of the Alexandra Palace and Inchicore arrangements. Witness disagreed with Mr. Andrews' statement, that supposing the lamps at Glasgow on one side went up in brilliancy on short circuiting the other side, it would show that it was not the three-wire system. He thought it was quite possible that with an old machine of the type used then short circuiting one side might increase the electromotive force on the other. He differed from Mr. Andrews, because in the first place short circuiting one side of an old-fashioned machine took the load off that side, then the engine would go a little faster, and so the machine would give a little higher pressure on the other side. He had not tried it with a Siemens machine of this particular type, but he had used some time ago an old Gramme machine about the same date, and he found that even without going faster if they short-circuited one side the other side went up in electromotive force. A clever fellow might have thought of rigidly coupling up the two alternators, but certainly most people would not. In 1882 witness himself would not have been a sufficiently clever fellow to have thought of doing it. The regulator at Sardinia-street was not Dr. Hopkinson's regulator. At Sardinia-street they now used pilot wires. He had made a regulator according to the directions. He chose the way shown in Fig. 1. [Model handed to the witness.] It was made during the adjournment. He found that a regulator made as in Fig. 2 and connected up as in Fig. 1 could not be made to work, as far as he knew. The regulator was tested by Mr. Harrison, chief of the Standardising Institution in St. Martin's-lane.

Cross-examined by Mr. MOULTON, witness stated that in 1882 any electrician who knew that the alternators must keep in step had knowledge enough to know they must be rigidly coupled. With regard to his (J.S. 1) regulator, and the other one, there was no essential difference. As regards the position of the coils the exhibit S.P.T. 4 was most like Dr. Hopkinson's regulator. There the fine wire coils were end to end with the coarse wire coils, as shown in Fig. 2. The induction difficulty would not be appreciably increased by lapping the coarse wire coils round the fine wire coils.

Mr. MOULTON: Are you prepared to say that S.P.T. 4 will not work perfectly with alternating currents?—I should like to know how S.P.T. 4 is connected up. That is an essential part.

Connected up as in Fig. 1, or letting the whole current go through?—Letting the whole current go through I think it might work. I think it is very possible it would work. Putting a low-resistance shunt to it, as in Fig. 1, I think it certainly would *not* work.

Is it possible to have a system in which the mains are at constant potential where they are tapped by a customer without that being a parallel system?—It is possible in the case of its being only tapped once.

I never heard of *one* parallel line in my life! The only case in which it is not parallel is where the mains are tapped in only one place?—Yes.

In continuation of cross-examination, witness said: "Feeding conductors" was a known phrase, but oddly enough patentee did not use it in the usual way.

Cross-examined next in detail with regard to various passages in the specification, witness said that they pointed to parallel.

Mr. MOULTON: Is there anything in this specification which would direct a man to put up the system where you tap the mains only once?—No doubt, as I said before, Dr. Hopkinson was thinking of parallel. There is no direction about tapping at one place; but tapping at one place is a particular case of tapping at one or many.

With the exception of the Gülcher lamp, can you tell me one that was known to be able to work in parallel?—I do not know of any that were except the Gülcher; the question, as far as I know, never came up.

Re-examined by Mr. FINLAY, witness said that in connecting his regulator he endeavoured to follow the directions of the specification.

Mr. HUGH ERAT HARRISON, examined by Mr. FINLAY, stated that he had read the parts of Dr. Hopkinson's specification which specially referred to the regulator. He tested model regulator made by Mr. Swinburne with a direct current. It did not act very well, but it did act. He then tried it with an alternating current, and it failed. The regulator was connected in the manner described in the specification. He did not think it could possibly be made to work with alternate currents, except where the whole of the current passed through the thick wire coil.

Cross-examined by Sir RICHARD WEBSTER, witness said that prior to the case coming on he had not been consulted at all about the sufficiency of the regulators. The mutual induction was not much more likely to be set up when they had the thick wire bodily surrounding the thin and the powerful current running through the thick wire than it was when they had got the two windings end to end; the difference would be excessively small. Presuming that a gentleman in 1882 was minded to use alternating-current machines, he could not point to any direction in any book which would lead him to couple them otherwise than rigidly.

After re-examination by Mr. FINLAY witness withdrew.

Prof. ALEXANDER B. W. KENNEDY, examined by Mr. WALLACE with regard to the novelty of Dr. Hopkinson's patent, said that he agreed generally with the other witnesses that it consisted in bringing back the third wire to the dynamo. He found no limitation in the specification to the use of the system to incandescent lamps.

Mr. WILLIAM MORRIS MORDEY, examined by Mr. WALLACE, stated that he did not agree with Mr. Belfield that the three-wire system could *not* be worked on a single alternator. It could be worked with many advantages on a single alternator. In his opinion the three-wire system would be useful as applied to arc lighting. At that date (1881-82) arc lamps were used in parallel. The fact that was attracting most attention at that time was the successful working of arc lamps in parallel. That was the one fact that stood out in those two years as of most interest. He could give references to that from the technical press. With regard to the connection of the alternators at the date of the patent, on reading the specification, and being told that the arrangement shown in Fig. 5 was applicable to alternating currents, he could have worked the three-wire system on an alternating current machine,. It would not have been at all obvious in 1882 that he must put in rigid coupling. He was quite sure regulators, as shown in specification, would not work successfully with alternate currents.

Cross-examined by Mr. MOULTON, witness stated a regulator made on the lines of the specification might do for the backwoods, but it would not do for London. He was not content with a thing that was no use.

Dr. JOHN HOPKINSON was then re-called and further examined by Sir RICHARD WEBSTER, and stated that the model J.S. 1 was obviously different to the eye; it was different, and that difference was material. The arrangement of coils in the defendants' model was such as to increase the mutual induction between the two circuits. The mutual induction was the more important.

Cross-examined by Mr. WALLACE, witness said that there was nothing in his specification to lead a man to lay the thick coil over the thin. The only figure was Fig. 2, and that showed it as arranged in their own model.

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Mr. RANKIN KENNEDY, examined by Sir RICHARD WEBSTER, stated that in October, 1881, he was residing at Paisley, near Glasgow, and was acquainted with Mr. Graham, an electrical engineer in Sauchiehall-street, Glasgow. He entered into an agreement with him for the sale of a patent. He first began to go to the Sauchiehall Works about the beginning of December, 1881. He saw Mr. Akester there, who was endeavouring to make incandescent lamps there. He knew a gentleman of the name of Forrest. He first knew him early in February, 1882. He knew Mr. Andrews. First met him about the end of January, 1882. On December 15th or 16th, 1881, he had a dispute with Mr. Graham, and for a time left him. It was made up again about the end of January or the beginning of February at Mr. Graham's house. About this time he was helping to light the Fine Art Gallery in Glasgow—that was early in November, 1881—on the simple multiple system, at first with Maxim lamps. The lamps had been obtained at the end of October, 1881. They were supposed to be 65 volts. He also knew Mr. Bottomley and Lord Kelvin. He had an intimate recollection of all that went on in the Sauchiehall-lane workshop, and the dynamo and the wiring and everything about it. It was a 2-H.P. Otto gas-engine. Shortly after the dynamo was fitted up, Mr. Andrews testing it. He tried to keep a current between the two outside terminals; the dynamo subsequently came into witness' possession, and was taken to pieces. All the coils were in series, with the broad ring cut out. With regard to the wiring at the works, his impression was that there were three wires put up from a dynamo that was down below the workshop, a Gramme machine. The number of the Siemens machine was 155 or 1,555. In March, 1882, when the Siemens machine first came, the workshop was lit up by gas. There was no permanent installation to light the shop with electricity. Never at any time. All done by gas. Sometimes a Maxim lamp was hung up temporarily, and light obtained from that. At no time did he ever see that middle wire go back to the dynamo. About May 19th or May 20th, 1882, on returning from the Crystal Palace, he altered the dynamo. He put it back into the same connection that it had when it came from Siemens'—with the broad ring as a common return. That was in June. At Woodside the dynamo was coupled up on a three-wire system; that was in 1884. Mr. Andrews was at Woodside, and came on to witness' premises. At no time, from anybody, neither from Andrews, Forrest, or Graham, did he ever hear either working on the three-wire system suggested or anything consistent with it. It was new to him when Dr. Muirhead told it to him at the end of 1882. After his return from London he saw some of the boys take a piece of wire and connect it across from the outer to the inner wire for the purpose of putting out some of the lamps. The effect was to put out the lamps on that side, and to brighten up those on the other. This could not have happened if it had been on the three-wire system. The lamps on one side of the Fine Art Gallery under certain circumstances used to get too bright and break down. They found when short circuiting took place on one side all the lamps went out on that side, and the others brightened up. That was on the compound parallel.

Cross-examined by Sir HORACE DAVEY, witness stated that he was in the employment of the National Electric Company during the spring of 1882, and had charge of the dynamo manufacturing at Polmadie, not at Sauchiehall-street. The main purpose for which he went to Sauchiehall-street was to experiment with his arc lamp. The manufacturing of his arc lamp had nothing whatever to do with the installation which Mr. Andrews speaks of. His impression was that the number on this Siemens dynamo was 155. The broad collecting ring was removed immediately the dynamo was first started. McKellop, a workman of Andrews, removed it. Witness was not present when he removed it. Connection was not replaced on March 28th; it may have been during his absence at the Crystal Palace.

Sir HORACE DAVEY: I will ask you distinctly. Are you prepared to state that Mr. Andrews' statement that the workshop was lighted with electric lights, and the current through the wires was used for the purpose of the manufacture of incandescent lamps, from March to June, is altogether untrue?—Part of it is because there was no lighting of the shop at any time.

Mr. Andrews was in charge of the shop, was not he?—He was.

You were a visitor?—Yes.

Will you undertake to say that Mr. Andrews' statement was untrue as to the lighting of the shop?—I will. There was no lighting of the shop.

No lighting of the shop at all?—There were some lamps fitted in the shop, but not on any system whatever.

The Court adjourned until Thursday.

THURSDAY, NOVEMBER 24TH.

On the further hearing of this case the cross-examination of Mr. Rankin Kennedy was continued, and further evidence was adduced on behalf of the plaintiff to rebut the defendants' evidence with reference to the alleged anticipation of the three-wire system by Mr. Andrews. Witnesses also on both sides gave evidence as to experiments made in their presence the evening before at the Westinghouse Company's laboratory with an apparatus constructed according to the first claim of Dr. Hopkinson's patent, in order to demonstrate whether or not the apparatus would work with alternating currents. Lord Kelvin and Dr. Bottomley, as well as Dr. Hopkinson, alleged that the experiments proved that the apparatus could be effectively worked, while Mr. Swinburne's evidence on behalf of the defendants was to the effect that the result of the experiments did not show that the apparatus could be used commercially. Sir Horace Davey commenced to sum up the defendants' case, and argued that the plaintiff's specification for the three-wire system was wide enough to cover the use of a third wire, as applied at Inchicore and at the Alexandra Palace. He had not completed his argument at the rising of the Court. A full report of the proceedings will appear in our next issue.

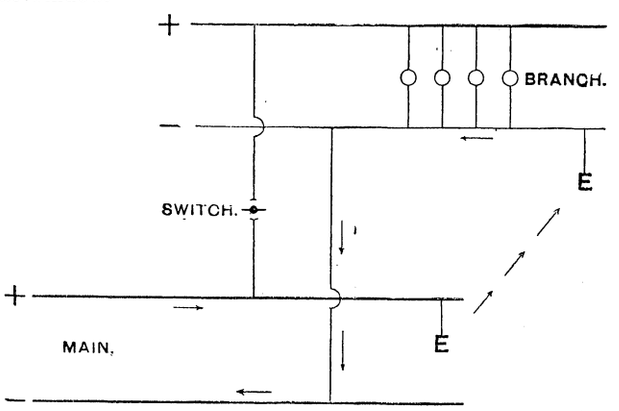
CORRESPONDENCE.

THE REGENT STREET FIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It would appear from a paragraph in your last week's issue, anent the recent fire in Regent-street, that you have satisfied yourself the cause of that fire was in nowise connected with the electric installation. As the circumstances are somewhat peculiar and interesting, and as I have reason for doubting the correctness of your conclusions, I shall be glad if you will permit me to lay before you a few facts concerning the fire worthy of consideration.

The fire was first discovered about four o'clock in the morning in an enclosed bay window, and in the vicinity of a plastered iron column, to which was attached a vertical row of incandescent lamps and their reflectors, the whole being draped with plush. A second column was similarly lighted and draped, and above was a horizontal row of lights capable of being raised and lowered, with flexible attachments. The window had not been entered for several days (nearly a fortnight) and there was nothing whatever in the nature of the goods displayed that will for a moment sustain the supposition of spontaneous ignition. In fact, there was nothing in that window capable of generating heat beyond the lighting arrangements—which, in this case, were wholly electric. The lamps were on three separate minor circuits controlled by single pole switches. It appears these lamps had all been switched off on their respective circuits about eight o'clock in the evening, that is to say, fully eight hours before the outbreak of the fire. Current, however, was otherwise on throughout the night in the shop. Now, under these circumstances there are but two possible hypotheses as to the cause of the fire, and both have to do with the lighting of that window.



First, there is the possible contact of the drapery with one or more of the lights, leading to charring, smouldering, and eventually flame. The second is that of an "earth" on one of the circuits. I regard the first as too improbable to be sustained, but, as regards the second, I find no such difficulty.

"What!" it will be asked, "an *earth* after the current had been switched off eight hours?" Well, at first sight, the objection appears fatal to the theory, but upon closer inspection the obstacle disappears.

Without troubling you with too many details, let me say there is ample evidence in connection with the wiring to account for an "earth," provided there was current in the branch. In considering this question of current it is important to remember the lamps were switched off on one pole only, and by aid of the accompanying diagram it will be seen, with certain conditions granted, how it was possible for an earth to have been maintained after switching off.

Assume in the first place an "earth" on the main *positive* pole—an assumption fully warranted in this particular case. Next assume also an earth on the opposite pole of the window circuit, and upon which there was no switch, again requiring no great stretch of the imagination. You have thus the chain completed. The diagram shows at a glance how it was possible for a leak to have been maintained throughout the night after

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switching off. With this granted there is ample evidence to account for the appearance of the fire on or about that window column.

Now, Sir, this opens up the important question of "earthing." It is well known, though perhaps not admitted, that upon many supply companies' mains there exists considerable leakage on one pole or the other, and a few years' experience seems to point to the impossibility of practically maintaining both poles rigidly above the potential of the earth on large public supply systems. If that be so, then I say advisedly it is time to reconsider our position. Our rules are framed and our wiring based largely upon the supposition of "no earth." If "no earth" is a fallacy then equally so are our rules, and the present system of wiring needs overhauling. Instead of having, as we fondly believe, two strings to our bow, we have but one, and that often a very weak one. But with a known and constant weak side in our mains (obtainable only by earthing one pole) we should know better how to meet and provide for contingencies of the kind referred to. For instance, had the side of the house installation shown earthed in the diagram, been connected to the known earthed main, and the side in which the switch is inserted connected with the insulated main, then it will be seen no such mishap as I have surmised could have occurred.

Earthing is simplicity itself with concentric cables and fittings, but there are difficulties to be overcome in connection with existing installations on other systems. I do not despair, however, in their being eventually surmounted, provided all interested co-operate in bringing about a much-needed change.

I am well aware that what I have here written will be regarded by many of my *confrères* and others as little short of rank heresy, but I invite them to carefully consider the matter, when they will find there is more in it than appears on the surface.

With apologies for the length of this letter.—Yours, &c.,

Guardian Fire Office, H. HUMAN.
11, Lombard-street, E.C.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

TENDERS INVITED.—The city authorities invite tenders for the electric lighting of Santiago, Chili, and will receive same until March 1, 1893.

SALES BY AUCTION.—The sale by auction of the contents of the East Down Electrical Works, East Down Park, Lewisham (lately in the occupation of Messrs. A. B. Gill and Co.), a preliminary announcement of which appeared in our last issue, has, it will be seen by our advertisement columns, been fixed for Tuesday, the 13th prox.

——— Messrs. Wheatley Kirk, Price, and Goulty are issuing the complete catalogue of the valuable boilers, engines, machinery, machine tools, stores, &c., of the Springfield Works, Basford, and the Queen's-road Works, Nottingham, which will be sold by auction on the works premises on Tuesday and Wednesday next, the 29th and 30th inst., commencing at 10 for 11 each day. A large quantity of bleaching, dyeing, dressing and finishing machinery is included in the sale, all of which is in excellent condition. The Queen's-road works are within five minutes' walk of the Midland and Great Northern Stations at Nottingham, and the Basford Works are within 15 minutes train journey of Nottingham.

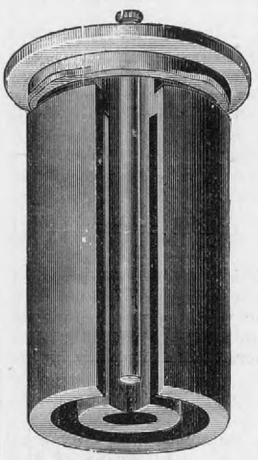
DISSOLUTION OF PARTNERSHIP.—Messrs. Hubert Fielden Jackson and William Leopold Whittaker, carrying on business as electrical engineers at 85, Queen Victoria-street, E.C., under the style of W. L. Whittaker and Co., have dissolved partnership. Accounts will be received and paid by Mr. H. F. Jackson.

MESSRS. BUMSTED AND CHANDLER. — Messrs. Bumsted and Chandler have just put in two 60-H.P. engines at the Naval and Military Club, Piccadilly, in conjunction with Messrs. Crompton and Co., who have supplied the dynamo and apparatus for the installation. The output of each Crompton dynamo is 110 volts, 400 amperes, 425 revolutions; they are of the single-limbed type, with iron magnets. The armatures are of the drum-wound type, the conductors being bars of Crompton patent compressed stranded cable on the outside of the core, and strip copper bent to correct shape at the ends of the core. The engines have each two high-pressure 8in. cylinders and two low-pressure 11in. cylinders, with piston valves at the sides, cutting off steam in the high-pressure cylinders at half stroke, boiler pressure=140lb., at which pressure the engines indicate 72 H.P., the exhaust being turned into the brick chimney stack. The engines are said to be singularly free from vibration and noise.

MESSRS. J. G. STATTER AND CO.—We have to acknowledge the receipt of the new catalogue and price list issued by this firm, which is replete with information respecting the Statter dynamos and motors, engines, and engine accessories, foundation work, electric traction, fittings, instruments, lamps, &c., and the general appearance of the book is creditable to all concerned. Messrs. Statter and Co. have joined the long list of electrical firms who have come to the conclusion that it is best and wisest to devote considerable care and attention to their price lists, and they will, doubtless, be fully recompensed for the additional outlay incurred. The only complaint we have to make is that the firm's name on the cover is illegible. Such price lists as these are indispensable to architects, contractors, and other large indenters and users of electrical plant and apparatus, and will be carefully preserved.

TELEPHONE AMALGAMATION.—The *Glasgow Herald* of Wednesday last contained a gossipy leaderette on a scheme for amalgamation between the National Telephone Company, the New Telephone Company, and the Consolidated Telephone Construction and Maintenance Company, which is sufficiently inaccurate in some particulars to justify us in assuming it to be chiefly gossip. We have been unable to obtain any confirmation from head-quarters.

MILL LIGHTING.—Messrs. W. H. Allen and Co. have recently completed an installation of the electric light in the York-road Mill for the York-street Spinning Company of Belfast. The installation consists of 65 32-c.p. and 20 16-c.p. incandescent lamps, with the necessary generating plant and accessories. The switchboard and connections have been so arranged as to permit of easy extension. A special insulation has been adopted for the cables and fittings to adapt them to withstand the effects of the hot and damp atmosphere of the spinning-room.



THE STANDARD BATTERY.—Messrs. Shippey Bros. send us a specimen of a cell, known in America as the Law battery, but which in this country will be known as the "Standard." It consists of an ordinary zinc rod and two split cylinders of carbon or agglomerate, arranged as in the illustration. An ebonite cover grips the top of the jar with wedge bayonets. In the absence of tests we can say nothing of the performance of this battery. The idea of arranging the zinc in this way seems to be that a larger surface of carbon can be utilised. The only real test of the utility of this plan would be a careful observation of the internal resistance, and this we have had no opportunity of making. We note that in the American advertisements of this battery it is stated that "the element is everlasting, and is so guaranteed."

ELECTRIC HEATING.—We have received from Syracuse N.Y., a descriptive pamphlet, giving illustrations of various kinds of electric heaters, including car heaters, office heaters, grating, or mat heaters, kettle heaters, cooking stoves, &c.

MESSRS. DRAKE AND GORHAM.—This firm have secured the contracts for lighting the residences of Baron H. de Worms, M.P., in Grosvenor-place, W.; Sir E. H. Carbutt, in Hyde Park-gardens; and Mr. Wood, in Lowndes-square; and also of the business premises in Moorgate-street for Messrs. Schwann Bros. Sir Gervas Glyn at Ewell, Mr. Hallett at Orpington, and Mr. Herman at Cambridge, have placed orders with the firm.

BAZAAR LIGHTING.—A successful bazaar was held last week at the Vestry Hall, Turnham Green, S.W. The walls were tastefully illuminated by incandescent lamps, the current being derived from accumulators. The whole of the electrical gear was kindly lent by Mr. R. A. Scott, of Acton Hill, and the installation was carried out by members of the Acton Hill Engineering Works, who gave their services. Owing to a ball having been held on the premises the previous evening, the electrical work had to be carried out during the night. The Countess of Winchelsea and Nottingham, who performed the opening ceremony, expressed much pleasure at the effective illumination of the hall.

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COLLIER AUDIBLE TELEPHONE SYNDICATE (LIMITED).—Creditors of this Syndicate (in voluntary liquidation) must send particulars of their claims to the liquidator, Mr. Godefroi Drew Ingall, 4, Coleman-street, E.C., on or before December 16th.

SIAM.—The Brush Electrical Engineering Company (Limited) have received advices by cable from their representatives at Bangkok that the central station plant supplied by them to the Siam Electric Light Company (a reference to which Company appeared in our last issue) has undergone the fortnight's trial prescribed by the arbitrators under their award with complete success, and to the entire satisfaction of the experts, and that the balance of moneys due thereon has been paid over by the Treasury.

THE LONDON CHAMBER OF ARBITRATION, GUILDHALL.—This Chamber, which has been established by the Corporation of the City of London, with the co-operation of the London Chamber of Commerce, for the speedy and inexpensive settlement of disputes arising in the course of business, has now been organised, and it is to be hoped that the facilities thus provided for disputants will enable them to settle their differences without having recourse to expensive litigation, and especially such trade disputes as can best be dealt with by experienced men of business.

MR. THOMAS PARKER.—Mr. T. Parker, of the Electric Construction Corporation (Limited), Wolverhampton, was the recipient last week of a handsome brougham and an illuminated address from the Liberal electors of the Kingswinsford division of Staffordshire. It will be remembered that Mr. Parker unsuccessfully contested the division in the Liberal interest at the last election, and made a plucky fight.

ELECTRIC LIGHT AND ATHLETICS.—Mr. Lang, the proprietor of the Carrick-street Cycling and Athletic Grounds at Ayr, has recently introduced the electric light, the result being a distinct success. At the recent trial, the effect gave so much satisfaction to those present that it was resolved to postpone several important athletic events, in order that they might take place at night instead of in the daytime, the result being that a very much larger number of people witnessed the sports than would have otherwise been the case to the profit of the management. There is room for development in this direction.

COUNTRY HOUSE LIGHTING.—Benmore, near Kilman, Argyleshire, has recently been fitted throughout with the electric light. A Priestman patent oil engine supplies the motive power, the installation consisting of about 180 lights. The electroliers and fittings used in the installation were specially designed by Munro's Electrical Manufacturing Company (Limited), and the installation was carried out under the supervision and to the specifications of Mr. W. A. Bryson, of Glasgow. Messrs. Ernest Scott and Mountain (Limited) supplied the electrical machinery, and contracted for the erection of the plant.

DUNDEE.—Mr. C. Martin delivered an interesting lecture before the Dundee Mechanical Society last week on electric light and power. Lord Provost Matthewson presided, and the room in the Technical Institute, where the lecture was delivered, was crowded. After the lecture a cordial vote of thanks was accorded to Mr. Martin.——At the last monthly meeting of the Gas Commission it was agreed to fix the electric meter rents on a scale of 12½ per cent. on the cost of the meters, the meters selected to be used being Ferranti, Aron, or Kelvin. In reply to a question as to the progress which is being made with the works, it was stated that they were proceeding very rapidly, and that doubtless the city would be lighted by electricity about Christmas. Twenty-five per cent. of the total capacity of the present works had already been completed.

EALING.—At the Local Board meeting last week it was decided to expend the sum of £50 in procuring the report of an expert as to the advisability of inviting schemes for lighting the district by electricity. The Electric Lighting Committee of the Local Board had visited some of the districts which have already adopted the electric light, and recommended the course above referred to.

GUILDFORD.—The Electric Lighting Committee of the Urban Sanitary Authority has not yet met to discuss the subject of adopting the electric light for the district; but the members have collected a mass of evidence, which will shortly be laid before the local authority.

NORTHAMPTON.—The Lighting Committee of the Town Council have decided to extend the electric light, which was recently adopted for the large fountain in the Market Square, to the lighting of the whole square.

TORQUAY.—At their meeting last week the Torquay Town Council, after electing the Electricity Committee, discussed the question of the Electric Lighting Order, which expires in July next. Mr. Hex, who brought the matter forward, understood that it would not be necessary to take steps for the promotion of a Provisional Order as the Board of Trade had notified him that these Provisional Orders did not as a rule lapse simply because the compulsory works were not completed within the time limited by the Order. The discussion which followed showed that the members were taking a keen interest in the subject of the lighting of the town.

EXETER.—At the meeting of the Exeter City Council last week a letter was read from the Board of Trade calling attention to a complaint made by the Exeter Electric Lighting Company, that power had been granted to private persons to open up the streets for the purpose of supplying their own private premises with the electric light, and complaining that this power had been granted without the local authority insisting upon conditions similar to those contained in the Provisional Order granted to the Company. The Company asked the Board of Trade to exercise the powers vested in them by the Electric Lighting Acts, and to notify the local authority that they have no power to authorise breaking up the public streets for the purpose of laying electric mains by any persons other than those possessing a Board of Trade Licence or Provisional Order. After some discussion, it was decided to write to the Board of Trade simply acknowledging the receipt of the letter.

ISLINGTON AND HACKNEY.—The Vestry of the former and the Board of Works of the latter Authority have given notice of their intention to apply for a Provisional Order to enable them to produce a supply of electricity for public and private lighting. It is proposed to open up the principal streets in the district, including High-street and Upper-street, Islington; Holloway-road and Seven Sisters-road; High-street, Kingsland; High-street, Stoke Newington; Kingsland-road, Mare-street, Stoke Newington-road, and Dalston-lane.

LIVERPOOL.—The Mayor of Liverpool, Mr. R. D. Holt, has offered to instal the electric light in the large ball room of the Town Hall, but the Finance Committee of the Corporation think the work should be undertaken at the public cost, and the matter has been referred for consideration.

ELECTRIC TRACTION.—Before the Liverpool Polytechnic Society on Monday last a Paper on Electric Traction was read by Mr. F. G. Baily, of Universty College, Liverpool. After an historical account of the application of electricity as a tractive force, Mr. Baily described the methods now in use in the various traction systems.

LECTURES ON ELECTRICITY.—A series of free lectures is being given at the Picton Lecture Hall at Liverpool, and on Tuesday last Dr. Howard, of University College, explained to a crowded audience the various applications of electricity.

LLANDUDNO.—At the last meeting of the Improvement Commissioners the question of a considerable extension to the Gas Works came under consideration. The Chairman of the Lighting Committee informed a member that the question of electric lighting had not been overlooked.

RHONDDA VALLEY.—The localities of Cwmdare and Cwmparc in the Upper Rhondda, where the collieries of the Ocean Colliery Company are situate, and where the Company have hundreds of workmen's cottages, have recently been lighted by electricity, the generating plant being situate in the fan engine-house and the motive power produced by the fan engine. The light has also been extended to the chapels in the district.

JUNIOR ENGINEERING SOCIETY.—On Saturday last a party of members of this Society were shown over the Richmond Lock, Weir, and Foot Bridge Works by Mr. C. Le Neve Foster and Mr. E. Duncan Stoney, representing the Thames Conservancy and the contractors for the works, Messrs. Ransomes and Rapier.

SYDNEY, N.S.W.—The electric light is making steady and important progress in Sydney, and amongst the recent installations is that at the large wool stores of Messrs. Dalgety and Co., Miller Point, Sydney, where the electric light has been fitted throughout the large buildings (including the whole of the large wharves owned and occupied by Messrs. Dalgety) by the Electrical Material and Lighting Company (Limited). The lamps used for the wharf lighting are portable, and are found to be very convenient, as they can be moved from place to place wherever necessary for the work. One Brockie-Pell arc lamp of 2,000 c.p. is included in the installation. The dynamos are of the Manchester type.

WEST OF ENGLAND LIGHTING.—An article appears in the *Western Morning News* of the 16th inst. commenting upon the slow progress of the electric light in the West of England. The article is carefully written, and should have the effect of awakening an interest in the subject of municipal lighting in the west. The writer points out the many advantages of electric lighting over gas, and deals with the subject from a statistical point of view, showing how general the installation of the electric light is becoming, and calling upon the local authorities of Devon and Cornwall to bestir themselves in the matter.

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PATENT RECORD.

The following list of applications for patents and specifications has been compiled for this journal by MR. J. C. CHAPMAN, *patent and registration agent, Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any available information may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

October 25, 1892.

19,184. O. IMRAY. London. An improvement in incandescent electric lamps. (The Westinghouse Electric and Manufacturing Company, United States.)

19,194. C. L. DAVIES. London. Improvements in telephones and in the application thereof to railway signalling.

October 26, 1892.

19,220. E. FREUND. London. Improvements in electric batteries. (E. Freund, Austria.)

19,222. D. SALOMONS and L. PYKE. London. An improved apparatus for the production of electric currents, alternating in direction with great frequency.

19,236. G. WILKINSON. Lancashire. Improvements in and relating to the generation and distribution of electrical energy.

19,242. A. OBLASSER and C. THÉRYC. London. Improvements in cases for containing electric batteries and the like. [Date applied for under Patents Act, 1883, Sec. 103, April 26, 1892, being date of application in France.]

19,248. C. E. WEBBER. London. Improvements in conduits for electrical conductors.

October 27, 1892.

19,282. W. WALKER. Birmingham. An improvement in or connected with galvanic batteries.

19,293. R. BAUMANN. London. Improvements in electric lock and alarm.

October 28, 1892.

19,361. A. S. FORD. London. An improved process of electro-plating glass, china, &c.

19,385. W. LOWRIE. London. Improvements in or relating to the distribution of electrical energy and in maintaining the potential thereof.

19,386. W. LOWRIE. London. Improvements in or relating to the supply of electrical energy for propelling or lighting purposes upon electrical railways.

19,387. SIEMENS BROTHERS AND CO., LIMITED. London. Method of increasing the speed of signalling in submarine or subterranean cables, and the construction of such cables for this purpose. (Messrs. Siemens and Halske, Germany.)

19,393. T. FROGGATT. London. Improvements in electric battery apparatus.

19,404. J. S. RAWORTH. London. Improvements in or relating to safety cut-outs for electric generators, transformers, and motor generators coupled in parallel.

October 29, 1892.

19,451. H. F. JOEL. London. Improvements in voltaic batteries, electrodes, and connections.

19,478. A. PALAZ and V. DUBOUX. London. Improvements in electrical apparatus for increasing the adhesion of the wheels of engines on railway rails.

October 31, 1892.

19,496. W. LOWRIE. London. Improvements in and relating to electro-magnets and magnetic circuits.

19,497. H. CLEGG. West Norwood. Improvements in electric lamps and in their manufacture.

19,543. L. B. STEVENS. London. Improvements in electric indicating apparatus.

19,547. R. DAMSEAUX. London. Improvements in microphones.

19,569. O. FERGUSSON. London. Improvements in electrical connections.

November 1, 1892.

19,602. A. B. BLACKBURN. Manchester. Improvements in electric switches.

19,646. W. LOWRIE. London. Improvements in the method of supplying electrical energy of required potential to electric current circuits.

19,655. H. G. O'NEILL. London. Improvements in and relating to a method of and means for heating by electricity.

19,657. R. EWING. London. Improvements in underground conduits for electric cables.

19,665. G. S. HOOKER. London. Improvements in and relating to telephonic apparatus.

19,671. M. W. POLLARD. London. Improvements in means for conducting electricity for electric lighting and other purposes.

November 2, 1892.

19,690. O. A. ENHOLM. Manchester. Improvements in and connected with the distribution of current in incandescence electric light circuits. [Date applied for under Patents Act, 1883, Sec. 103, October 3, 1892, being date of application in United States.]

19,699. D. SINCLAIR. Glasgow. Improvements in telephonic apparatus.

19,714. H. CHITTY. London. Improvements in dynamo electric machines.

19,729. C. POLLAK. London. Improvements in and means or apparatus for rectifying alternating currents for working continuous current motors, and for electrolytical purposes.

19,730. G. J. PHILPOTT and A. J. WILLETT. Brighton. Improvements in distributing boxes for electric light, and power mains for underground and aërial purposes.

19,738. THE EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED, and E. A. GIMINGHAM. London. Improvements in portable electric safety lamps and batteries and appliances for charging them.

19,739. E. L. JOSEPH. London. An improved electrical switch.

19,749. H. HARRIS. London. Improvements in the construction of indicating and transmitting instruments for telephones.

19,758. W. LOWRIE. London. Improvements in electric conductors.

19,761. H. R. MALTBY. London. Improved means for obtaining electricity on board ship.

November 3, 1892.

19,771. J. MUIRHEAD. Glasgow. Improvements in and relating to telephonic instruments.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

17,836. LUCAS. Electric meters.
18,436. Baron KELVIN. Measuring and recording electric currents.
18,477. SCHLESINGER. Galvanic batteries.
20,686. MARTIN and HUNTER. Electric lights for ships.
21,018. SCHMIDT. Electric arc lamps.
21,143. ADAMS. Electric cut-outs.
21,154. SNELL and others. Electric lamp-holders.
21,246. MUNRO. Dynamos.
21,250. FRANK and ROSENTHAL. Phonographs.
21,369. LAKE (Müller). Secondary batteries.
21,651. DINGLE and URQUHART. Electric circuits.
21,702. THOMPSON (Kerckhove). Electrodes for accumulators.
21,720. HOWELL and POWNALL. Electric switches.
21,849. PATERSON and FURNEAUX. Dynamo electric machines.
21,923. BERRY. Driving clockwork electrically.
22,027. SILBERBERG. Electric light shades, &c.
22,145. THOMPSON (Hirsch). Galvanic batteries.
22,316. ANDREWS. Electrical distribution.
22,404. BOWDEN and others. Coupling electric mains.
22,542. PHILLIPS and ROSE. Conducting electricity to lamps.
22,695. IMRAY (Westinghouse Electric and Manufacturing Company). Electrical circuits.
22,725. DINGLE and URQUHART. Electric circuits.

1892.

1,626. EVERED. Electrical incandescent lamps.
13,920. KNIGHT and POTTER. Regulating electrically-driven mechanism
15,238. BENNETT. Telephonic switching apparatus.
15,691. DRILL. Electric air ships.
15,833. THOMPSON (Dill). Telegraphic apparatus.
15,864. ATKINSON. Electrical switches.
15,998. NEWTON (Barrett). Electric circuits and cables.
16,014. MACKINTOSH. Phonographs.
16,371. SOLEY and others. Electric locomotives.
16,434. DORMAN and SMITH. Electric light switches, &c.
16,461. MAIN. Secondary batteries.
16,469. WEBBER. Electric lamp fittings.

COMPANIES' MEETINGS & REPORTS.

Swan United Electric Light Company (Limited).

The tenth annual report of the Directors of this Company for the year ending September 30th last is issued, and will be presented to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel, E.C., on Tuesday, the 29th inst., at 12 o'clock.

The profit and loss account for the year shows a credit balance of £34,840. 11s. 11d., which, together with £8,010. 3s. 10d. brought forward from the last account, makes disposable the sum of £42,850. 15s. 9d. An interim dividend in respect to the first half of the year amounting to £14,558. 9s. 8d. has already been paid. The Board proposes that a further sum of £21,467. 8s. 4d. be divided free of income-tax, and that £6,824. 17s. 9d. be carried forward. The distribution of this amount in accordance with Clause 77 of the Articles of Association will work out at 4s. 2⅜d. per share on the 78,949 ordinary shares of the Company, £3. 10s. paid, and at 4s. 11⅜d. per share on the 19,750 £5 fully paid, being equivalent to 10 per cent. per annum on the partly paid, and of slightly under that rate upon the fully paid, shares. The dividend will be paid upon the register as it stood upon the 15th November inst., and the warrants will be issued on December 13th.

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The litigation on the German patents of the Company having happily terminated, and the bulk of the capital of the Company being now invested in the Edison and Swan Companies in Great Britain and France, the Board believe that the time has arrived when a fusion of the residuum of the foreign business of the Swan Company with the British Edison and Swan Company may be effected with advantage to both interests, and negotiations are pending with a view to effecting some arrangement in this direction.

The Directors desire to record their sense of the loss which the Company have sustained by the death of Mr. F. R. Leyland, Deputy-Chairman of the Company. The Directors have elected Major Samuel Flood Page, who had been Secretary and Manager of the Company for several years, to a seat on the Board. The Directors who retire by rotation are Mr. J. S. Forbes and Mr. E. W. Batt, who, being eligible, will offer themselves for re-election. Messrs. Welton, Jones and Co., the auditors, will also retire, and will offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322, *&c., &c.*]

COMPAGNIE DES FORCES ELECTRIQUES.—A Company with the above title has been formed in Paris, the chief promoters of the undertaking being M. Richemond, the Compagnie de Construction Electromécanique, the Compagnie Continentale Edison, the Société Générale des Téléphones, and Messrs. Ménier.

HEATLEY AND GRESHAM (LIMITED).—This Company was registered on November 15th, with a capital of £10,000, in £50 shares, to manufacture machinery, motors, boilers, &c., of all descriptions, and to carry on the business of mechanical and electrical engineers, iron workers, iron and brass founders, &c.

SCARBOROUGH ELECTRIC SUPPLY COMPANY (LIMITED).—This Company was registered on November 17th, with a capital of £50,000, in £10 shares. The objects are to carry on the business of electrical engineers and contractors, suppliers of electricity, undertakers for the supply of electricity for lighting, transmission of power, and other purposes, whether public or private, and manufacturers of, and dealers in, all apparatus and things required for, or capable of being used in connection with, the generation, accumulation, supply, distribution, and employment of electricity; to promote, support, and obtain any Acts, Provisional Orders, licenses, and other authorities necessary or desirable for carrying out any of the objects of the Company, and in particular to take a transfer of the powers, duties, and liabilities granted to, or imposed upon, the Mayor, Aldermen, and Burgesses of Scarborough by the Scarborough Electric Lighting Order, 1891. The subscribers are :—

	Shares.
Richard F. Steble, J.P., Ramsdale Bank, Belmont-road, Scarboro'.	50
George Alderson-Smith, J.P., Wheatcroft Cliff, Scarborough	50
John Dale, J.P., Netherbank, Scarborough.....	50
John W. Woodall, St. Nicholas House, Scarborough.....	50
George L. Beeforth, J.P., Belvedere, Scarborough.....	50
Hon. Charles A. Parsons, Heaton Works, Newcastle-upon-Tyne	50
John B. Simpson, Hedgefield House, Blaydon-on-Tyne	50
A. A. Campbell Swinton, 66, Victoria-street, Westminster, S.W.	50

WRIGHT AND BUTLER LAMP MANUFACTURING COMPANY (LIMITED).—This Company was registered on November 17th, with a capital of £100,000, divided into 4,000 Preference and 6,000 ordinary shares of £10 each, to acquire, take over as a going concern, and carry on the business of lamp manufacturers, brass and ironfounders, tin-plate workers, chandelier manufacturers, glass merchants, &c.

MISCELLANEOUS.——ANTI-FRICTION ROLLER BEARING SYNDICATE (LIMITED), capital £30,000, in £1 shares.——JAMES SAMPLE AND CO. (LIMITED), mechanical engineers, &c., capital £2,000, in £10 shares.——LEACH AND CO. (LIMITED), engineers, capital £5,000, in £5 shares.

ABELL'S ELECTRICAL ENGINEERING COMPANY (LIMITED).—The statutory return of this Company, made up to September 8, 1892, has been filed. The Company was registered on May 3, 1892, with a capital of £5,000, in £5 shares. At the time of making-up, 360 shares were taken up, of which 120 were issued as fully paid to the vendors. Upon the remaining 240 shares £3 per share has been called, resulting in the payment of £650, leaving £70 in arrears.

R. C. CUTTING, DOUGLASS, AND CO. (LIMITED).—At extraordinary general meetings of the members of this Company, held at the office on September 20th and October 7th, special resolutions were passed and confirmed that the Company be voluntarily wound up, and that Mr. S. J. Skelton, of Wardrobe-chambers, E.C., be the liquidator.

ELECTRIC TRUST (LIMITED).—The annual return of this Company made up to October 10th, was filed on October 19th. The Company was registered on June 24, 1889, with a capital of £60,000, in £10 shares, and in December, 1890, the capital was increased to £60,200 by the creation of 200 founders' shares of £1 each. At the time of making-up, 1,675 £10 shares and 167 founders' shares were taken up, the full amounts called, and all calls (£16,917) paid.

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The statutory return of this Company, made up to September 12th, was filed on November 15th. The capital of the Company is £98,000, in 14,000 shares of £7 each. At the time of making up 3,999 shares had been taken up, all of which had been issued with £5 considered as paid on each share. These shares have been issued to those shareholders in the Sheffield Telephone Exchange and Electric Light Company (Limited) who agreed to take partly-paid shares in the new Company in full consideration for their interest in the old Company.

TAYLOR AND TUCKER ART METAL COMPANY (LIMITED).—The annual return of this Company, made up to August 20th, has recently been filed. The Company was registered on May 10, 1889, with a capital of £5,000, in £1 shares. At the time of making-up, 4,400 shares were taken up, the full amounts called, and all calls (£4,400) paid.

COMPANIES TO BE STRUCK OFF THE REGISTER.—Tuesday's *London Gazette* contains a notification that at the expiration of three months the names of a great many companies will be struck off the register and the companies will be dissolved, unless cause is shown to the contrary. Amongst them are :—

Cooper's Patent Glass-lined Metal Piping Company (Limited)—taken over by Dan Rylands (Limited).
H. D. Cooper and Co. (Limited).
Durand Electric, Petroleum, and Gas Engine and Manufacturing Company (Limited).
Johannesburg Electricity Supply Company (Limited).
Morgan's Automatic Electric Signal System Syndicate (Limited).
Universal Electric Light and Power Trust Corporation (Limited).

CITY NOTES, &c.

CALLS DUE.—*Dec. 15th:* NATIONAL TELEPHONE COMPANY (LIMITED), £1 on 90,950 Five per Cent. Non-Cumulative Third Preference £5 shares.—*Dec. 30th:* ISLINGTON AND GENERAL ELECTRIC SUPPLY (LIMITED), final £1 on 45,000 £5 shares.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended November 20 were £899, as against £792 for the corresponding period of last year, being an increase of £107. The total receipts for half-year amount to £17,007, against £15,357 in the corresponding period of 1891, being an increase of £1,640.

DAN RYLANDS (LIMITED).—The Directors' report shows that the Company has experienced a prosperous year. After meeting interest charges and providing for the redemption of debentures, the Directors are able to recommend that a dividend of 10 per cent. be paid on the ordinary shares and that £733 be carried forward to the new account. Nearly £3,000 has been taken from revenue during the year to maintain the machinery and plant in good working order, and since the establishment of the Company in 1888 debentures to the extent of £14,800 have been redeemed out of profits.

ELECTRIC AND GENERAL INVESTMENT COMPANY (LIMITED).—Mr. George Herring has been elected Chairman of the Company in succession to the late Duke of Marlborough. The Directors have declared an interim dividend at the rate of 20 per cent. per annum for the six months ending the 30th inst. on the ordinary shares, payable on and after December 15th next; and the transfer books and register of members will be closed from December 1st to 15th (inclusive), for the purpose of preparing the necessary warrants.

HOVE ELECTRIC LIGHTING COMPANY (LIMITED).—As announced in our last issue, the statutory meeting of the shareholders of this Company was held on Monday last at the offices, Mansion House-buildings, E.C., with Colonel Felgate, R.E., in the chair. The report and accounts of the Directors were adopted, and the Chairman announced that 1,300 8-c.p. lamps had already been applied for, and that negotiations were in progress for the lighting of the Town Hall and the streets of Hove. On the motion of Mr. Albright, seconded by Mr. Sutton, a vote of thanks to the Chairman for presiding brought the meeting to a close.

MESSRS. RICHARD HORNSBY AND SONS (LIMITED).—The Directors of this Company recommend the payment of a dividend of 6 per cent. on the Preference Stock for the past half-year, and 2s. 6d. per share on the ordinary shares, making, with an interim dividend, 5s. per share for the year, free of income-tax. The dividend will be paid on and after the 15th proximo.

METROPOLITAN ELECTRIC SUPPLY COMPANY (LIMITED).—This Company give notice that the coupons of the Company's issue of £50,000 Five per Cent. Registered Debentures, due on December 1st next, will be paid on and after that date by the bankers, Messrs. Prescott, Dimsdale, Cave, Tugwell, and Co. (Limited), of 50, Cornhill, London, E.C., or at the Royal Bank of Scotland, 123, Bishopsgate-street Within. The register for debenture holders will be closed till December 1st.

SCARBOROUGH ELECTRIC SUPPLY COMPANY (LIMITED).—A prospectus is issued inviting applications for 2,000 shares of £10 each in this Company, payable £2 on application, £2 on allotment, and the balance by instalments of £2 at not less than monthly intervals. The authorised capital of the Company is £50,000. The Directorate includes the Hon.

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C. A. Parsons and Mr. A. A. Campbell Swinton (Managing Director and Consulting Engineer). The secretary is Mr. John Hall, 102, Westborough, Scarborough. The prospectus states that the Company is formed for supplying electricity for lighting, power, and other purposes in the town of Scarborough. The Company has taken over a Provisional Order obtained by the Corporation in 1891, and they will pay the Corporation the sum of 500gs. to cover the expenses incurred in obtaining the Order. Applications for shares should be in not later than December 3rd next.

SPANISH NATIONAL SUBMARINE TELEGRAPH COMPANY (LIMITED).—The numbers are announced of 89 bonds, amounting to £8,900, of the Six per Cent. Mortgage Debentures drawn for payment at par on or after December 31st.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended November 15th show a decrease of £185, as compared with the corresponding period. The July receipts, estimated at £4,114, realised £4,129.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Nov. 18, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,965.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 16.	Price Wednesday, Nov. 23.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 23.	
								Highest.	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	50½ 51½	50½ 51½	4 17 1	Jan., Apr., July, Oct.	50⅜	50⅛
£2,876,140	Stock	25/0	Do. Preferred	91 92	91 92	5 15 5	" "	92⅛	91¾
£2,876,140	Stock	5/0	Do. Deferred	11½ 12	11½ 12	..	" "	11⅞	..
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July ..	102½	..
130,000	£10	4/0	Brazilian Submarine ..... xd and bonus	10¾ 11¼	10¾ 11¼	5 15 7	Mar., June, Oct., Dec.	11⅛	10⅞
£68,200	£100	5%	Do. 5 per Cent. Bonds	101 104	101 104	4 16 2	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	104 108	106 110	4 10 11	June and December	107	..
$7,716,000	$100	$1⅔	Commercial Cable Capital Stock	181 183	183 185	3 15 8	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½ 12½	11¼ 12½	6 19 2	February and August	..	..
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	" "	..	..
12,931	5	1/7⅕	Direct Spanish (£4 paid)	3 3½	3 3½	4 11 5	April and October..	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11½ 11⅞	11½ 11⅞	5 19 2	Jan., Apr., July, Oct.	11⅞	11½
400,000	10	2/6	Eastern	14¾ 15	14¾ 15	4 6 8	" "	15	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15¾ 16¼	15¾ 16¼	3 13 10	" "	16⅛	..
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109 112	109 112	3 11 5	May and November	111⅛	110
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	109	..
250,000	10	2/6	Eastern Extension	14¾ 15	14¾ 15	4 13 4	Jan., Apr., July, Oct.	15	14⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	110¼	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104 107	104 107	4 13 6	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103 106	104 107	4 13 6	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	103 106	3 15 6	February & August	105¼	..
180,227	10	1/0	Globe Telegraph and Trust	9⅞ 10⅛	9⅞ 10	4 15 0	Jan., Apr., July, Oct.	10	9⅞
180,042	10	6%	Do. 6 per Cent. Preference	15 15½	14⅞ 15⅛	3 19 4	" "	15⅛	14⅞
150,000	10	5/0	Great Northern	18¾ 19¼	19 19½	4 7 2	Jan., April, and July	..	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	104 107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	43 45	43 45	5 11 1	May and November	43½	..
38,348	10	4/0	London Platino-Brazilian	6 7	6 7	5 14 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	107 110	107 110	5 9 1	March & September	108½	..
10,802	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October..	8⅜	8
3,381	£100 Cert.	30 0	Submarine Cables Trust 6%	117 121	116 120	5 0 0	" "	116½	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July ..	7¼	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	100⅛	100
30,000	10	2/0	West Coast of America	2½ 3½	2⅜ 3⅜	..	January and July ..	3	..
£150,000	100	8%	Do. Debentures 8% 1902	103 107	103 107	7 9 7	June and December	..	..
88,321	10	6d.	West India and Panama xd	1¼ 1⅜	1¼ 1⅜	..	" "	1⅜	..
34,563	10	6%	Do. 6 per Cent. 1st Preference xd	10 10½	10 10½	5 14 3	May and November	10½	10⅛
4,669	10	6%	Do. 6 per Cent. 2nd Pref. xd	8⅛ 9⅛	8⅛ 9⅛	6 6 4	" "	..	..
64,242	15	3/0	Western and Brazilian xd	8 8⅛	7⅞ 8¼	5 9 1	" "	8 5/16	
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred xd	6 6½	5¾ 6¼	6 0 1	" "	6⅛	
33,129	7½	4/6	Do. 5 per Cent. Deferred	2¼ 2¾	2 2⅜	..	" "	2 7/16	
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	106 109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	106 109	5 10 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	120⅛	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
224,800	14/0	1½d.	Consolidated Telephone Const. & Maintenance	¼ ⅜	¼ ⅜	6 10 10	May and November	..	..
220,000	£1	4⅜d.	Oriental (11s. paid)	7/16 9/16	7/16 9/16	7 18 2	Yearly	..	..
438,984	5	3/6	National	4¾ 5	4⅝ 5⅛	5 17 1	June and December	5 1/16	4⅞
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 14½	14 15	4 0 0	" "	14½	14½
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13⅞ 14	13⅞ 14½	4 4 3	" "	14⅛	14
420,000	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	111 113	112 114	3 18 11	January and July ..	113	112¾
48,000	£10	..	New Telephone, Limited (£2 paid)	3¾ 4⅛	3¾ 4⅛	..	..	4 1/16	3 15/16
58,000	5	1/0	United River Plate	2⅜ 3	2⅜ 3	..	January and July ..	2 15/16	2⅜
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	—	..	—
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	10½ 11	10½ 11	..	—	10¾	10⅝
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	—	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	2¼ 3½	2⅜ 3⅜	..	—	—	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5½	5 5½	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	5½ 5⅝	5½ 5⅝	..	January and July ..	..	..
30,000	£5	4½% '91	Liverpool Electric Supply (£3 10s. paid)	3 7/16 3⅝	3⅞ 3 9/16	3 15 9	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 7/16 5 9/16	5 7/16 5 9/16	4 6 9	March	..	..
111,000	5	..	London Electric Supply	7/8 1	7/8 1	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	..	..	..
£50,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	103 105	103 106	4 14 4	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	—	—	..	..
18,680	£5	2/6	St. James' and Pall Mall	8 8½	8 8½	—	—	8⅝	8 7/16
7,900	£5	7%	Do. 7% Preference	8 8½	8 8½	—	—	8 7/16	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5¾ 6¼	2 8 0	—	6⅛	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1 9/16	Brush Electrical Engineering	3 3½	3⅜ 3⅝	..	—	3⅝	3 7/16
69,996	2	6%	Do. 6 per Cent. Preference	2¼ 2½	2⅜ 2⅝	5 1 1	..	2⅝	2¼
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼ 5⅝	5½ 5¾	6 7 3	January and July ..	..	..
12,139	5	17%	Edison and Swan United	.. ..	.. ..	—	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	2¾ 3½	2¾ 3¼	..	..	..	..
45,000	10	12/0	Electric Construction	3¾ 4½	3½ 4	..	—	4	3¾
70,000	2	10/0	Elmore's Patent Copper Depositing	1¼ 1½	1⅜ 1⅝	..	—	1½	1⅜
20,000	5	..	Fowler-Waring Cables (fully paid)	2½ 3½	2 3	..	..	2½	
50,000	10	10/0	India Rubber, Gutta Percha & c., Works	21½ 22½	21½ 22½	5 11 1	February & August	22	21⅜
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	1⅜ ¼	4/0 4/6	..	..	..	..
78,949	5	2/9⅔	Swan United (£3. 10s. paid)	3¼ 3¾	3¼ 3¾	10 4 10	May and November	3⅝	3⅜
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July...	46⅜	45¾
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103 106	103 106	4 14 4	January and July ..	105¾	..
—	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	½ ¾	½ ¾	..	—	..	..
—	£5	8%	Do. Preference (fully paid)	2½ 3	2½ 3	..	—	..	..
			RAILWAYS AND TRAMWAYS.						
50,000	£10	½%	City and South London Railway	3 4	3 4	1 5 0	—	3¾	3½

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Harbour Office, Belfast, 25th November, 1892.

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Capital Paid up	£366,702	0 0
Fire and other Reserve Funds, including Balance of Profit and Loss	2,981,078	0 0
Life and Annuity Funds	4,546,577	0 0
Total Invested Funds, 31st December, 1891	£7,894,357	0 0

INCOME FOR THE YEAR. . . . £2,230,635

The following Comparative Statement shows the progress of the Company:—

1881	... Life Funds	£2,737,858	... Total Funds	£4,673,299
1886	... „	3,257,609	... „	5,672,041
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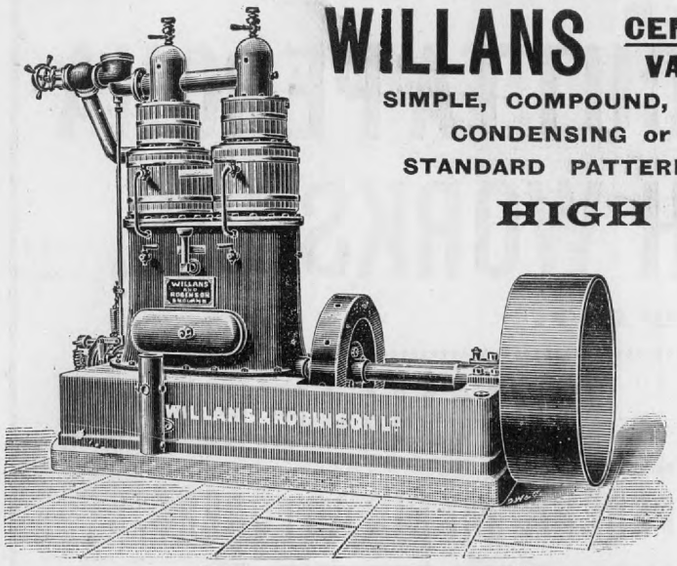

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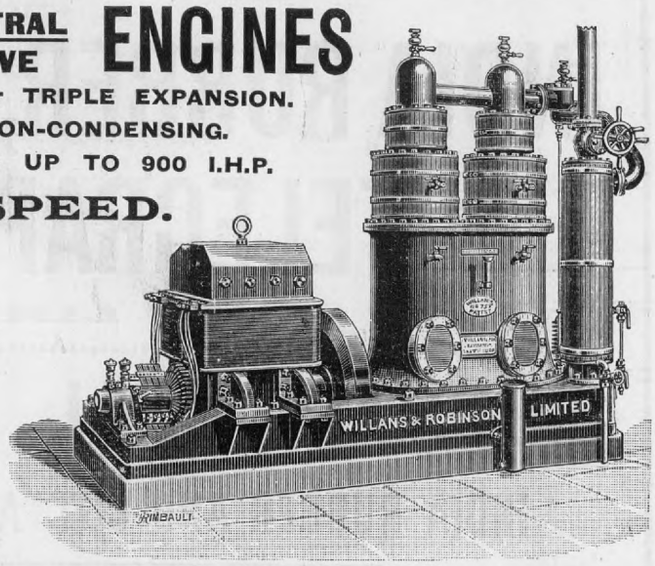

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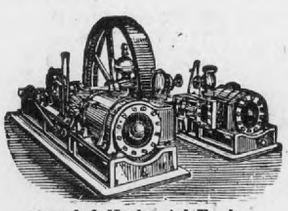

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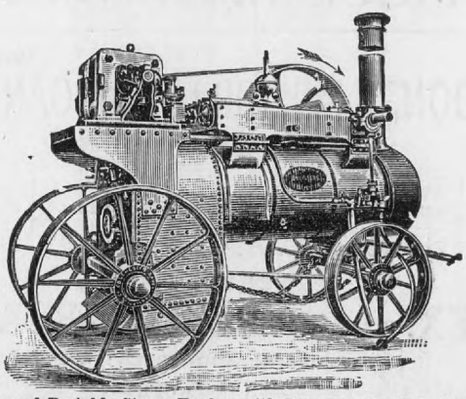

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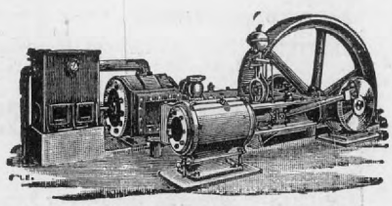

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 759.—Vol. XXX FRIDAY, DECEMBER 2, 1892. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

The French counterpart of the Electrical Trade Section of the London Chamber of Commerce, the Syndicat Professionnel des Industries Électriques, seems to be strikingly similar to our own institution. As at Botolph House, the attendance is usually small, and the discussions long and luminous. Thus, at the last meeting of the Syndicat Professionnel the first subject discussed was the question of arbitration; should or should not the Syndicat undertake such duties? The President, M. Sciama, was inclined to say no, since the Tribunal de Commerce was not legally bound to accept the decisions nor the litigants to submit to the jurisdiction of the Syndicat. In the end, however, the duties of arbitrator were undertaken, these admittedly cogent objections notwithstanding.

The next business of the meeting was the nomination of a technical assessor for the Tribunal de Commerce, a function, alas! which the Electrical Trade Section is not likely as yet to be called upon to perform. Next followed a report with regard to the interviews which had taken place between M. Sciama and M. Méline, President de la Commission des Douanes, in regard to the proposed Franco-Swiss tariff. This tariff-mongering, again, is not a piece of work which is likely to fall to the lot of those who attend the meetings at Botolph House.

The last item on the programme was a big one, like its title, being nothing less than a *projet de création d'un bureau de contrôle des installations électriques à l'interieur des habitations.* M. Fontaine set forth the difficulties which he had encountered, even in the preliminary stages, in realising this project; there were so many people to please—electricity supply companies, wiring contractors, consumers. It was generally agreed that the establishment of a central, impartial, and competent body to supervise interior wiring, draw up rules, and grant certificates was desirable, and likely to meet with considerable support, "provided the contribution demanded was not too onerous." A final decision, however, was deferred until the Syndicat should meet again "enlightened by the discussion which had just taken place."

Manganin has received a bad character, though professors have praised it; the alloy has been under a cloud, although the highest authority in the land has publicly extolled it; at least two of our most careful instrument makers tried it and found that not only did it fail to fulfil its early promises, but that it behaved in a curiously capricious manner. Whether the first imported samples were of an inferior quality or whether the full instructions for use were not given, or if given, were neglected—which we think is the least likely explanation—has not transpired. But we are glad to be able to report that manganin is recovering its lost reputation; and at least one engineer, if he swears at all, on which point we have no definite information, swears by it. To announce the discovery of an alloy, the electrical resistance of which is practically independent of its temperature, is a matter of very considerable importance, but to give great credit to the scientific institution which was responsible for the announcement was rather premature.

An interesting account by Dr. Lindeck of the properties of manganin will be found elsewhere in our present issue, and it is there recorded that Mr. Weston, of Newark, U.S.A., observed the low temperature coefficient of manganese alloys. When Lord Kelvin stated at Edinburgh during the discussion at the British Association that the Physikalische Anstalt had not been in existence two years before this valuable alloy was discovered, Prof. von Helmholtz interposed the remark that the discovery had been made by an American engineer. This, because Mr. Weston was domiciled in America. Prof. S. P. Thompson, however, observed that Mr. Weston was an Englishman. Graham Bell, Tesla, and a score of others whose nationalities have not yet become fused into that strange ethnical alloy, the American nation, commonly pass as Americans, and their discoveries are credited to that Republic.

The assertion made some years ago that manganin had a negligible temperature coefficient was sufficient to induce instrument makers to experiment with it, but when they found it to be unreliable, no repetition of such assertions would induce them to spend time in investigating its peculiarities. The important process of annealing at 140°C. for five hours is clearly insisted upon by Dr. Lindeck, but he gives no information about the effect of insulating materials upon it. The best paraffin is being abandoned for resistance coils, since even this sometimes attacks the wires; but paraffin seems to have a very marked effect on manganin, and it suffers not only from oxidation but in mechanical

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manipulation, unless carefully annealed. With the exception of some imported resistance boxes, "made in Germany," we have heard of its use in considerable quantities only from Mr. CROMPTON, who has constructed some very large water-cooled resistances, which, in connection with his improved potentiometer, serve to measure with great accuracy the large currents generated by supply stations.

THE minor conveniences of electric lighting add up eventually to no small sum, though this cannot be expressed in absolute dimensions; suffice it that these amenities outweigh the apparently cheaper cost of gas. The imposition of any inconvenience, even if it be only the use of short-lived lamps, should be discouraged, and anything that would entail the sudden extinction of all the lamps in a house on account, not of an accident, but of an error of judgment on the part of the consumer, should by all means be avoided. And yet we understand that it has been seriously proposed to enforce that which may be called the "Leeds" system of charging, by adjusting of the main fuse. By this system, our readers will remember, each customer is to be called upon to declare "the maximum number of lights required to be in use at any one time," and a system of rebates is based on this declaration. We have already remarked that only a very few customers are likely to benefit even by the first step of this sliding scale.

IN the "Hopkinson" or "Manchester" method of charging the maximum current must be declared, but Prof. KENNEDY points out in our Correspondence Columns this week that the notion of using the main fuse is obviously out of the question, and he proposes a current indicator with a non-return pointer. This is an improvement upon our suggestion of a recording instrument, but the question of what really is the maximum current, is raised. There is in most houses what may be called a normal or family maximum, and on occasions, which are numerous or rare in proportion to the hospitality of the household, there is a festive or maximum maximum, and even this may be exceeded on exceptional occasions. The difficulty arises in deciding which of these is to be the maximum for the purpose of settling the charge. To take the normal maximum will be to check the use of portable, occasional, or temporary lamps, and, indeed, to encourage householders of moderate means to leave some of their reception rooms unwired. To take the festive maximum will be to render the rebate practically inoperative. We are not altogether favourably inclined to Dr. HOPKINSON'S plan and look upon it rather as an ingenious method of making both ends meet in an otherwise unprofitable district.

WHILE the "Leeds" and the "Hopkinson" methods of charging have been contrived from the point of view of the supply company, M. HOSPITALIER has some advice to offer to consumers. The lamp curves, which will be found in another column, are interesting, but we agree with M. HOSPITALIER that it will be very difficult to get the general public to understand the argument, even if the exact *smashing point* could be clearly indicated.

WALL-SOCKETS with switches are among the many minor blessings of domestic electric lighting. The ease with which the current may thus be turned on compared with the fumbling with a plug commends itself to all who use them. But a little accident which has happened at Sir DAVID SALOMON'S laboratory suggests that there may be something more than convenience in such an arrangement, and in sending us the result he writes that he has always insisted upon the combination of a switch with a wall-socket on the score of safety. The plug in question was used with a Kelvin multicellular voltmeter. One of the contacts is in good condition, but the other is burned, and has been unmistakeably fused, as though a six or eight ampere arc had played for a few seconds. Sir DAVID SALOMONS assures us, however, that the damage was done bit by bit over a period of about six months. Occasionally the voltmeter did not move, and the plug was "pushed a little"—and at last it failed. The cover and base being fireproof, no harm was done. Sir DAVID SALOMONS has been good enough to give us further information on this subject in reply to our inquiries, and he points out that a No. 18 S.W.G. copper wire was not destroyed, and therefore a sudden short circuit must have been out of the question. Mr. PREECE'S experiments on fuse wires, however, show that no less than one hundred amperes are required to fuse No. 18 copper wire, though, of course, it would carry much less when covered in. We still hesitate to accept the "bit by bit" theory, but little accidents like these are worthy of careful attention, and we have been indebted to Sir DAVID SALOMONS on former occasions for interesting details of such failures.

O.S.A.—A full report of Mr. Ll. B. Atkinson's presidential address on "Human Dynamics" will appear in our next issue, revised by Mr. Atkinson.

Electric Light Mains in Paris.—It is said that at least two of the Paris electricity supply companies propose to relay their entire network of mains.

Electric Traction in Sweden.—The Municipality of Stockholm has granted a concession to the Stockholm-Rimbo Railway Company for an electric tramway.

The South Staffordshire Cars.—Mr. Dickenson, general manager to the South Staffordshire Tramway Company, made arrangements to inaugurate the electric system yesterday.

Post Office Appointment.—Mr. J. Gavey, superintending engineer, to be principal technical officer in succession to Mr. Hookey, who has been appointed assistant engineer-in-chief.

Belfast.—In consequence of a decision arrived at by the Belfast Harbour Commissioners, a considerable portion of the County Down side of the harbour will, at an early date, be lit by electricity.

Cable to the Andamans.—The question of connecting Port Blair with the main land by cable has, says the *Indian Engineer*, been once more shelved by the Government of India on the ground of financial exigencies.

The Chicago Auditorium.—The auditorium building at Chicago is lighted by electricity by means of an isolated plant which is the largest of the kind. The installation comprises 25,000 incandescent and 200 arc lamps.

Sir John Pender.—The Queen held an investiture of the Order of St. Michael and St. George at Windsor Castle on Tuesday last, at which Sir John Pender was formally invested with the insignia of the Order.

Electrical Courses.—The Turçoing Chamber of Commerce has recently inaugurated a course of instruction in industrial electricity adapted for workmen and foremen, and has confided the work of instruction to—M. l'Abbé Courquin.

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Cambridge.—The Electric Lighting Company turned on current for the first time last week. It is stated that the Master of Magdalen has applied for an injunction to compel the Company to abate the nuisance caused by their generating station.

The Joy Valve Gear.—Mr. David Joy, the inventor of the well-known valve gear, is applying for an extension of his patents for "improvements in steam engines." Caveats from those opposing the extension must be filed before December 20th next.

Hamburg.—The streets of Hamburg are to be electrically lighted, and the principal roads are now furnished with arc lamp standards. The method used in Milan, of suspending the lamp in the middle of the street by means of a cross wire, is also being tried.

Yarmouth.—The Electric Light Committee (consisting of the whole Town Council), sitting to discuss and determine the question of the introduction of the light into the town, have resolved to recommend the Council to undertake the lighting of the borough by electricity, involving an outlay of £20,000.

Hove.—The electric lighting of Hove was formally inaugurated on Monday evening at the Town Hall in the presence of a large and influential gathering, presided over by Mr. Woodruff, J.P., Chairman of the Hove Commissioners. The formal switching on of the current was performed by Lady Louise Loder.

Discoveries of Metals.—According to *Industries* a further discovery of plumbago has been made at Baddegama, in the Galle district, Ceylon, the vein being 4ft. thick, and lying close to the surface. A new discovery of platinum and iridium has also recently been made in the Mudgee district of New South Wales.

Montreal.—A petition, said to have about 10,000 signatures, has been sent to the City Council against the running of electric cars all the winter. The plea for this is that the streets on which the cars run will be almost bare of snow and prevent sleighing, while other streets will be covered with snow and forbid wheeling.

Exhibitions.—After some difficulties, which have now been satisfactorily surmounted, the project for holding in Rome in 1895-96 an International Exhibition of Fine Arts and Electricity is said to be under way. This is intended to solemnise the twenty-fifth anniversary of the annexation of Rome to the Kingdom of Italy.

Wandsworth.—The Wandsworth District Electric Supply Order, 1890, has been revoked by the Board of Trade, the promoters having failed to comply with requirements. An Order has been applied for by the County of London Electric Lighting Company for the supply of electricity throughout the whole of the district of the Board.

Toynbee Hall Electrical Society.—Mr. R. W. Paul, of 44, Hatton-garden, has kindly presented the members of this society with one of his latest pattern Ayrton-Mather reflecting galvanometers (d'Arsonval type) for use in the laboratory at 34, Commercial-street. Competition among other electrical firms in this direction would be appreciated.

Physical Society.—Owing to pressure on our space we have been compelled to hold over our report of the proceedings at the last meeting of this Society. Without diagrams Messrs. Rimington and E. Wythe Smith's Paper on "Experiments in Electric and Magnetic Fields, Constant and Varying" would be unintelligible, and the diagrams occupy a considerable amount of space.

The Atlantic Cables.—A report appeared this week that an amalgamation between the Commercial Cable Company and the French Cable Company had been effected by the purchase of the control of the French Company by the Commercial Company. There is no truth in these rumours, nor is it likely that such an amalgamation can be effected, seeing that French law directs that French cables must be owned by French citizens.

Simla.—The question of lighting Simla with electric light is under consideration, and it is proposed, if a practicable scheme is prepared, to form a company to carry it out. Engineers are examining the project for drawing the requisite power from the Sutlej. On account of the expense, however, this project, says the *Indian Engineer*, is likely to be given up in favour of another, which would draw the power from the municipal waterworks.

Transmission of Power in Cassel.—The Cassel transmission of power plant was described by Mr. Kapp in a Paper read by him at the recent meeting of the British Association in Edinburgh. (See *The Electrician*, Vol. XXIX., p. 422.) This installation possesses several remarkable features, not the least being that it has paid, although only in operation nine months, the profits, it is stated, being about 25 per cent. of the receipts, which were about £3,500.

Electric Power Transmission in Scandinavia.—The largest electric transmission of power plant in Sweden has recently been installed at Grycksbo, in the Kopparberg district. At a distance of about two and a-half miles from the paper mills is a waterfall, whose power has now been utilised for the working of the mills; a turbine of 60 H.P. being fixed at the waterfall. The current is transmitted along a copper wire, 6·4 millimetres in diameter, suspended by means of oil insulators.

The Marseilles Electric Tramway.—According to *La Lumière Electrique* the electric cars at Marseilles are not meeting with an unqualified success. It has been found necessary to put in new and more powerful motors, which is not surprising if, as our contemporary alleges, 40-passenger cars have often to take 70 passengers up an incline. The Administration also have found it necessary to double all the telephone circuits contiguous to the line at the expense of the tramway company.

"Wire to Wire" Electric Communication.—In a letter to *The Times* of Wednesday, Col. J. R. Magrath, late assistant to the Director-General of Telegraphs in India, begs to say that, before the Mutiny in 1857, Sir William O'Shaughnessy, Director-General of Electric Telegraphs in India, made fairly successful experiments in the direction of "wire to wire" communication, which no doubt would have been continued and improved but for the Mutiny needing their utmost efforts to keep the telegraph lines in workng order.

Electric Lighting in North Kensington.—The Works Committee of the Kensington Vestry having recommended that an application be made to the Board of Trade, and all other necessary steps taken to obtain the revocation of that portion of the House-to-House Electric Light Supply Order, 1889, relating to North Kensington area, and that it be referred back to the Works and Sanitary Committee to consider what action should be taken with a view to obtaining a supply of electrical energy in the area in question, the recommendation was adopted at the last meeting of the Vestry.

Hull.—Following the example of the St. Pancras Vestry, the Town Council of Hull has determined to give the local electric light installation contractors, most of whom are agents for the large electrical firms, the opportunity of exhibiting electrical appliances. The Exhibition will be held in the Sessions Court, and it will probably be open to the public for five days. The object is to give the public the opportunity of gaining information and witnessing the advantages of electricity. Messrs. Crompton have arranged to give an exhibition of cooking by electricity. The municipal central station will be completed by Christmas.

Photographing Vowel Sounds.—At the recent International Congress of Physiology at Liège, Prof. Hermann, says the *Engineer*, showed the possibility of photographing the relative vibrations produced by the vowel sounds. The vowels were sung into a phonograph. Immediately afterwards they were reproduced very slowly, and the vibrations recorded by a microphone. The latter was furnished with a mirror which reflected the light of an electric lamp upon a registering cylinder, covered with sensitised paper and protected by another cylinder with a small opening which gave passage to the rays of light from the reflector. By this means was obtained very distinct photographic traces, and the constancy was remarkable for the different letters.

Electricity Supply in Paris.—The electricity supply business seems to be turning the corner even in Paris, where it labours under several unnecessary disadvantages. The report of the Société anonyme d'Éclairage Électrique du Secteur de la Place Clichy, which serves a district somewhat similar in character to

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that allotted to the Metropolitan Electric Light Company, although considerably smaller, made a net profit during the year which ended on June 30th last of over £7,000, the gross receipts amounting to £26,000. On June 30, 1891, 9,517 lamps were connected to this Company's mains; on June 30, 1892, the total was 29,522. The main mileage is 20½, and the cable mileage 121½. It is proposed to increase the Company's capital by £40,000, making a total of £160,000.

Cable Restorations and Repairs:

CABLE RESTORATIONS.

	Interrupted.	Repaired.
Para-Maranham	Oct. 15, 1892	Nov. 28, 1892
Fao-Bushire	Nov. 24, 1892	Nov. 28, 1892

CABLES ACTUALLY INTERRUPTED.

	Date of Interruption.
Bolama-Bissao (communication with)	September 9, 1892
Cayenne-Vizeu	September 24, 1892
Ceara-Maranham	November 9, 1892
St. Thome-Loanda*	November 24, 1892
Hong Kong-Macao	November 29, 1892
Penang-Medan	December 1, 1892

* Communication with South Africa is still maintained by the east coast route.

The Electric Light and Plant Life.—At the meeting of the Manchester Association of Engineers on Saturday last the discussion on Mr. B. H. Thwaite's Paper on "The Economic Possibilities of the Generation of Electromotive Force at the Coalfields, and its Distribution and Application to Industrial Centres" was concluded. After the discussion an interesting demonstration of the effects of the actinic rays emitted from the electric arc on organic plant life was given by Mr. Thwaite. The growth of plants, he said, could be appreciably accelerated by the judicious use of the electric light. The leaves of the *acacia cophanta*, closed in sleep, and removed from darkness into the beam of the arc, opened almost immediately, the leaves nearest the root being the first to be influenced.

Société Générale des Téléphones.—The experts nominated to adjudicate in the dispute between this Company and the State as to the value of the material summarily taken over by the latter from the former on September 1, 1889, have decided that 9,300,000frs. would be an equitable sum to pay for it. To this 1,100,000frs. interest should be added. The Société Générale has already received 5,000,000frs. on account. The net outlay of the Société Générale was 14,336,000frs., so that, at this rate, it will sustain a loss of over 4,000,000frs. The Société Générale also claims to be compensated for the value of the plant as forming part of a going concern. Although their opinion was only asked with regard to the value of the material, the experts have, it is said, reported that they think the additional claim should be allowed. According to *L'Industrie Electrique*, it has been proposed to form a special company to fight the State in the Law Courts.

The Thomson-Houston Lightning Guard.—In an article which we reprinted last week (p. 95) from *L'Electricien*, testimony was borne to the great practical value of the well-known Thomson-Houston electro-magnetic lightning guard. In a recent issue *L'Industrie Electrique* prints an abstract from a letter addressed by the manager of the St. Brieuc central station (see *The Electrician*, Vol. XXVI., p. 757) to the Thomson-Houston Company in Paris of similar import. The extract reads as follows:—

"During the evening of October 13th-14th an extremely violent storm burst over the town and neighbourhood. The lightning struck the primary line running from the Ponts Neufs Station to the distribution network three times, giving rise on each occasion to a discharge spark about 1 metre long. These discharges were carried away to earth before traversing the dynamo, and the lightning protector immediately broke the short circuit formed by the arc and restored the line current. The extinction was instantaneous and the restoration of the circuit almost immediate. For an hour small discharges occurred in one or the other of the two lightning arresters, discharges evidently due to a small electrostatic charge which had accumulated on the primary wire. In the station there is a lighting line which comes from a transformer and conveys the current for the lighting of the station and workmen's shed a little distance off. This line was also struck, and *not* being protected by a lightning guard, it was ruptured and the transformer burnt out."

The Admiralty and Departmental Inventors.—A revised regulation has been issued by the Admiralty on the subject of patents for inventions. It states that any officer or subordinate employed in a civil capacity in an administrative, a manufacturing, or an experimental department under the Admiralty is to understand that he accepts such employment subject to the condition that if he is desirous of taking out a patent for any invention he shall, before seeking provisional protection, obtain their Lordships' approval, the application being made through the head of his department and accompanied by a full description of his invention. Permission to patent will not be granted as a matter of course, but each application will be dealt with according to the circumstances of the case. Where the invention is or may be applicable to the use of Her Majesty's service their Lordships' approval, if granted, will be subject to such conditions as to assignment of the patent or to its use by the Government as they may think fit to impose. In defining such conditions, and in the settlement of terms for the use of the invention, regard will be had to any facilities in originating, working out, and perfecting the invention which the inventor may have enjoyed by reason of his official position.

County Council Lecture on Electricity as applied to Mining.—The Technical Education Committees of the County Councils of Nottingham and Derbyshire have arranged for the delivery of a third series of lectures for the benefit and instruction of mining engineers and colliery managers. These lectures are being given by Prof. Robinson, Prof. Clowes, and George Fletcher, Esq. In connection with the series, Prof. Robinson on Saturday, the 26th ult., in the University College, Nottingham, gave a very practical dissertation upon Electricity as applied to Mining. The lecturer had arranged, by the courtesy of various firms, an interesting series of experiments illustrative of the generation and transmission of electricity. A large number of diagrams showing the coupling of various types of machines, and the application of motors to pumping, hauling, winding, and coal-cutting, gave a practical illustration of the text of his lecture. Messrs. J. Davis and Son, of Derby showed one of their patent safety motors, and Mr. Albion T. Snell lent some valuable drawings illustrative of electric locomotives suitable for mining work, and also a series of drawings showing developments in electric coal-cutting machines, with which he has been largely identified during the past few years. Messrs. Crompton and Messrs. Goolden and Co. also lent interesting diagrams and apparatus.

The Westinghouse Incandescent Lamp.—Great interest, says *Industries*, has naturally been shown in the new Westinghouse incandescent lamp, which is to be outside the Edison patent. The lamp, so far as it has been described up to the present time, is disappointing. We do not in the least sympathise with Edison, as we do not consider he invented the lamp, but given that the judges, after going into the matter carefully, think he did, he is legally entitled to the monopoly. The attempts to evade his patent seem puerile so far. The claim is for a globe made entirely of glass. Surely this cannot be circumvented by using a separate glass stopper. Clearly a glass bottle with a glass stopper is made entirely of glass, and luting the stopper would not put it outside the description. The doctrine of "mechanical equivalents" would, of course, cover this in England; but, we believe, the American practice is to follow the literal meaning of the words of the claim more closely. We wonder some one does not hold that the ordinary lamp is outside the claim because the platinum wires themselves act as a minute portion of the globe, so that the globe is not entirely of glass. Another scheme is to employ silicate of soda for sealing in the wires. How this helps the matter it is difficult to see. Silicate of soda is one kind of glass, and is commonly known as "water glass." The property of dissolving in water does not make it no longer a glass. The insolubility of calcium or lead glass is a mere accidental property, with no direct bearing on the matter, and using a soluble glass can hardly be seriously taken as avoiding Edison's patent, even if it admits of leading-in wires not made of platinum, as obviously any other wire might be used if it could be sealed in properly. If some one now found out that he could make lamp bulbs of, say, a mixture of cryolite and fluorspar, and that the material would seal in copper wires, the use of this material would still be a detailed modification of Edison, and could not in fairness be taken as being outside his patent, whether the law says so or not.

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THE WYNNE SYSTEM OF ELECTRIC TRACTION.

In *The Electrician* of February 28, 1890 (Vol. XXIV.), a report by Messrs. Mordey, J. Raworth, and Scott Russell upon the Wynne tramway system was published, and gave rise to a lively correspondence. The various patents for a sectional contact rail, whether a mid-rail or tram-rail, and the methods of putting a number of sections into contact with a buried conductor were discussed, and the claims of other inventors were set forth. In Mr. Wynne's system a contact rail is laid in the middle of the track, flush or nearly flush with the roadway, and is crenellated so as to fit between the granite sets; this zigzagging of the rail ensures that the short sections of

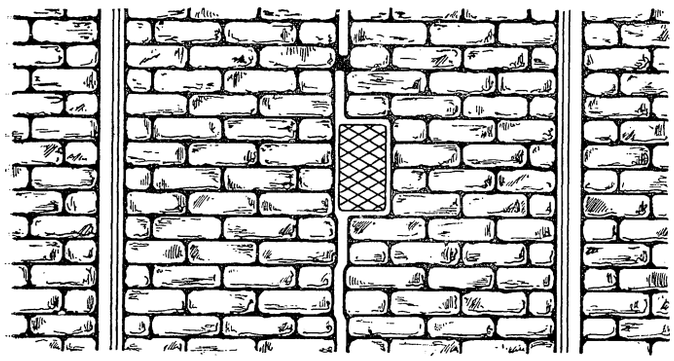

FIG. 1.—Part of Track showing Tram Lines, Mid-Rail,and Contact Box.

which it is composed will not alter their relative positions, and offers some foothold for horses. The leading feature of this system is that only those sections actually covered by the moving car are charged, that is, connected with the buried conductor. The sections are 5ft. long, and five of them, at least, are always covered by the car; they are laid on asphalte concrete, and are run in with bitumen, which affords tolerable insulation between the sections and from the earth. These sections are charged in pairs as the car moves over them.

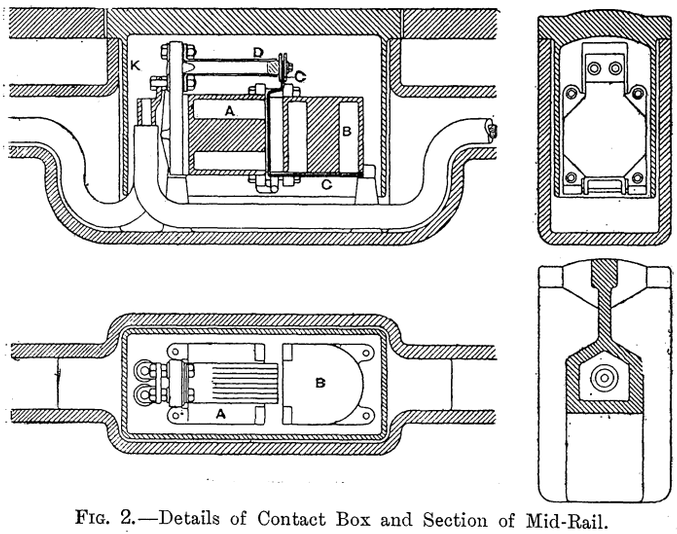

FIG. 2.—Details of Contact Box and Section of Mid-Rail.

Mr. Wynne has recently modified the details of his system, and by placing the contact boxes between two sections, he is able to reduce the number of magnetic switches while retaining the important principle that only those sections which are under the car and its platforms are charged. The contact boxes are placed at intervals of 10ft. The covers of these boxes are constructed on the diving-bell principle, the enclosed air preventing water from rising into the interior. The connections are easily accessible, and the contacts may be quickly replaced. A part of the line in Fig. 1 shows a contact box with portions of the crenellated rails.

Before proceeding further, the details of the contact boxes must be described. In Fig. 2 two sections and a plan of this device are shown, together with a section of the mid-rail, showing the buried conductor. This conductor is led into the box and the two ends are brought up and sweated to a double shoe from which the current is tapped off. This shoe is a single casting, and consists of two thimbles or ferrules united by a cross piece. The ends of the conductor sections are turned up and enter these ferrules, one of which is shown in the side elevation of the contact box. A pair of split contact springs are provided, and the shoe is connected to the lower one. Two tubular magnets A and B are mounted in the box, and to save space, they are arranged one vertically and the other horizontally. The windings and connections of these magnets are not shown in our illustration, but they are easily described. Two insulated wires are connected to the upper contact spring. One of these goes to one magnet and thence to the cast-iron case of the box, thus putting it in connection with one section of contact rail. The second wire goes to the other magnet, and thence runs alongside

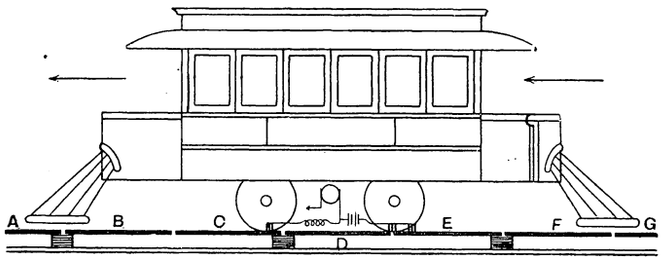

FIG. 3.—General Arrangement of Wynne System, showing Sectional Contact Rail and Diagram of Connections.

the main conductor for a short distance back along the line to the next section of the contact rail. A double armature, C C, carries a copper contact wedge, D, which is thrust between the contact springs when either or both of the magnets are excited. A diagrammatic view of the system is given in Fig. 3, where seven sections or parts of sections of the mid-rail are shown, lettered A, B, C, &c. The sections A and B are not yet connected with the buried conductor; C and D are so connected, and E and F are just about to be cut out. When this is done the armatures fall back by gravity. The contact between the conductor and the section F is maintained by the magnet in series with section E. One forward brush contact and two rear brushes are shown. One rear brush would generally suffice; but the object of having two is to ensure the bridging between two sections, so that a good contact may be made with one before the other is broken. The current passes from these brushes through the motor, and thence by the wheels and tram-rails to earth. In event of the breaking of the circuit, whether in stopping the car, or when it has been allowed to run down hill, the contacts in the contact boxes fall open. To enable connection to be re-made two or three secondary batteries are carried on the car, and being arranged with a small resistance of about $\frac{1}{3}$ ohm, as shown in the diagram, are kept always charged.

An experimental line has been laid on the works of the Electric Construction Corporation at Wolverhampton, and meets, we understand, with the full approval of Mr. Parker. We hope that Mr. Wynne will succeed before long in securing a line for the practical working of this system, which presents many advantages over the methods already in use.

THE WURTS TANK LIGHTNING ARRESTER.

An ingenious adaptation of Dr. Oliver Lodge's principle of "diluting down" electric discharges is described by Mr. A. J. Wurts in the *Electrical Engineer* of New York. In many American cities and towns, particularly in the Western sections of the country, it has, Mr. Wurts assures us, been common practice during thunderstorms to shut down the plant, pull down the trolleys and wait till the storm has spent itself. So far the ordinary spark gap arrester has proved of value, in that it has, without question, saved many thousands of dollars worth ofproperty.

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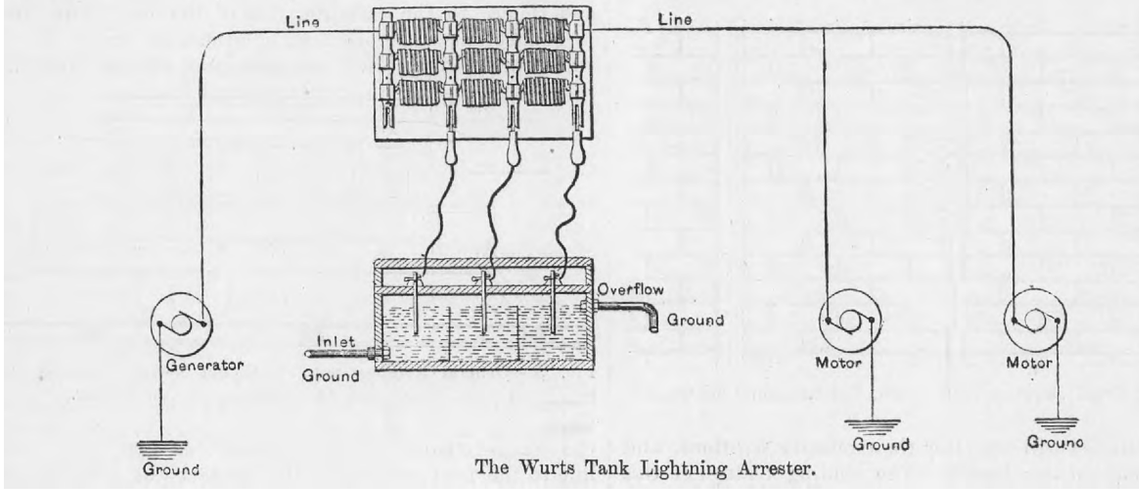
Railway requirements are, however, better met by the "tank arrester," which consists of a coil of wire connected in the main circuit with several discharge circuits leading from different points in the coil to electrodes immersed in a tank of water, the latter being connected to the ground. Its construction will be understood by referring to the diagram. The coils made of 0000 copper wire, are nine in number, arranged three in series and three in parallel. The current capacity of No. 0000 wire is about 300 amperes, so that the capacity of the entire set of coils may be varied by any multiple of this number. The set shown in the engraving has a capacity of 900 amperes, and is mounted on a backboard, the dimensions of which are 32 × 20in. The tank is of wood, lined with galvanised iron, and its dimensions are 32 × 28 × 10in. The three electrodes are ordinary flat arc light carbons held in simple clamps, and the method of connecting these to the coils is clearly shown. The inlet is, of course, connected to the city main, and thus forms the best possible ground connection for the tank. The coils are connected in series with the station ammeter, and when thus connected will stand guard over the entire station.



The Wurts Tank Lightning Arrester.

The action of the combination is as follows:—All charges which may accumulate on the trolley line or feeders will be forced to pass through the coil before reaching any of the generators. The function of the coil is then to cause the fatal "side flash" to occur *there* rather than in the coils of the armature, and this is the more readily accomplished from the fact that there are several low-resistance paths from this coil to earth without the necessity of piercing any insulating material or jumping over the smallest air space. In other words, there is an exceedingly difficult path for the lightning discharges to reach the generators, and an extremely easy path for them to reach the earth. Furthermore, the fact that the line is directly connected to earth without the intervention of the air gap, offers a constant drain through which the static charge may dissipate itself, that is, the charge need not accumulate on the line till its intensity is sufficient to jump the spark gap of an ordinary lightning arrester.

Dynamo leakage is, of course, to be expected, and during the first stages in the development of this arrester the leakage was so excessive that the scheme would have been abandoned had it not been for the fortunate discovery that this leakage was reduced about 70 per cent. by the use of running water. With running water fed through a half-inch pipe at ordinary city pressure, the leakage amounts to 6 or 7 amperes at 500 volts. But in consideration of the almost certain protection that the arrester will afford, this loss of power sinks into insignificance, and in fact the leakage need only occur during thunderstorms, as the discharge circuits may be cut out at other times by pulling the plugs.

A number of these arresters have been in use during the past season in various parts of the States.

LOW CAPACITY TELEPHONE CABLE.

The bad effects of india-rubber and the excellent qualities of paper and air insulation for telephone cables have been recognised for some years; but numerous difficulties of construction have presented themselves, and many tests were necessary.

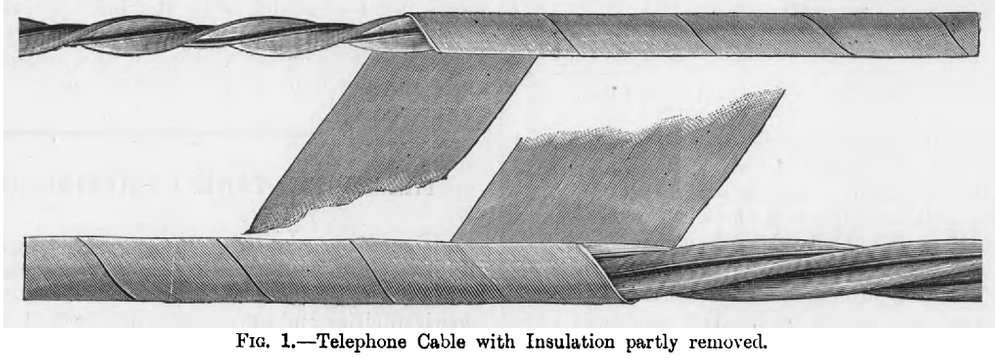


Fig. 1.—Telephone Cable with Insulation partly removed.

A new departure in telephone cable manufacture has, however, now been made in Europe by Messrs. Felten and Guilleaume, the well-known firm of electrical engineers and cable manufacturers. The accompanying illustrations (Figs. 1, 2, and 3) are self-explanatory; but a brief description of the construction of this cable will doubtless prove interesting. As will be seen from the drawings, the copper conductors of one metallic circuit are insulated from each other by a spiral barrier of paper; each circuit is then lapped with paper strips, either impregnated or unimpregnated, forming much larger air spaces than is possible by any other means. The necessary number of twin conductors to form the cable is then stranded in opposite directions, the whole being finally covered with lead; this may be braided externally if required. It will be

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seen that there is the smallest possible contact between the copper conductors and the insulating material, and, consequently, the capacity is reduced to a minimum, and is guaranteed by the manufacturers to be less than 0·08 microfarads per statute mile with dry insulation, or 0·10 microfarads per statute mile with impregnated insulation; in reality the tests show much lower figures, whilst the insulation resistance is very high.

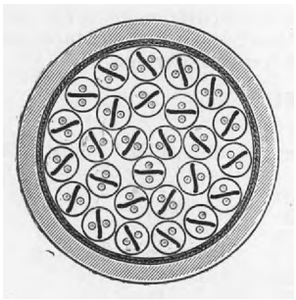


FIG. 2.—Section of Telephone Cable with Wires in pairs.

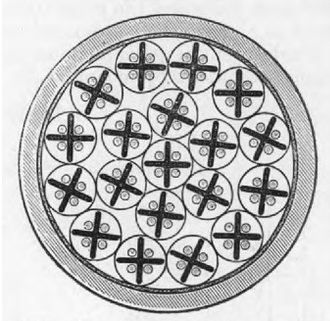
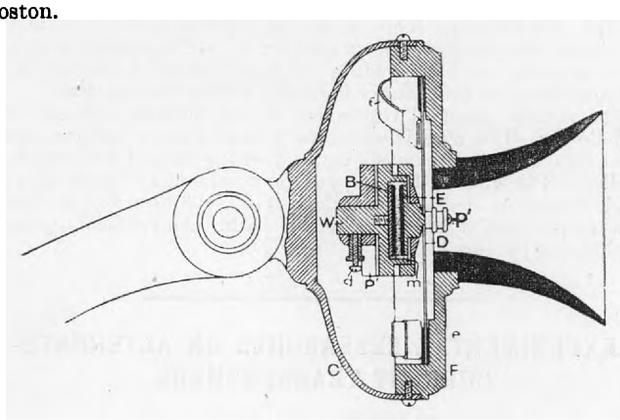


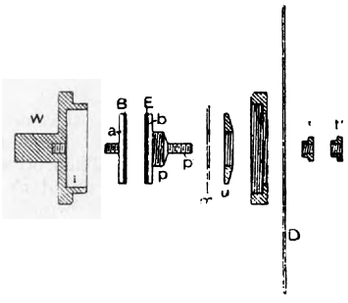
FIG. 3.—Section of Telephone Cable with Wires in "fours."

These cables are very light in weight compared with other types, and their volume is also considerably less, the diameter of one metallic circuit being about equal to that of a single conductor of existing makes; it follows, therefore, that a larger number of circuits can be gathered into a given area in this new type of cable. These cables can be constructed for metallic circuits in either "pairs" or "fours." With some modifications the same system is being applied to telegraph cables, where its advantages are especially favourable for long distance telegraphy.

THE "SOLID BACK" LONG-DISTANCE TELEPHONE TRANSMITTER.

The form of transmitter adopted by the American Telegraph and Telephone Company for their New York-Chicago line is known as the "Solid Back" transmitter. It is on the Hunning principle, and was devised by Mr. Anthony C. White, of Boston.





In this instrument it will be seen, says the *Electrical Engineer* of New York, the sound-receiving diaphragm D (*see* Figure) s attached directly to the disc E constituting the front or working electrode. B is a disc constituting the heavy back electrode, and there is finely-divided conducting material between the electrodes. A heavy metallic block, W, serves as a casing or frame for the electrodes and the finely-divided conducting material, being chambered to receive them. The finely-divided material, as in other instruments of the button type, is anthracite carbon, and the two electrodes E and B are discs of carbon. The walls of the chamber in the block W are lined with gummed paper, to prevent the short-circuiting of the instrument. It will be observed that there is a considerable space around the periphery of the two electrodes E and B to receive the finely-divided conducting material out of the direct path of the electric current. This construction prevents the clogging of the finely-divided material between the working electrode E and the walls of the chamber W that takes place when that electrode substantially fills the chamber.

The carbon electrode B is secured to the back on the bottom of the chambered block W by means of a brass disc *a*, soldered to the electrode and secured into the block. The front electrode E is soldered to a similar disc of brass, *b*, which by a threaded boss or pin, *p*, and nut, *u*, is secured to the inner face of a mica disc, *m*, that in turn is clamped to the sides or rim of the chambered block W by a threaded sleeve, *c*, serving to confine the finely-divided conducting material within the chamber of the block. The flexibility of the mica permits the front electrode E to have a piston-like movement in the chamber. The entire button, it will be seen, is secured by a set-screw, *d*, to a heavy brass bridge-piece, P', whose ends in turn are set into the metallic frame F of the receiving diaphragm, which, with its dampening and insulating ring, is held in place by means of padded springs, *f*. The frame F is set in a metallic cup-shaped outer casing, C.

ALLOYS FOR RESISTANCE COILS.*

BY DR. ST. LINDECK.

In a previous article I briefly discussed the results of the researches instituted with a view to the construction of resistances, having the utmost possible constancy. The first alloy tried with this in view and considered as perfectly suitable was "patent-nickel"—25 per cent. Ni, and 75 per cent. Cu. Although the temperature coefficient of this substance is only about one-half of that of German silver it is nevertheless necessary to take into account in all measurements having any pretensions to accuracy the relation of its specific resistance with the temperature.

In 1889 Mr. Weston, of Newark (U.S.A.), observed that the resistance of the alloys of manganese and copper, or manganese, nickel and copper scarcely changed at all with the temperature. However, the researches of Mr. Weston do not appear to have led to any really practical result; at any rate I do not know whether such alloys have been employed on a large scale in the making of resistances in the United States. Even Mr. Weston himself does not appear to have made much use of his important discovery.

The Reichsanstalt took up his work and succeeded in obtaining results of interest at the same time from the practical and scientific point of view. A whole series of alloys, some composed of copper and manganese, and others of these two substances associated with nickel were submitted to experiment. It was found that the mere addition of 4 per cent. of manganese to pure copper reduced the value of the temperature coefficient to that of the patent nickel without exhibiting, however, any characteristics worthy of note. If the proportion of manganese was raised to 10 per cent. the curve showing the modifications of the resistance with the temperature took a more interesting form, which I shall refer to more in detail later on. The specific resistance of the alloy increases with the proportion of manganese; the resistance of one of these alloys consisting of 30 per cent. manganese and 70 per cent. copper, exceeded 100 microhms per cubic centimetre. Alloys with a higher proportion of manganese could no longer be drawn.

The alloy, the stability of which as a resistance has been tested during several years, and which is at present in commercial use under the name of *manganin*, is composed of 84 per cent. copper, 12 per cent. manganese, and about 4 per cent. nickel. Its specific resistance is 42 microhms per cubic centimetre. In the annexed diagram, in which temperatures are plotted as abscissæ, and the values of an accurate resistance equivalent to the ohm are plotted as ordinates, shows the changes in the resistance of manganin with temperature. Between 0° and 10°C. the temperature coefficient has the value of 0·000025. As the temperature rises this value

* From *L'Électricien*.

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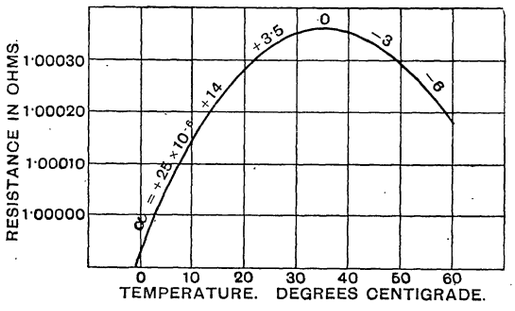
decreases, and between 30° and 40°C. the change of the specific resistance with the temperature is finally no longer sensible. After this the resistance begins to diminish as the temperature rises, so that the *temperature coefficient becomes negative*. We are, therefore, in the presence of the interesting case of a metal exhibiting properties which we have hitherto been accustomed to connect with electrolytes. As the reader may ascertain for himself by inspecting the diagram, the absolute values of the temperature coefficients are so small that in all cases where the highest accuracy is not required the temperature coefficients of manganin may be taken as zero. In fact, it is necessary to use very sensitive instruments and methods to show any change at all of the specific resistance with temperature. In order to make sure that the resistance always assumed the same value for the same temperature, in other words, to show that there was no hysteresis in the relations of these two quantities, some points of the curve were determined in ascending and others in descending the scale of temperature, and they were frequently repeated. No deviations were discovered which exceeded the limits of errors of observation. We may, therefore, consider it as settled by these measurements and observations, frequently repeated with different manganin resistances, that this peculiar behaviour is a constant physical property of the substance.

It has already been shown that rise of temperature has a durable effect on the resistance of coiled wires, and also of such wires as have not been submitted to a higher temperature. Manganin behaves in this respect like the alloys free from zinc, patent nickel, for example ; if we heat a coil composed of one of the two elements for the first time, the resistance is permanently lowered. For this reason it is necessary to eliminate these permanent changes from a coil intended to be used in tests similar to those described above. This is attained by submitting the coil as soon as wound to a temperature of 140°C. for five hours. Indeed, we ought naturally always to take this precaution in such investigations, no matter what material we are working with.



As we can see by the diagram, a manganin coil attains maximum resistance at a particular temperature. This maximum is not always attained at the same temperature by different wires. We know that the electrical properties of wires vary slightly with their dimensions ; moreover, the slightest difference in physical quality has an effect. Frequently the temperature of maximum resistance is found to be somewhat lower, especially in the case of wires larger than those in ordinary work, than is the case with the wire the curve of which is shown in the diagram. The assumption of invariability of resistance for the fluctuations of temperature usual in a room is a correct one. The fact that the maximum resistance of manganin is obtained at a temperature not very far off the average temperature of a laboratory was the reason which stimulated the Reichsanstalt to support its production on a commercial scale.

The two tables below give some data with regard to the constancy of manganin resistances. Table I. comprises the results of measurements made on a resistance of about 3 ohms, which was employed to determine the electromotive force of a normal Latimer-Clark cell by the aid of a silver voltameter. A current of half an ampere flowed through the resistance for one hour in each experiment. The resistance was used more than fifty times in this way. The table shows that the resistance has not varied in an appreciable degree in two and a-half years. Owing to its shape, the resistance is not capable of being measured more accurately.

Table I.

——	Ohm.	——	Ohm.
6/I 1890	2·9998	22/VII 1891	2·9996
15/IV „	99	9/II 1892	98
12/II 1891	98	17/VII „	96

Table II. shows the differences existing in the values of four one ohm resistances of precision, made in July of last year. A short time after we undertook the work of comparing the resistances with each other, and of measuring their absolute values. These comparative values did not possess quite the same accuracy as the values now given. Nevertheless, the fact is ascertained that *the greatest changes of resistance which can have taken place within the year amount to 0·005 per cent.* When we remember that resistances made in the ordinary manner undergo a maximum amount of alteration in the first year after winding, the assertion that the manufacture of wire resistances has been considerably improved by the researches carried out by the Reichsanstalt may be considered as proved. The following data refer to a temperature of 18°C., the differences between the resistances marked I. to IV. are given in *microhms*. The asterisk denotes that the measurements were made by the differential galvanometer method; the other measurements having been made by means of the Wheatstone bridge.

Table II.

——	December, '91.*	February, '92.	July, 1892.*	July, 1892.
I.—II.	-121×10^{-6}	−124	−117	—
I.—III.	−135	−135	−129	—
I.—IV.	− 80	− 79	− 86	—
II.—III.	− 14	− 15	− 12	−16
II.—IV.	+ 41	+ 39	+ 31	—
III.—IV.	+ 55	+ 53	+ 43	−48

A great advantage of manganin over all other alloys at present known is its extreme inferiority in thermo-electric power when in the presence of copper. Whilst for German silver, &c., the thermo-electric value is between 20 and 30 microvolts per degree Centigrade, for manganin it is only 1 to 2 microvolts, a circumstance to be seriously considered in measurements of precision.

In concluding this account of the investigations of the Reichsanstalt in this direction, I should mention that a series of alloys was tested, which, like patent nickel, was composed of nickel and copper only, in different proportions. The result of these investigations goes to show that without the addition of manganese we can obtain very low temperature coefficients. An alloy of about 50 per cent. copper and 50 per cent. nickel has a temperature of between 0·003 per cent. and 0·004 per cent. per degree Centigrade. Unfortunately this material, known in commerce by the name of *constantan*, is but little suited for resistances of precision, owing to its thermo-electric behaviour in the presence of copper. Constantan has a thermo-electromotive force of 40 microvolts per degree Centigrade in the presence of copper, and thus greatly exceeds in thermo-electric power the Iron-German silver couple so frequently used.

In the open air manganin does not do well. Its use is not to be recommended in cases were bare wires are employed, especially if there is likely to be a great generation of heat by the current. Moreover, a few precautions must be observed when drawing the material, since manganin is more easily oxidisable than copper and nickel. On the other hand, as soon as covered wires are employed manganin surpasses all known alloys ; in fact, manganin is almost without exception employed in the manufacture of resistances by German firms, in the manner indicated by the Reichsanstalt.

The normal standard resistances of the Reichsanstalt are made as follows :—The wire is wound on a metal tube, which, to ensure good insulation, is previously covered with a strip of silk soaked in shellac. The wire is then slipped on a bobbin, and again given a thick coating of shellac, after which it is submitted for five hours to a temperature of 140°C. in an air bath. An artificial *ageing* is in this way produced.

EXPERIMENTAL RESEARCHES ON ALTERNATE-CURRENT TRANSFORMERS.†

BY J. A. FLEMING, M.A., D.SC., F.R.S.

(Continued from page 102.)

III.—*Experiments with the Three-Ammeter Method of Measuring Alternating-Current Power.*

10. We next directed our attention to that modification of the voltmeter method suggested by the writer, and which involves current measurements instead of pressure. Theoretically, this method requires three ammeters, A_1, A_2, A_3, arranged in connection with the transformer under test, as shown in Fig. 6. In putting this method into practice we found it necessary, in the first place, to scheme some simple method of regulating the P.D. at the terminals of the transformer under test. This was accomplished as follows : —A 10-H.P. transformer had its primary, or fine-wire, circuit inserted in series with the primary current of the transformer under test. The secondary, or thick-wire, circuit of the 10-H.P.

† Abstract of a Paper read before the Institution of Electrical Engineers on November 24, 1892.

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transformer was closed through a variable resistance consisting of 15 to 20 plates of battery carbon three inches square and a quarter of an inch in thickness, pressed together more or less by a screw clamp. By suitably compressing these plates we were able to regulate with great nicety the secondary current of the 10-H.P. transformer, and hence to adjust the resultant impedance of the primary circuit of the 10-H.P. transformer. The volts at the terminals of the transformer under test could then be kept perfectly constant, irrespective of slight variations due to the dynamo. As a non-inductive resistance we employed a series of 50-c.p. incandescent lamps. We then found that, working under these conditions, we could dispense with the third ammeter, A_3, and make one measurement once for all of the current taken by this series of lamps at 2,400 volts. Finally we reduced the method to the use of a single ammeter, as follows :—An ammeter was put in the primary circuit of the transformer under test, and the P. D. at the terminals of this transformer was kept constant at 2,400 volts. A series of incandescence lamps (generally 24 100-volt 16 c.p. lamps) was joined across the primary mains, and two readings of the ammeter taken—a first when the row of lamps was between the ammeter and transformer, and a second when the ammeter was between the lamps and transformer. An independent determination was made of the current taken by the lamps. These changes of position of the ammeter were made by mercury cup connections, so as to avoid at any time actually breaking the primary circuit. It will be easily seen that this single-ammeter method poss sses

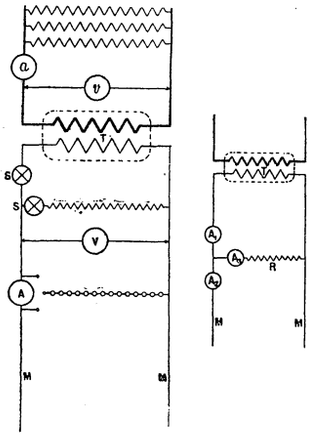

FIG. 6.—Plan of Connections for Ammeter Method.

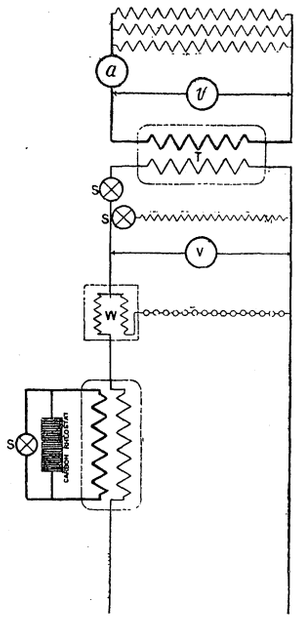

FIG. 7.—Connections of Dynamometer Wattmeter Method.

all the advantages, whatever they are, of the three-ammeter method, and is much simpler to work. The conclusions arrived at with respect to this ammeter method is, that ordinary commercial ammeters do not enable us to determine the currents with anything like the accuracy necessary when we are operating on open magnetic circuit transformers at no load. It would certainly be necessary to be able to read currents of magnitudes from 0·25 to 5 amperes to the third decimal place, and that is not in general a practicable matter by commercial instruments.

Table IX.—Ferranti Transformer (1885 *pattern*).—No. 747. Power, 5-H.P. Secondary volts, 100. Frequency used, 81·6 periods per second. Average final temperature of transformer=212° F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=12·50 ohms at 212° F. Secondary circuit resistance=0·0252 ohm at 212° F.

[Table IX. shows that the primary amperes rose from ·332 to 1·89. The secondary amperes rose from 0 to 38·78, and the secondary volts fell from 100·9 to 99·1. The total power taken up in the transformer rose from 538 to 636.]

Table X.—5 H.P. (1885 *pattern*) *Ferranti Transformer.*—Primary volts=2,400 (kept constant). Secondary volts at no load=100·9.

[Table X. shows that the primary amperes rose from 0·329 to 1·9. The secondary current rose from 0 to 39·19, and the secondary volts rose from 0 to 2·4. The primary copper losses rose from 1·3 to 45·2. The secondary copper losses rose from 0 to 38·7. The real primary watts rose from 538 to 4,580, and the apparent primary watts from 790 to 4,555. The power factor rose from ·68 to 1.]

Table XI.—Ferranti Transformer (1885 *pattern, re wound*).—No. 539. Power, 5-H P. Secondary volts, 100. Frequency used, 81·6 periods per second. Average final temperature of transformer, 150°F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistanee=29·80 ohms at 150°F. Secondary circuit resistance=0·057 ohm at 150°F.

[Table XI. shows that the primary amperes rose from 0·11 to 1·741. The secondary current rose from 0 to 39·65, and the secondary volts fell from 102·7 to 98·4. The total power taken up in the transformer varied between 235 and 399.]

Table XII.—5-H. P. (1885 *pattern, rewound*) *Ferranti Transformer.*—Primary volts=2,400 (kept constant). Secondary volts at no load=102·7.

[Table XII. shows that the primary amperes rose from 0·11 to 1·741. The secondary amperes rose from 0 to 39·65. The real primary watts rose from 235 to 4,301, and the apparent primary watts from 264 to 4,178. The primary copper losses rose from 0 to 90, and the secondary copper losses from 0 to 89·5. The power factor rose from 0·98 to 1·03.]

Table XIII.—Westinghouse Transformer.—Power, 6,500 watts. Secondary volts, 100. Frequency used, 82·5 periods per second. Average final temperature of transformer, 96°F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=5·95 ohms at 96°F. Secondary circuit resistance=0·0108 ohm at 96°F.

[Table XIII. shows that the primary amperes rose from 0·05 to 2 775. The secondary amperes rose from 0 to 64·748. The secondary volts fell from 101 to 98·6. The total power taken up in the transformer rose from 95 to 214.]

Table XIV.—Westinghouse Transformer.—Primary volts, 2,400 (kept constant). Secondary volts at no load=101·0.

[Table XIV. shows that the primary amperes rose from 0·05 to 2·775. The secondary current rose from 0 to 64·74. The primary copper losses rose from 0 to 45·8, and the secondary copper losses from 0 to 45·3. The real primary watts rose from 95 to 6,598, and the secondary primary watts rose from 120 to 6,660. The power factor varied between 0·79 and 1·03.]

IV.—*Experiments with the Dynamometer-Wattmeter Method of Measuring Alternating Current Power.*

11. Dissatisfied on the whole with the practical results and difficulties of the voltmeter and ammeter methods, attention was next turned to the employment of the dynamometer wattmeter as an instrument for the measurement of the power given to the primary circuit of transformers. There is no need to recapitulate well-known facts about the use of such an instrument for this purpose. It is well understood that a wattmeter or dynamometer with independent series and shunt coils can be used for this purpose, provided that the shunt circuit has a practically zero time constant, and the only difficulty which presents itself in passing an opinion on the suitability of any particular two-circuit dynamometer for this purpose is that of knowing whether the shunt circuit really *is* practically so far free from sensible inductance or capacity as to make this the case—and this, as our experiments show, must not be taken for granted without investigation. Two wattmeter dynamometers were provided. The first consisted of a Siemens dynamometer of the usual pattern, intended to be used as an ammeter for currents of 0·2 to 4 amperes. The fixed coil consisted of a few dozen or so turns of wire, and the moveable coil of four turns. We arranged the connections so that it could be used as a wattmeter, the fixed coil being the series coil, and the moveable coil of four turns being put in series with 24 100-volt 50-c.p. incandescent, or also with two rows of 24 16-c.p. lamps arranged in parallel, and this arranged as a shunt circuit. Contrary to the usual practice we had then a wattmeter in which the shunt circuit carried the larger current. This circuit was traversed by a current of from 1·8 to 2·94 amperes when placed across 2,400-volt mains, according to the group of lamps used.

This dynamometer wattmeter had then a shunt circuit consisting of the 24 series of lamp filaments *plus* the four turns of wire on its moveable coil. It had, therefore, a very small inductance. This wattmeter was calibrated by applying it to measure the known power taken up in our standard resistance. The six coils of our No. 1 resistance, each consisting of about 1,600 ohms, were arranged, two in series and three in parallel, across 2,400-volt mains. The current through these resistances was measured by a Kelvin deci-ampere balance, and found to be 2·230 amperes ; the P.D. between the mains was measured by the Swinburne voltmeter, and found to be 2,400 volts, and kept at that value by a regulating transformer with carbon resistance on the secondary circuit (*see* Fig. 7) ; and from these measurements the power taken up in the resistance was known. It was 5,357 watts. The dynamometer wattmeter was then arranged so as to measure the known power being absorbed by this resistance, and the constant of the wattmeter thus determined. A torsion of 175deg. of the dynamometer head was found

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to be required when the resistance was absorbing the above power. This constant was frequently determined. The value was close to 30·6 watts per division of the scale. It will be seen, therefore, that we were employing a wattmeter which, although it absorbed considerable power in its own shunt circuit, had a range of measurement from 12,000 watts down to about 10 or 12 as a minimum visible.

We found it essential to standardise the wattmeter on the largest power-absorbing arrangement possible, so as to get the greatest possible wattmeter scale reading on a known power-absorption in determining the instrumental constant. For if a small power reading was taken, then any error in the scale reading was multiplied up in getting the watts corresponding to a larger scale reading taken from a value of the constant, and sensible errors introduced.

In addition to this instrument, Mr. Swinburne provided two of his own non-inductive wattmeters. In this last instrument the shunt circuit consisted of a small bobbin of a good many (probably a hundred or more) turns of fine wire, having a resistance of about 300 ohms. In series with this externally, and forming part of the wsttmeter shunt circuit, were two doubly wound wire resistances in brass boxes; having a total resistance of about 100,000 ohms, assumed to be practically non-inductive. Provided with these wattmeters, we proceeded to make a series of tests on various transformers of the power absorbed when the transformer was doing secondary work of various loads. The results are embodied in the series of tables below. In each case the Siemens dynamometer, called hereafter the "dynamometer wattmeter," was standardised on the inductionless resistance when absorbing about 7 H.P., and then, having obtained the constant, its readings were taken when placed on the primary circuit of the transformer. The column headed "Power taken up by Swinburne Wattmeter," records the observations made with the first wattmeter he sent having an outer case of brass.

In Table IX. are given the figures of observation for the 5-H.P. (1885 type, old form) Ferranti transformer. The transformer had gradually increasing loads of lamps put upon its secondary circuit, and whilst the power, W_1, supplied to the primary was measured by the dynamometer wattmeter, that given up by the secondary, W_2, was measured by a Kelvin balance and electrostatic voltmeter placed on the secondary circuit. We measured also the primary current value in amperes corresponding to each definite load on the secondary circuit. We obtained, therefore, for every transformer, the volts, or P.D. across both terminals, the ampere current, and the watt output of the secondary circuit, and at the same time the ampere current and power absorbed in watts by the primary circuit; and hence the difference between W_1 and W_2, or the power lost in the transformer, is also known for each secondary load. Finally, also, the ratio of W_2 to W_1 in percentages can be calculated, and gives us the efficiency. In all these experiments the P.D. on the primary terminals was kept carefully constant at 2,400 volts, and the constant of the primary wattmeter checked at the beginning and end of each series of observations.

A series of tests of this kind was made on each one of the following 10 transformers:—A Ferranti 5-H.P. (1885 type), a Ferranti 5-H.P. (after having had the primary and secondary circuits both replaced by others of double the length), two 15-H.P. (1892 type) Ferranti, a 20-H.P. (1892 type) Ferranti, a Westinghouse 6,500-watt (the same transformer used by Dr. Hopkinson in his recent tests), a Mordey-Brush 6,000-watt, a Thomson-Houston 4,500-watt, a Kapp 4,000-watt, and a Swinburne 3,000-watt "Hedgehog." For each transformer was determined the currents and terminal potential differences corresponding to the various stages of secondary load from no load up to the full nominal output of the transformer, and at the same time the power, W_1, given to the transformer primary circuit, and the power, W_2, taken off from the secondary circuit. The "total lost watts," $W_1 - W_2$, and the efficiency, or ratio W_2/W_1, corresponding to each secondary load, were also calculated. From the known or measured value of the resistances of the copper circuits (taken when the transformer was warm) and the measured currents we could calculate the copper losses ($C^2 R$ losses) in both circuits, separately and together, to the nearest integer, omitting fractions of a watt in most cases; and from the primary volts and current we obtained the value of the "apparent watts" given to the transformer at each stage; and from the "apparent" and "true" watts given to the primary circuit we could deduce the power-factor corresponding to any secondary output. The values of the secondary terminal P.D., or volts, gave us also the "total secondary drop" at each load, and from the resistances and currents could be found the "copper drop," or volts lost by resistance. The observations and calculations for each of the 10 transformers tested are given in full in Tables IX. to XXIX., inclusive, which sufficiently explain themselves.

Table XV.—Ferranti Transformer (1892 *pattern*).—No. 2,194. Power, 15-H.P. Secondary volts, 100. Frequency used, 81·6 periods per second. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=6·45 ohms. Secondary circuit resistance=0 0134 ohm.

[Table XV. shows that the primary amperes rose from 0·076 to 3·715, when no further readings were recorded. The secondary current rose from 0 to 114·63, and the secondary volts fell from 100·4 to 97. The total power taken up in the transformer varied between 149 and 570.]

Table XVI.—15-*H.P.* (1892 *pattern*) *Ferranti Transformer.*—Primary volts, 3,400 (kept constant). Secondary volts at no load=100·4.

[Table XVI. shows that the primary amperes rose from 0·076 to 4·762. The secondary current rose from 0 to 112·89. The primary copper losses rose from 0 to 146·4, and the secondary copper losses from 0 to 171. The real primary watts rose from 149 to 11,496, and the apparent primary watts from 188 to 11,429. The power factor varied between 0·82 and 1·05.]

Table XVII.—Ferranti Transformer (1892 *pattern re-wound*).—No. 2,193. Power, 15-H.P. Secondary volts=100. Frequency used, 82·5 periods per second. Volts on primary circuit (V_1) =2,400 (kept constant). Primary circuit resistance=3·77 ohms Secondary circuit resistance=0·0092 ohm.

[Table XVII. shows that the primary amperes rose from 0·103 to 4·837. The secondary amperes rose from 0 to 113·85. The secondary volts fell from 100 to 97 8. The total power taken up in the transformer rose from 229 to 607 watts.]

Table XVIII.—15-*H.P.* (1892 *pattern, re-wound*) *Ferranti Transformer.* Primary volts, 2,400 (kept constant). Secondary volts at no load=100·0.

[Table XVIII. shows that the primary amperes rose from 0·103 to 4·837. The secondary current rose from 0 to 113·85. The primary copper losses rose from 88·1, and the secondary copper losses from 0 to 119. The real primary watts rose from 229 to 11,742, and the apparent primary watts rose from 247 to 11,609. The power factor varied between 0·93 and 1·01.]

Table XIX.—Ferranti Transformer (1892 *pattern*). No. 2,184. Power, 20-H.P. Secondary volts = 100. Frequency used, 82·7 periods per second. Average final temperature of transformer, 98F. Volts on primary circuit (V_1) = 2,400 (kept constant). Primary circuit resistance = 2·75 ohms at 98°F. Secondary circuit resistance = 0 0061 ohm at 98°F.

[Table XIX. shows that the primary amperes rose from 0·112 to 6·5. The secondary amperes rose from 0 to 151·44. The secondary volts varied between 100 and 97·9. The total power taken up in the transformer varied between 210 and 525.]

Table XX.—20-*H.P.* (1892 *pattern*) *Ferranti Transformer.* Primary volts, 2,400 (kept constant). Secondary volts at no load = 100·0.

[Table XX. shows that the primary amperes rose from 0·112 to 6·5. The secondary current rose from 0 to 151·44. The primary copper losses rose from 0 to 116, and the secondary copper losses from 0 to 138. The real primary watts rose from 230 to 15,322, and the apparent primary watts rose from 269 to 15,600. The power factor varied between 0·86 and 1·03.]

Table XXI.—Mordey Transformer.—No. 1868. Power, 6,000 watts. Secondary volts, 50 and 100. Frequency used, 82·9 periods per second. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=7·73 ohms. Secondary circuit resistance=0·0163 ohm.

[Table XXI. shows that the primary amperes rose from 0·076 to 2·668. The secondary amperes rose from 0 to 61·58. The secondary volts fell from 101·1 to 99·2. The total power taken up in the transformer varied between 148 and 311.]

Table XXII.—Mordey Transformer. — Primary volts, 2,400 (kept constant). Secondary volts at no load=101·1.

[Table XXII. shows that the primary amperes rose from 0·076 to 2·668. The secondary current rose from 0 to 61·58. The primary copper losses rose from 0 to 55, and the secondary copper losses from 0 to 62. The real primary watts rose from 148 to 6,420, and the apparent primary watts rose from 182 to 6,403. The power factor varied between 0·81 and 1·03.]

Table XXIII.—Thomson-Houston Transformer.—No. 46,740. Power, 4,500 watts. Secondary volts, 50 and 100. Frequency used, 82·1 periods per second. Average final temperature of transformer, 102° F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=19·68 ohms at 102° F. Secondary circuit resistance=0·019 ohm at 102° F.

[Table XXIII. shows that the primary amperes rose from 0·083 to 1·96. The secondary amperes rose from 0 to 46. The secondary volts fell from 99·8 to 96·5. The total power taken up in the transformer varied between 114 and 265.]

Table XXIV.—Thomson-Houston Transformer.—Primary volts, 2,400 (kept constant). Secondary volts at no load=99·8.

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[Table XXIV. shows that the primary amperes rose from 0·083 to 1·96. The secondary current rose from 0 to 46. The primary copper losses rose from 0 to 76, and the secondary copper losses from 0 to 40. The real primary watts rose from 116 to 4,695, and the apparent primary watts rose from 199 to 4,704. The power factor varied between 0·58 and 1·01.]

Table XXV.—Kapp Transformer.—No. 570. Power, 4,000 watts. Secondary volts, 100. Frequency used, 82·1 periods per second. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=11·38 ohms. Secondary circuit resistance=0·024 ohm.

[Table XXV. shows that the primary amperes rose from 0·145 to 1·750. The secondary amperes rose from 0 to 40·89. The secondary volts fell from 99 to 97·1. The total power taken up in the transformer rose from 152 to 236.]

Table XXVI.—Kapp Transformer.—Primary volts, 2,400 (kept constant). Secondary volts at no load=99·0.

[Table XXVI. shows that the primary amperes rose from 0·145 to 1·75. The secondary current rose from 0 to 40·89. The primary copper losses rose from 0 to 34·5, and the secondary copper losses from 0 to 42. The real primary watts rose from 152 to 4,207, and the apparent primary watts rose from 348 to 4,200. The power factor varied between 0·61 and 1·01.]

Table XXVII.—Swinburne "Hedgehog" Transformer.—No. 342. Power, 3,000 watts. Volts, 100. Frequency used, 81·1 periods per second. Average final temperature of transformer, 145°F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=24·50 ohms at 145°F. Secondary circuit resistance=0·051 ohm at 145°F.

[Table XXVII. shows that the primary amperes rose from 0·756 to 1 566. The secondary amperes rose from 0 to 30·2, the secondary volts fell from 101·8 to 0·99. The total power taken up in the transformer varied between 111 and 207.]

Table XXVIII.—Swinburne "Hedgehog" Transformer.—No. 342. Power, 3,000 watts. Volts, 100. Frequency used, 82·3 periods per second. Average final temperature of transformer, 145°F. Volts on primary circuit (V_1)=2,400 (kept constant). Primary circuit resistance=24·00 ohms at 145°F. Secondary circuit resistance=0·051 ohm at 145°F.

[Table XXVIII. shows that the primary amperes rose from 0·756 to 1·567. The secondary amperes rose from 0 to 30·33. The secondary volts fell from 101·9 to 98·6. The total power taken up in the transformer varied between 117 and 217.]

Table XXIX.—Swinburne "Hedgehog" Transformer.—Primary volts, 2,400 (kept constant). Secondary volts at no load=102·00.

[Table XXIX. shows that the primary amperes rose from 0·756 to 1 567. The secondary current rose from 0 to 30·33. The primary copper losses rose from 13·7 to 59, and the secondary copper losses from 0 to 46·9. The real primary watts rose from 121 to 3,163, and the apparent primary watts rose from 1,816 to 3,761. The power factor rose from 0·07 to 0·84.]

12. The results of these numerous observations are set out graphically, and thus represented to the eye, in a series of diagrams, shown in Figs. 8 to 45 inclusive. For each transformer four diagrams have been prepared.

The first shows the "total lost watts" curve, or $W_1 - W_2$, plotted as a curve in terms of the corresponding secondary output W_2; and on the same diagram is given a curve showing the total copper losses (C^2R) in the transformer in both circuits together. Hence the difference of the ordinates of these two curves gives the value of the losses other than those due to ohmic resistance in the transformer. The second diagram shows the value of the two currents, primary and secondary, plotted in terms of the secondary output. Since all the closed magnetic circuit transformers tested had a transformation ratio and windings in the ratio of 24 to 1, the primary current and 1-24th part of the secondary current are plotted together on the same scale. The third diagram gives the efficiency curve. The efficiencies in per cents. corresponding to decimal fractions of the full secondary output, are calculated from the "total loss" curve and then drawn. Hence they are all comparable, and we can see at a glance the percentage efficiency corresponding to loads of one-tenth, two-tenths, &c., of the full secondary load. The fourth curve is the "secondary drop" curve, and gives the "total observed drop," the "drop" due to secondary and to primary resistance, and the surplus or "leakage drop" due to leakage of induction, all plotted in terms of the secondary output. The efficiency values are tabulated in Table XXX. for the different fractions of full load for all the transformers.

13. It is desirable to make one or two remarks about each transformer, and draw some general conclusions.

Ferranti Transformer, 1885 *type, 5 H.P.* (Tables IX. and X., Figs. 8, 9, 10*, 11*.)

It is obvious that this transformer is, in comparison with modern ones of the same size, very wasteful of energy in transformation. But we must bear in mind that in 1885 little or none of our present knowledge about iron core energy losses existed, and it is not to be wondered at that its design is imperfect, according to modern views. The immense core loss of 549 watts (540 by three-voltmeter method) makes it possess a low efficiency at all loads, and gives it a flat efficiency curve. Its small copper losses, however, make it remarkably good in regulation, it having only 2·4 per cent. of total secondary drop. It is hardly necessary to say that Mr. Ferranti's present type of transformer is a vast improvement on these, and holds its own with the best now made.

Ferranti Transformer, 1885 (*re-wound*). (Tables XI. and XII., Figs. 8, 12, 13*, and 14*.)

The effect of doubling the length of both the primary and secondary circuit is shown in the curves of this transformer. The total internal losses are halved, but the copper losses and "secondary drop" about doubled.

Ferranti Transformers, 1892 *type*, 15 *and* 20 *H.P.* (Tables XV., XVI., XVII., XVIII., XIX., XX. Figs. 19*, 20, 21*, 22*, 23, 24*, 25*, 26*, 27, 28*, 29*.)

These new transformers of Mr. Ferranti's are exceedingly good transformers. The total loss on open circuit of the 20-H.P. is only 1·3 per cent. of the full secondary output. The maximum efficiency is 97·1 per cent., and the efficiency at one-tenth of full load is 85 per cent., whilst the total secondary drop is only 2·1 per cent.

Two sets of curves are given for the transformer of 15 H.P. size. In two transformers tested there was a difference in the winding which resulted in the total internal loss being greater in one than in the other. In the transformer having the greatest total loss the copper losses (C^2R) are least, and the "secondary drop" diminished, therefore, about 1 per cent. The efficiency curve of all these transformers is very square-shouldered, owing to the high efficiency (about 85 to 87 per cent.) at one-tenth of the full secondary load.

Table XXX.

Efficiencies of Transformers Calculated from Curves of Total Losses. From Observations by Dynamometer Wattmeter.

Size and Description of Transformer.	Fractions of Full Secondary Load.												
	0	0·025	0·05	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
	Percentage Efficiencies.												
6,500-watt Westinghouse	0	61·8	75·9	85·7	91·9	94·0	95·1	96·0	96·3	96·6	96·8	96·9	96·9
3,000-watt Swinburne	0	39·3	56 2	71·7	82·9	87·6	89·8	91·2	92·2	92·8	93·2	93·4	93·5
4,500-watt Thomson-Houston	0	49·1	65·4	78·8	87·8	91·1	92·9	93·8	94·2	94·6	95·0	95·0	94·7
20-H.P.)1892 pattern) Ferranti	0	62·0	76·6	86·5	92·6	95·0	95·6	96·1	96·5	96·8	96·8	96·6	96·6
15-H.P. ,, ,, ,,	0	65·5	79·0	88·1	93·4	95·0	95·7	96·0	96·2	96·3	96·1	95·8	95·5
15-H.P. ,, ,, ,, (re-wound)	0	55·0	70·8	83·0	90·5	93·1	94·5	95·1	95·4	95·5	95·4	95·2	94·7
6,000-watt Mordey	0	52·1	67·6	80·1	88·5	91·1	92·7	93·7	94·2	94·7	94·9	95·1	95·4
4,000-watt Kapp	0	39·5	56·5	72·3	83·8	88·0	90·4	91·9	92·6	93·3	93 8	94·0	94·2
5-H.P. (1885 pattern) Ferranti (re-wound)	0	28·8	44·5	61·4	75·6	81·9	85·5	87·7	89·0	89·8	90·2	90·5	90·8
5-H.P. ,, ,, ,,	0	14·6	25·3	40·3	57·2	66·5	72·5	76·4	79·1	81·5	83·1	84·5	85·5

* This figure is omitted because the curves of the transformer closely resemble those which we have given as specimen curves. The actual limits of the other curves may be easily found by referring to our abstract of the tables.

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Westinghouse Transformer, 6,500-*watt*. (Tables XIII. and XIV. Figs. 15, 16, 17, and 18.)

This transformer was one of the pair tested by Dr. J. Hopkinson by his elegant differential method. His results are recorded in *The Electrician* of June 24 and July 1, 1892. Employing a method depending upon the graphic description of the instantaneous curves of current and E.M.F., Dr. Hopkinson deduced the power lost in the transformer at no load, quarter, half, and full load. Hence the corresponding efficiencies. The same quantities were given me independently as determined by the manufacturers from tests made at Pittsburgh. These are here collected with my own results for comparison. Dr. Hopkinson's results are placed in the column marked H, those of the manufacturers in column P, and my own in column F; and it will be seen that we all substantially agree in the values of the quantities measured :—

Quantities Measured.	P.	H.	F.
Watts lost at no load	91	114	98
Watts lost at half load	—	149	141
Watts lost at full load	—	236	209
Secondary drop at full load	2%	2·2%	2·4%
Efficiency at half load	96·4	96%	96%
Efficiency at full load	97%	96·9%	96·9%
Total copper losses (C^2R) at full load, in watts	104	—	93

It is clear, therefore, that there is no serious disagreement between us, and that this transformer is a very excellent instrument. Its maximum efficiency is just upon 97 per cent., and its efficiency at one-tenth of full load is nearly 85 per cent.

The loss in power at no load is by my figures 1·46 per cent. (by Dr. Hopkinson's 1·75 per cent.) of the full secondary output. The core of this transformer is made of a high quality of pure steel, the plates being slightly oxidised to insulate them for eddy currents.

Mordey Transformer, 6,000-*watt*. (Tables XXI. and XXII. Figs. 30*, 31, 32*, and 33*.)

Two transformers of this size were tested. In one the three-voltmeter method showed the power loss at no load to be 125 watts; in the other the dynamometer wattmeter gave 148 watts. If we take the mean of these results, we get 136 watts as the open-circuit loss. This is 2·27 per cent. of 6,000 watts.

We found the "total secondary drop" between no load and full load to be 1·9 per cent. of the voltage at no load. In the official publications of the Brush Company the manufacturer's figures, for this sized transformer, for the open-circuit loss as a percentage of full load is given as 1·82 per cent., and the percentage total drop is 2·25 per cent. ; but these figures refer to the 6-kilowatt transformer worked at a frequency of 100 ∿ and transforming from 2,000 to 100 volts. As the transformer tested by us had a transformation ratio of 24 to 1, and worked at 83 ∿, it is a question how far the official figures may be applied to it; but, at any rate, our determinations agree with those of the manufacturer

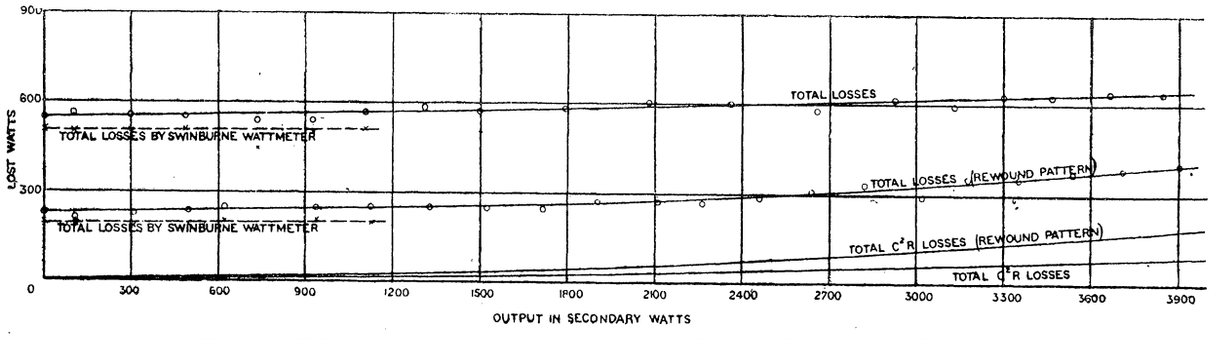

FIG. 8.—5-H.P. (1885 Pattern) Ferranti Transformer. Losses by Dynamometer Wattmeter.

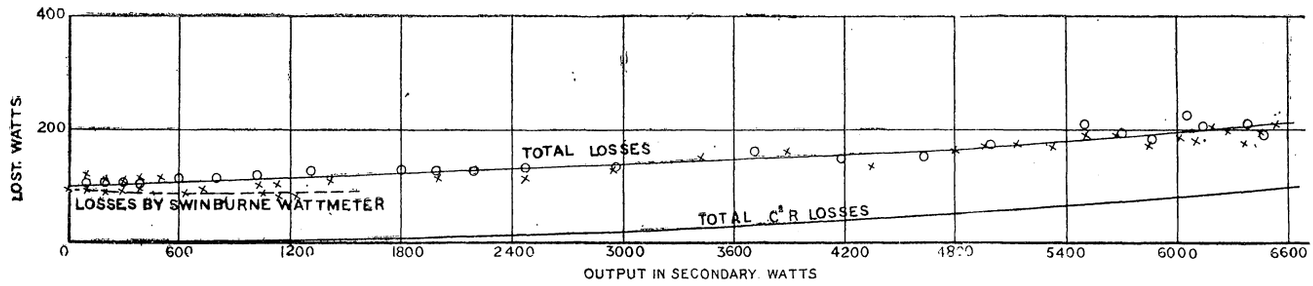

FIG. 15.—Westinghouse Transformer. Losses by Dynamometer Wattmeter.

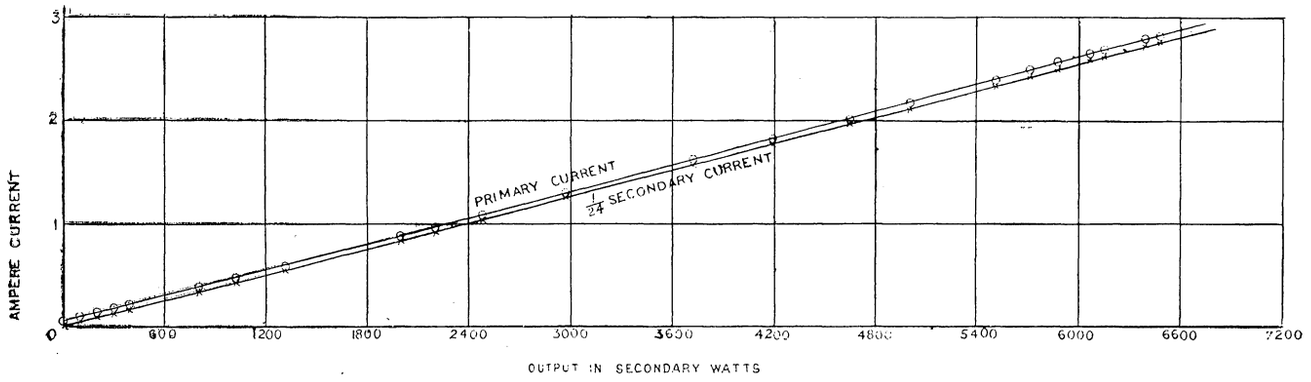

FIG. 17.—6500 Watt Westinghouse Transformer.

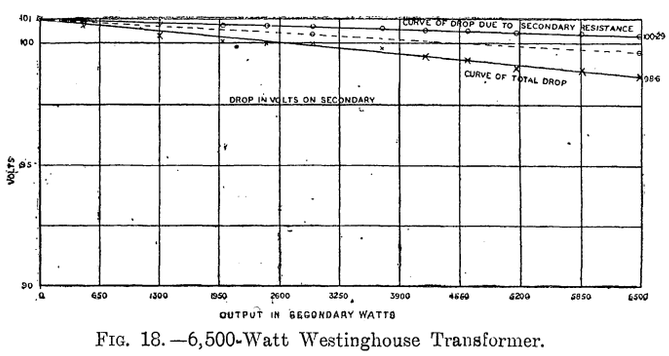

FIG. 18.—6,500-Watt Westinghouse Transformer.

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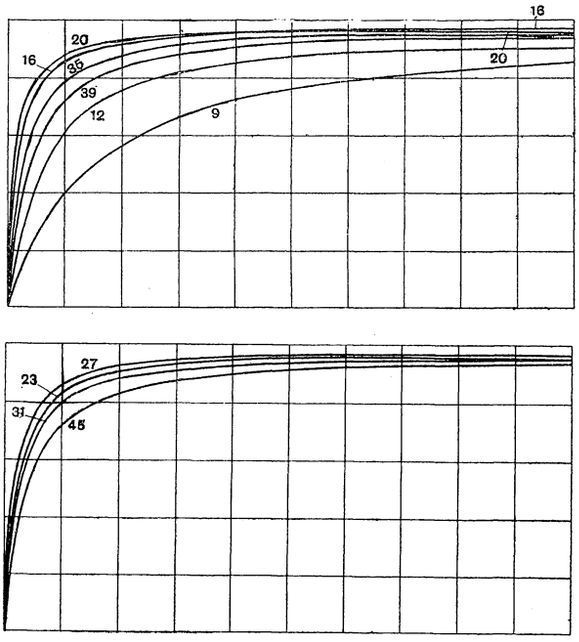
very fairly in assigning a value of not far from 2 per cent. both to the open-circuit loss and total secondary drop.

According to our observations this transformer takes rank as one of the best for regulation, having regard to its size and its open-circuit loss. The maximum total copper loss (C^2R loss) is 117 watts, and the maximum total loss at full load is 311 watts. The maximum



Efficiency Curves. The number against each curve refers to the Figure mentioned in the paper.

efficiency is close to 96 per cent., and the efficiency at one-tenth of full load is 80 per cent. These figures are, perhaps, not quite comparable with those of the 20 to 1 6,000-watt transformer worked at 100 ~, but they are, at any rate, not very different from the values of the similar quantities given by the manufacturers for this last transformer.

We shall deal more at length presently with the important question of the constancy of the iron losses at all loads, which the observations on this tranformers bring out most clearly.

(To be concluded.)

ELECTRIC LIGHTING AND TRACTION NOTICES.

The time for giving official notice in the *London Gazette* of Private Bills to be presented to Parliament next Session, and of all Provisional Orders, expired on Wednesday. From the following list of notices relating to electric lighting and traction enterprises it will be seen that there are 17 traction notices and 20 electric lighting notices. Last year the figures were 15 and 34 respectively. Of the grand total of 37 notices no less than 17 are given by Local Authorities, who seem as anxious as ever to retain their grasp on electrical enterprise.

ELECTRIC LIGHTING NOTICES.

THE METROPOLIS.

Districts.	Names of Applicants.
Barnet.....	Local Board.
Hackney	Board of Works.
Hammersmith..	Vestry.
Islington.....	Vestry.
Islington (St. Mary).	Holloway Electricity Supply Company.
Islington	County of London Electric Lighting Company.
Newmarket ...	British Electric Light Company.
Poplar.....	Board of Works.
South Kensington	Kensington and Knightsbridge Electric Lighting Company.
Thames Embankment, Westminster and Waterloo Bridges,	London County Council.

THE PROVINCES.

Towns.	Names of Applicants.
Altrincham and Bowdon.	Manchester Edison Swan Company.
Beckenham (Kent).	Local Board.
Bridgend.....	Local Board.
Brighton.....	Brighton and Hove Electric Lighting Company.
Colchester	Corporation.
Eccles	Corporation.
Harrogate	Corporation.
Newcastle-on-Tyne.	Newcastle-on-Tyne Electric Supply Company.
Reading	Reading Electric Supply Company.
Taunton	Corporation.

ELECTRIC TRACTION NOTICES.

Names of Applicants.	Powers Sought.
Barry Dock and Railway Company.	Construction of electric tramway to Barry Island.
Birmingham and Midland Tramways.	Authority to lease the undertaking. Use of electrical or other power.
Birmingham Central Tramways Company.	Construction of tramways. Use of electrical, cable, or other power.
Blackpool Corporation....	Use of electrical or other power for tramway.
Blackpool, St. Anne's, & Lytham Tramways.	Use of electrical or other power.
Bolton Corporation.	Use of electrical or other power for tramway.
Brighton and Rottingdean Seashore Electric Railway Company.	Extension of present line.
City and South London Railway.	Extension of time.
Company to be formed ..	Construction of underground line between Clapham and Paddington.
Hull Street Tramway Co.	Power to transfer undertaking. Use of electrical or other power.
London, Deptford, and Greenwich Tramways Company.	Extension of time. Use of electrical or other power except steam.
Plymouth Corporation...	Use by the Corporation and their lessees of electrical or other power.
Salford Corporation.... ..	Use of electrical or other power.
South Eastern Railway...	Construction of tramway at St. Leonard, Hythe. Use of electricity or other motive power.
South Staffordshire Tramways.	Use of electrical or other power.
West Metropolitan Tramways.	Use of electrical or other power.
Wigan Corporation	Use of electrical or other power.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, December 2nd.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Ordinary Meeting. Paper to be read:—"Water-tube Steam Boilers," by Harry Fraser.

MONDAY, December 5th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting. Paper to be read:—"The Shortlands and Nunhead Railway," by A. G. Drury.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture. I., 3, "The Generation of Light from Coal Gas," by Prof. Vivian B. Lewes.

TUESDAY, December 6th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed:—"The Manufacture of Small Arms," by John Rigby, M.A. At this Meeting the first monthly ballot for Members for the session will be taken.

WEDNESDAY, December 7th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read:—"The Chicago Exhibition, 1893," by James Dredge.

THURSDAY, December 8th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Annual Business Meeting, and discussion on Dr. J. A. Fleming's Paper on "Experimental Researches on Alternate Current Transformers."

FRIDAY, December 9th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. Papers to be read:—(1) "On Colour Vision," by W. B. Croft; (2) "On Japanese Magic Mirrors," by Prof. S. P. Thompson; (3) "Reflection from Diffusing Surfaces," by Dr. Sumpner.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read:—"Electric Light Cables," by E. S. Franklin.

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STEEL-PLATE PORTRAITS

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ELECTRIC TRACTION.

"There is surely no greater wisdom," wrote BACON, "than well to time the beginnings and onsets of things . . . first to watch and then to speed," and by carefully watching what others are doing, and by using every caution in the beginnings and onsets of the art of Electric Traction in this country, we shall doubtless arrive at not only speed, but at comfort and economy. Though but few electric lines have been laid in England, no greater variety can be found even in America; almost every system has been tried, excepting, perhaps, primary batteries and drehstrom; and while the trolley is the accepted solution of the problem in the United States, only three examples, and these, the most recent, are to be found in this country. We are not prepared to admit that because little success has attended other efforts, we have been forced to this unsightly and by no means simple system; but if, as its advocates are ever ready to assert, it be really more economical both to erect and to run, there is hope that experience will be gained in such matters as are common to all systems, and that when a margin of profit has thus been realised, some

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more civilised methods may become possible. As a choice between evils the experimental line in Bradford is vastly preferable to the noisy, dirty, and hideous steam trams; as a convenient means of access to the pleasure grounds of Roundhay, the trolley wires and posts in the suburb of Leeds may be forgiven, while those parts of South Staffordshire, in which the latest line has been erected, are long past spoiling. Much as we dislike the idea of trolley lines along any roads or streets in which the least regard is paid to appearance, we must confess that public taste has already given way to the introduction of tram lines with tame resignation where once they were stoutly opposed, and that it is quite possible that the trolley line may some day be seen along Princes-street, Edinburgh, or the High in Oxford, or any other equally fine street, if such there be, which has been disfigured by the tram and its lines. Fortunately there are other systems, little if anything behind the trolley in expense of working, and perhaps not much more costly to equip; and of these we may hope to see some examples at no distant date.

The first electric tram line was one of the few true trolley lines that have been tried; we refer to the Siemens' car at the Paris Electrical Exhibition of 1881. Two conductors were erected on posts alongside the track, and on these two collectors ran, being attached to the car by flexible wires. A return has been made to the general arrangement of this method in the adoption of a side conductor on the South Staffordshire line, a trolley rod being used instead of the flexible cords. The other features of the South Staffordshire line which we have recently described call for no special comment. With the exception of this detail there is little to distinguish it from the common practice in America. Our requirements and habits as well as our climate and the price of labour all go to determine the value of rapid transit and the choice of a system of traction. While the dampness of the atmosphere renders the insulation of bare conductors rather difficult, we find that other countries have their peculiar drawbacks. It is a common custom in the Western States to stop all the electric cars as soon as a thunderstorm begins, since a far-spreading trolley line with all its concomitant network of slings, spans, strain wires or pull-offs, anchorings, duplicate guards, besides hangers, brackets, and frogs, all earthed at and through the car itself, is too strong a temptation for the lightning, and the traffic must be stopped and the trolleys released, unless, indeed, such protectors as that of Wurts are found to be efficient. In Montreal, again, the citizens were recently represented as delighted with the idea of having a tramway service in the winter, but it is now stated that a petition with 10,000 signatures has been sent to the City Council protesting against it, since the roads would be spoiled for sleighing.

For the streets of towns in which trolley wires will not be permitted, there is a considerable choice of closed or slotted conduit lines. The experience gained at Blackpool has been of great value in proving the practicability of a slot under very trying circumstances, but many closed conduit systems have been offered, and on an experimental scale they have been found to work with every promise of success. The names of Ayrton and Perry, Wheless, Hopkinson, Short and Naysmith, Pollock and Binswanger, J. Gordon, Holroyd Smith, Lineff and Wynne are connected with closed conduits. Three ways of making contact between a sectional contact rail and a buried conductor have been proposed—the weight of the car, electro-magnetic switches, and a picking-up magnet, carried by the car. The Wynne system, which is described in another column, is the latest development of these types, and the only difficulty that seems to present itself is the maintenance in working order of some 530 electro-magnetic switches per mile of line. The diving-bell cover will certainly go a long way towards protecting these devices from actual water, and it must be remembered that if one or two missed fire occasionally, the car would run on by its momentum.

In neither of the two books which are reviewed in our present issue, nor in any Paper before an engineering society, have the advantages or the possibility of constructing a variable gearing been discussed. We have thrown out a suggestion for such a gear in these columns, and a most promising and thoroughly mechanical design for an alternative double gearing was shown to us only this week. The use of a disc wheel as in an integrating instrument has been tried by the Conolly gas motor, but it is out of the question under a tramcar. The slipping friction clutch is a makeshift on unsound principles; it is frequently suggested, and the fallacy is as frequently pointed out, but the use of resistances and the waste of heavy currents through armatures in starting is as radically bad, clumsy, and wasteful a method as it is possible to conceive. The grouping of cells in various ways, when storage batteries are used, is better, for there is little or no waste of volts. Mr. Reckenzaun says that no engineer would be so foolish as to employ a 30 H.P. motor where a smaller motor would suffice, but a car with only a 4 H.P. motor cannot mount a hill, and thereupon he, like all other traction men, recommends two motors, and Mr. Holroyd Smith, to make doubly sure, uses four. Two motors, it is true, can be used to drive independent axles, and in the event of disablement of one, the other motor will see the car home somehow, but the same arguments might be applied to the design of a steam locomotive. What is really wanted to enable electric traction to compete with other mechanical systems—and the competition with cable lines promises to be very severe—is an equivalent to the expansion gear. A rather complicated arrangement of motor and dynamotor proposed by Ward Leonard, and independently hit upon by an English engineer, would work under a constant high pressure and generate on board the car whatever power was needed, wasting practically none. This is an electrical solution of the problem; but when there is a choice between a mechanical and an electrical method it will generally be found that the latter is the most attractive and complicated, though easy to design, while the former is more sure and trustworthy,

A renewed interest is being taken in electric traction, and several inventors and manufacturers are eagerly inquiring for openings. Storage battery makers in particular are striving to throw off the reproach of expense and other disadvantages under which accumulator traction has laboured. The Electrical Power Storage Company have several negotiations in hand, and the Epstein Electric Accumulator Company are supplying additional sets of batteries for the Birmingham Tramways and propose to undertake maintenance contracts at about $1\frac{1}{2}$d. per car mile. As a rule, however, the capital of Tramway Companies is so large, and the tenure of their lines is so short, that they find great difficulty in contemplating a change in their methods of traction. But while this may constitute a difficulty, it must not be forgotten that no stronger argument can be found for giving every attention to the development of electric traction, since the expiry of these tenures should be seized upon, affording as they will the most important opportunities for the introduction of new systems. The desirability of rapid transit and facilities for locomotion is becoming more and more manifest, and many a suburb owes its very existence to the services of trains, trams, or 'bus, which take its residents to their daily work.

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REVIEWS.

Street Railways: Their Construction, Operation, and Maintenance (Trams). By C. B. FAIRCHILD. (New York: Street Railway Publishing Company, 1892.)

This large and well-illustrated volume claims to be "a handbook for those building or operating either electric, cable, horse, or elevated lines." By way of explaining to the old-fashioned Britisher what is meant by a street railway the title-page concedes the explanation—trams. A very useful book on traction might be written without a single illustration or even diagram, and the whole subject might most advantageously be discussed from general principles of design and management without entering into details, which, after all, only embody one way, and one particular way, of carrying out such principles under a certain set of conditions, many of which may not, perhaps, be found together in another example. The book before us attempts to cover electric, cable, horse, and purely mechanical traction; inclined roads, rack railways, elevated railways, car building, track construction, rules and regulations, bookkeeping and management. It is more than doubtful whether any one man could be found to write a useful and in any sense complete book on so wide a subject, using the word complete to denote merely that the various sections and sub-sections contain more than a casual example and give more than a mere smattering of the information which the reader may fairly expect.

The editor of such a journal as the *Street Railway Gazette* of New York has, undoubtedly, an ample stock of material whereon to draw; but by a mere compilation of examples, interesting as they may be to one who already knows something of perhaps one branch of the business, interesting because they tell him what is being done in allied branches, and not without attraction to the young engineer who may examine the results, the art of construction cannot be imparted without a proper examination of the general principles of design.

By way of making a good start, the author leads off with an introduction on the elements of electrical science, but it is quite inadequate to enable an intelligent engineer to understand the problems of electric traction. Trucks, gears, and motors are illustrated in profusion, but by engravings from photographs, showing outside views. The idea of such illustrations is to give the general arrangement, but the general arrangement cannot be understood even by the initiated unless it be accompanied by sections and elevations in a systematic manner. They tell the engineer little or nothing; makers are, of course, quite aware of this, and willingly give a photograph to be engraved when they grudge an outline tracing. Many illustrations appear to give a good deal of information, while they really give none, and in no case is this more marked than in perspective views from photographs of the under-frames of electric tram-cars, with motors and gear complete. They satisfy the general public, however, who think that if they cannot understand a jumble of tie-bars, wheels, and brake-gear with a motor or two half buried in the midst, it is their own fault. In the section devoted to electric traction stations we find illustrations showing in one case thirteen, and in another twenty-one, separate dynamos, but not a word about the design of such stations, or the reasons for a choice of a unit. We cannot expect to find any attention paid to the humble attempts at electrical traction in this country or on the continent, but we remark that worm gear is not even mentioned, and conduit systems are dismissed in three lines.

The second chapter, on cable lines, appears to be the best in the book. It contains copious illustrations of conduits and conduit frames, curve-pulleys, grips, cables, splices, &c., but we notice only one roller grip, that which is used on Brooklyn Bridge. Really fine direct-acting or rope-driving engines are used for this work, a great relief after the rows of little engines belted to dynamos, or to countershafts, in the first chapter. The chapter on horse traction, illustrated with plans and views of stables, may be passed over as having little to do with engineering; and the next one, on steam, compressed air, and gas, because it is very poor. Rack railways and "elevated roads" have little to do with trams, and need no comment. A long chapter deals with car-building, and here we have coaches and trucks innumerable. Some of the illustrations are intelligible to the engineer, and give a good idea of what has been done; but how these designs were arrived at, or to what special purposes they are suited, not a hint is given. The profile of car wheels, and the conditions governing the length of wheel base, are utterly neglected. Considerable space, on the other hand, is devoted to coach-painting, glass-embossing, and trimming. Track construction and road making are treated in a rather better style, but only one-half of a single sentence is allowed for the relation between wheel-base and minimum radius of curve. Twenty-nine quarto pages are filled with a collection of rules and bye-laws. Under rules for drivers we find, No. 12, a driver must not spit tobacco juice so that the wind will carry it on to the passengers, and No. 36 enjoins that on the Sabbath the bells on the horses must be muffled, and the speed reduced to a moderate pace when passing churches or their immediate vicinity. The book concludes with chapters on municipal licences and on book-keeping. This last is, perhaps, more useful than any other in the volume, and contains numerous examples of report forms, log sheets, and ledger rulings. These, however, are merely suggestive for the most part, since each manager must devise such details and not copy them. Having said all that he has to say, but having 47 illustrations of cars and 102 blocks of sundry appliances left over, the author prints them by themselves without comment. The whole book suggests compilation from advertisements and trade catalogues and newspaper notices, but is worth perusal by those who are interested in them and are already familiar with one or more branches of the important subject with which it deals, for some illustrations speak for themselves, and mutely tell the tale of construction and even of design to those who have already a fair knowledge of engineering.

Electric Traction on Railways and Tramways. By ANTHONY RECKENZAUN. (London: 1892.)

A book by Mr. Reckenzaun on electric traction cannot but command attention, and even though he describes it as an endeavour to summarise as concisely as possible the present state of electric traction, he takes too keen an interest in the work to content himself with a mere description of the methods and constructive details, which are to-day in use. The book contains an excellent elementary account of the principles which govern the design and working of electric lines, but it is very unequal. Dynamos, for example, are dismissed in a few words, possibly because no distinct type of machine or system of driving has been adopted; it is, nevertheless, an omission. The author apologises for departing from a systematic arrangement of chapters on account of new and interesting matter received at the last moment, but this is of minor importance compared with the disjointed arrangement of the introduction which contains much that is of importance. Prony-brakes with levers are rather out of date, and no dexterity is demanded in the use of a rope brake. Fleeming Jenkin's brake is described and leather is recommended for the cords. When, however, ropes are used, and spring balances are substituted for weights, all the old difficulties disappear. A few useful notes on motor efficiency are given in the first chapter, but make no claim for originality. The author has collected some valuable data on traction, and discusses the effect of inertia on starting, tractive force, increased friction on curves, calculations for gradients, and like matters, which, though common to all systems of mechanical traction, are completely ignored in the more pretentious book which we have just noticed.

In proceeding to the design of motors, the author quickly, and we think on very insufficient grounds, arrives at the conclusion that two motors ought to be employed. After a few pages on design, several types of motors are described, and these are followed by speed-regulating switches, and the various devices, each one in our opinion more clumsy than the last, by which electricians rather than electrical engineers have attempted to control the power developed by their motors. A good account is given of the principal systems of trolley and conduit lines, with many details of construction.

A chapter is devoted to secondary batteries, and, as might be expected, a large portion of it is concerned with the difficulties and causes of deterioration. After this a number of important

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lines are described including those of Portrush, Bessbrook, City and South London, the projected Central London Railway and the Birmingham tramway. The next chapter is headed "Practical considerations relative to public convenience and general utility; advantages of electric traction," but on turning over a page or two we find ourselves in the intricacies of "bucking." There is a good deal worth reading in this chapter, but as there are but few paragraph headings or sections, and as each page of the book bears the headline "Electric Traction," it is rather difficult to find one's way in it. A number of tests of various lines, including load-diagrams of the City and South London line, are given. Some nineteen pages on the cost of working conclude the volume. It was not until we came to accounts of the Frankfort-Offenbach, and of the Halle Tramways, and recognised them as having appeared in Mr. Reckenzaun's Paper, read before the Institution of Electrical Engineers, that we recollected that such a Paper had been written, a sufficient proof, if one were needed, that the author has done something more than merely expand and add to that communication.

THE ABUSE OF LONG-LIVED INCANDESCENT LAMPS.

When incandescent lamps first began to come into commercial use, says M. Hospitalier in *l'Industrie Electrique*, people were content to estimate their value, on the one hand, by their *initial* consumption of energy in watts per candle, and by the *average* life guaranteed by the maker. Unfortunately, the specific consumption is one of the most variable of factors, according to the *régime* adopted and the qualities of the lamp. To get a clearer idea of the value of a lamp we must pursue our investigations further, and take into account the diminution of candle-power with time, the price of the lamp and its life, and the cost of electric energy. Endeavouring to bring in these different factors in a rational manner, Mr. Edward O'Keenan has evolved an analytical method, both ingenious and practical, which it may prove useful to describe, and, at the same time, indicate the singular result to which it clearly leads, namely:—*Consumers smash your old lamps after a few hundred hours' service!*

This conclusion, which has nothing in it displeasing to glow-lamp manufacturers, is justified by Mr. O'Keenan's method, which I propose to elucidate and apply to typical modern glow-lamps, making use of the figures given by M. Ch. Haubtmann in an interesting article entitled "Investigation of the Consumption of Incandescent Lamps,"* published in *l'Electricien* of September 24, 1892, p. 201. (*See* also *The Electrician*, September 30th, Vol. XXIX., p. 590.)

Mr. O'Keenan seeks to determine the moment in its existence at which a lamp should be broken up, and this moment he calls *smashing point*. This point is determined by plotting a certain number of curves showing the peculiar characteristics of a lamp, and enabling us to estimate its value at any instant of its existence from various points of view. All these curves are plotted with hours of service as abscissæ, and with the following quantities as ordinates:—

A. The electric energy in watts consumed at any instant.

B. Candle-power (Fig. 1).

C. Energy consumed (watt hours) since the lamp was put into service (*i.e.*, the integral of curve A).

D. The quantity of light produced by the lamp (candle hours) since it was put into service (*i.e.*, the integral of curve B).

E. The cost of the energy (in francs) consumed by the lamp since it was put into service. Curves C and E may be made one by a suitable choice of a scale of ordinates.

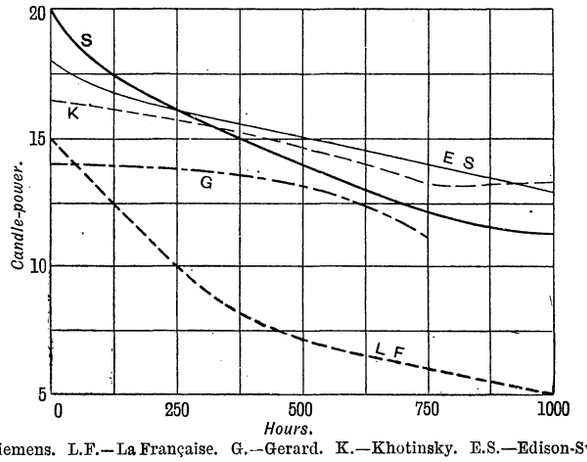
F. *Total* cost of the lamp (in francs) since being put into service; a curve which is obtained in raising the curve E by an amount equal to the price of the lamp.

* Certain qualifications having been put forward with regard to M. Haubtmann's figures, we only use them in this article to illustrate the method.

[To simplify the calculations and the construction of the curves I have taken the electric energy as costing 1 franc per kilowatt hour, and the lamp at 2 francs; figures which are, as a matter of fact, very near the actual truth in Paris.]

G. Specific cost (Fig. 2) at any instant, in centimes, per candle-hour; obtained by taking the ratio of the ordinates of curves C and D.

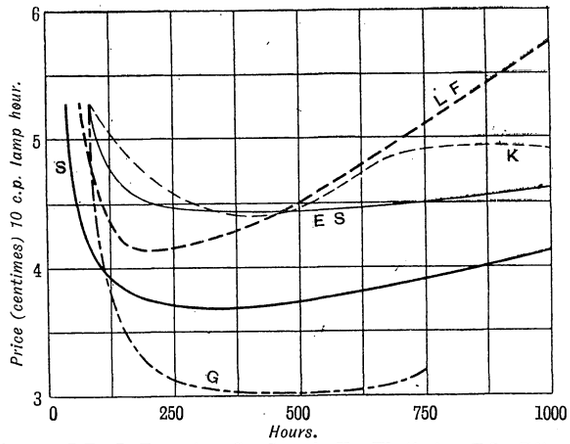
$$\text{Specific cost} = \frac{\text{Total cost in francs}}{\text{Quantity of light in candle-hours.}}$$



S.—Siemens. L.F.—La Française. G.—Gerard. K.—Khotinsky. E.S.—Edison-Swan.

FIG. 1.—Candle-power as a function of Time.

This last curve characterises every type of lamp working in a given manner. It shows, generally speaking that, during the first hours the specific cost, asymptotic to the axis of y, rapidly diminishes, then falls more slowly to a minimum, and then ascends indefinitely owing to the reduction of the candle-power. There is, therefore, a moment at which a given quantity of light has been obtained for a minimum price. It is precisely at that moment that we must remove the lamp, replace it, and break it; or, rather, return it to the maker, and obtain a sum varying from 5 to 15 centimes, say, on the average, 10 centimes.



S.—Siemens. L.F.—La Française. G.—Gerard. K.—Khotinsky. E.S.—Edison-Swan

FIG. 2.—*Specific Cost* as a function of Time.

Mr. O'Keenan's method, applied to 102 volts 16 c.p. lamps of La Compagnie la Française, shows that the *smashing point* for them arrives after 200 hours' use. In fact, if we keep them burning after that the result is that, after 2,000 hours, we have a 5 c.p. lamp taking 8·8 watts to the candle. Mr. O'Keenan has in his possession a curiosity in the shape of an old, much-blackened lamp, taking 17 watts to the candle. That figure alone shows that the lamp deserves to have been broken long ago. In no case (*see* Fig. 2) is the *smashing point* deferred beyond 500 hours.

The conclusion which stands out clearly, after a study of all these curves, is that the *smashing point* being always reached *before* the nominal life of the lamp has been spanned, our lamps last too long. To remedy this defect the mode of manufacture and the standardising should be modified, so as to make the smashing point coincide with the life; in other words, the

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lamp must be *pushed*. This is shown by the curves which have been obtained when working at 102 to 110 volts in lamps of the same make and type.

Until this consummation is reached the consumer will continue to demand long-lived lamps, and it will be very difficult to make him understand that it is to his interest to break a lamp after a few hundred hours' use, because the advantage will not present itself to him in the guise of a material and direct economy. The substitution of an old lamp for a new one does not sensibly modify the indications of the meter, and the substitution is itself an undoubted expense; to wit, the cost of the new lamp. The gain, of course, lies in obtaining more light, or, to speak more accurately, in obtaining a larger quantity of light for the same price. But this is a form of economy which scarcely appeals to the generality of consumers. For a long time to come the long life of incandescent lamps will continue to be misused without people seeing, as in the case of all other abuses, the error of their ways.

THE SWINBURNE ELECTROSTATIC WATT OR VOLTMETER.

This instrument, of which we have recently heard so much, has been greatly improved since the first original ones were supplied to Dr. Fleming for his transformer tests. In its present form the instrument is a very delicate and accurate instrument.

The electro-magnetic damping arrangement has been done away with, and an adjustable oil-damper substituted, which enables any degree of damping desired to be obtained. The moving system has been very much lightened, and so the troubles of creeping zero, &c., have been eliminated. The torsion head has been improved by adding a tangent screw fine adjustment, to enable the spot to be brought accurately to zero, but the first rough adjustment may be done by turning the head as usual. A vernier has also been added to the scale, so that the pointer may be read to one-tenth of a degree. On steady volts the new instrument may be read to half a volt in 2,000 volts.

Dr. Fleming's initial difficulty with cross sparking was simply due to his using for 1,800 and 2,000 volts, instruments which had only been designed and intended for 1,000. Messrs. Swinburne have, however, increased the distance between the vanes and boxes considerably, so that there is now no danger of sparking with high volts.

IMPROVEMENTS IN ELECTRIC MAINS AND DISTRIBURION.

At the Manchester meeting of the British Association in 1887 Prof. G. Forbes proposed to construct mains for electrical distribution in the form of copper tubes. The stiffness of such a conductor presents advantages, and they can be easily drawn from flat strip. A gap or slot of a quarter of an inch was to be left between the edges of the strip, and it was proposed that as the load increased owing to the requirements of the district, a number of bare copper wires could be drawn through from manhole to manhole. Connection between the lengths of the conductors was not fully worked out, and junction boxes were ignored, house connections were to be made through 1in. holes into which gas pipes were to be tapped. This was put forward as an essentially "bare copper" system, and insulating discs of porcelain were to support the copper tubes in cast-iron pipes. Nothing more has been heard of copper tubes, and without discussing who was the actual inventor, it is safe to say that Mr. Crompton has since fully developed with complete success the strip and conduit system, and that others have followed, not always with equal success. To meet the difficulties of entrance of water into badly-made, ill-drained, or leaky conduits, and to save the trouble of tightening, Messrs. Gordon and Co. propose to adopt brazed copper tubes in porcelain ring insulators, and to lay these on a concrete bed at the bottom of a trench, and run them in solid with an asphalte composition. It is proposed to use tubes from three-quarters of an inch in external diameter, one-eighth of an inch thick, to 2 inches diameter, and one-sixteenth of an inch thick. It is suggested that pilot wires or telephone wires may be laid in the tubes, and Prof. Forbes' idea of reinforcing the section of the conductor by drawing in bare copper strand is also contemplated.

In the absence of any information about the asphalte composition, we are not surprised to hear that the insulation resistance is not quite so high as that of the best cables, but the claim that it is practically impossible to injure it must be received with caution. We are informed that in the course of the experimental test a piece of wet clay fell upon the asphalte before it was set and gradually sunk through it and formed a connection across the tubes. The insulation resistance at once fell very considerably, though not sufficiently to stop the use of the mains. Bubbles appeared for about three-quarters of an hour over the point where the clay had sunk in, and at the end of that period the insulation resistance rose to its full amount, and the main appeared to be in perfect order. On removing the clay afterwards it was found to be baked hard and dry. A sheet of calico is to be laid over the asphalte to prevent such accidents in future. It is intended to use this system at present solely for circuits not exceeding 200 volts, but an experimental length of it at Bray has been subjected continuously to 1,000 volts, and remains in perfect order.

Messrs. Gordon and Co. claim that in case of any fault occurring, "a little heat is developed at the fault which at once melts the asphaltes in the neighbourhood; but it then flows in and repairs the fault." We hope that this excellent result may be realised in practice. The stiffness of the tubes is a good point, and certain readily calculable advantages may be realised by the decrease in virtual resistance for alternating currents. We are not informed how joints are made; these become of some importance when the short lengths of tube and the long lengths of strip are considered. Attempts to secure stiffness by placing copper strip on edge have been made by several contractors who followed Mr. Crompton's plan at a respectful distance, but he had tried it and had abandoned it before the strained flat strip was arrived at. The use of tubes, however, suggests that strip might be rolled into a V like angle iron. This would hardly span eleven or twelve yards like the strained strips, but would offer facilities for drawing in additional length, and if more convenient, the veeing could be done on the spot, the strip being brought on to the work in the flat. The virtual resistance of such "angle copper" would be much more nearly that of a thin tube than of a solid rod.

Messrs. Gordon and Co. are also introducing improvements in alternate-current distribution which are intended to avoid the royalties demanded for the three-wire system. In order to avoid committing contempt of Court, we hasten to add that by this invention the third wire is dispensed with altogether. The alternating current is to be supplied at 200 volts, from sub-stations to feeding points. Here an equalising transformer is placed, which is wound with two circuits of a similar number of turns. These two circuits are connected in series across the 200-volt mains, and 100-volt service wires are led from each. When the load on each circuit is the same, the transformer is inoperative, but when the loads differ, the balance is transformed and transferred from the lighter to the more heavily-loaded side. So many minds have been busy with transformers and methods of using them, that it seems difficult to find any arrangement which has not already been suggested, but if this invention is found to be both novel and practically efficient, it ought to be of considerable value. An interesting feature of this arrangement is that this transformer is the exact analogue (using this term in its strict biological sense) to the batteries used at the stations of the Kensington Knightsbridge Company. We understand that both the improvements in the mains and this method of distribution have been devised by Mr. T. Tomlinson, who is the inventor of the very ingenious automatic sub-station regulator which has been described in these columns.

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LEGAL INTELLIGENCE.

Hopkinson v. The St. James's and Pall Mall Electric Lighting Company (Limited).

THURSDAY, NOVEMBER 24TH.

On the hearing of this case being resumed, Mr. RANKIN KENNEDY was re-called and further cross-examined by Sir HORACE DAVEY, and stated that in the early part of 1882 he was engaged in perfecting the Kennedy arc lamp. He was sure that he went regularly to the workshop before he went to the Crystal Palace. It was not the fact that he used to conduct his business at Mr. Muir's office round the corner. Before he went to tho Crystal Palace there was no regular incandescent lighting though he had seen one or two Maxim lamps there lighted occasionally. The lamps were placed on the circuit of Siemen's dynamo. He did not closely examine the way the lamps were attached to the wires. He could not therefore tell whether some of the lamps were attached to the first and second wire, and some to the second and third. He would pledge his word that there were never more than two wires attached to the dynamo.

Examined with regard to diagram J.D. A.1 (see *The Electrician*, November 11, p. 47), witness said that it was generally correct. Although Mr. Andrews says he personally connected a third wire with the dynamo, witness felt sufficiently positive on the point to contradict Mr. Andrews. Mr. Andrews was head of the workshop and witness's visits to the workshop were intermittent. Occasionally he went there not upon any business connected with the Maxim lamps, but on business connected with the Kennedy lamp which was preparing for the Crystal Palace. He must necessarily have seen the third wire if it had been hanging from the roof. He had altered the Siemens' dynamo some time in June. The centre ring, which had been previously disconnected, was re-connected by him. The third ring was never removed. It was merely disconnected. No alteration had been made in the construction of the dynamo, but merely in the connections, and they could be made good in, say, half an hour. When he took the dynamo in hand the broad ring formed one pole, say the negative pole. The other two rings were positive to the broad ring. Before he took it in hand and re-connected the broad ring it was working all coils in series with the two narrow rings forming the two poles.

Re-examined by Mr. ASTON, witness stated that during the period before he went to the Crystal Palace, he constantly went to the workshop for the experimental purposes referred to, and ascertained the construction of the dynamo, as he wanted to understand the construction of that particular dynamo, dynamo making being his particular study at that date, and that being the first Siemens' alternating machine he had had an opportunity of actually having in hand. He returned from the Crystal Palace on the 19th May, and went to the workshop oftener than ever. They were busy preparing six arc lamps to go to Chatham Dockyard. The dynamo and engine were entirely idle at the time. No incandescent lamps were being made and no lighting was required. They never made any that were fit even to be tested. When he returned from the Crystal Palace and examined the dynamo, it was not in a condition to be used in connection with the three-wire system. He saw it with the middle ring disconnected both before he went to the Crystal Palace and after. During the whole of the time that he was there, both before the Crystal Palace and after, there were only two wires which came down from the roof and were connected with the dynamo. But supposing that a third wire came from the roof in the same way as the other two wires, it could not have been done so without his observing it.

Mr. DAVID GRAHAM, examined by Mr. HOPKINSON, stated that at the close of the year 1881 he was in business and very much interested in electrical matters. He became acquainted with Mr. Rankin Kennedy in October, 1881. The Otto gas engine was 2 H.P. He remembered taking the premises at Sauchiehall-lane on a weekly tenancy. He remembered the formation of the National Electric Company at the beginning of the year 1882. He was Managing Director of the Company. He knew what the three-wire system was now, but not then. He never saw anything of the sort. Mr. Andrews never told him anything of the kind. Mr. Andrews was then entirely a servant of the Company, and employed to assist in the experiments that were going on, working under witness. They never produced an incandescent lamp fit to be sold. The glass blowing went on at Sauchiehall-lane, but previously it went on in his premises adjoining. In his view it was a perfectly private workshop. It was on the second floor and entered from a back lane, and up a back stair. It certainly was not a place where he expected people to come in without his permission. With regard to the practical lighting of the place, till he went away on the 1st April, it was gas lighting. He never saw any system of electrical lighting there. Arc lighting was the only lighting that he saw, and that was experimental or testing the lamps that were being made.

Cross-examined by Sir HORACE DAVEY, witness stated that from April to June he had no personal knowledge of what was being done at the workshop.

Re-examined by Mr. ASTON, witness stated that he went away to the Crystal Palace from about April to May. During that time he had constant reports from Glasgow. He never heard of any use of the three-wire system by Mr. Andrews or anybody else. He never heard of it until this case was brought up.

Mr. DAVID JOHNSTON SMITH, examined by Mr. HOPKINSON, stated that he was the Secretary of the National Electrical Company in the year 1882. There was nothing successfully manufactured there and sold. The workshop was a private workshop.

Cross-examined by Sir HORACE DAVEY, witness stated that he never had occasion himself to refuse anybody admission, and he was not personally aware of anybody being refused who requested to see what was going on.

Mr. WILLIAM MACFARLANE, examined by Mr. ASTON, stated that early in 1882 he was engaged at the Sauchiehall-lane Works, Glasgow. He was there until the beginning of July in the same year. The Siemens' dynamo was there when he went there in March. He did not examine it. He was particularly engaged on Mr. Kennedy's lamps. During the time he was there the workshop was not lighted with incandescent lamps. He remembered the wires which came down from the ceiling and were connected with the dynamo. There were two. The workshop was lighted all the time that he was there by gas. His communications with Mr. Andrews were personal and direct and constant. He remembered once seeing two of Andrews' plate lamps tried at the same time. He remembered the pranks played by the workmen with the wires that went from the dynamo. He had seen them short-circuit the wires. The result of the short-circuiting was that one went out whilst the other blazed up. Being unable to form a distinct arc it blazed up and made a hissing sound.

Cross-examined by Sir HORACE DAVEY, witness stated that in 1882 he was an instrument maker in the workshop. He was not engaged on testing or any of the electrical part of the business, but on making Kennedy's lamps, and Mr. Andrews' lamps. He never saw any Maxim lamps placed upon the wires in the workshop. All the lamps that he saw burning he understood to be Akaster—purely experimental.

Sir HORACE DAVEY: You did not see any Maxim lamps put upon the wires?—Not for lighting the shop.

Not in the shop?—No, not for lighting up the shop.

Will you be good enough to answer my question. Did you or did you not see any Maxim lamps put upon the wires?

Mr. JUSTICE ROMER: At all; for any purpose?—Well, I have no knowledge of that, because we were not allowed to go where Mr. Andrews carried on his experiments with those lamps among the racks, and, therefore, I could not say what wires were on.

Sir HORACE DAVEY: Did you or did you not see lamps placed upon the wires you have mentioned and burning?—I have seen lamps put on the wires.

Incandescent lamps?—Incandescent lamps.

And burning?—And burning.

And giving light?—Yes.

In this workshop?—In this workshop, but not for the purpose of lighting.

Continuing, WITNESS stated that some of the lamps burnt almost a day, sometimes only a very short time, according to what Mr. Andrews was wanting. After Mr. Andrews went away he had been there till twelve o'clock at night and worked by gaslight.

Sir HORACE DAVEY: Did you ever see the incandescent lamps burning at night for the purpose of giving light?—No.

Did you see the incandescent lamps being made?—Yes, I have seen them on the racks.

Did you observe, or did you not observe, whether those racks were placed on three wires, or two wires, or how many wires they were placed on?—Two wires in all that ever I saw.

Are you prepared to say that there were not three wires hung round the room upon which the lamps were placed?—Well, I never saw them.

Mr. JAMES CURRIE, examined by Mr. HOPKINSON, stated that he was a glass blower. About the end of March, 1882, he went to the Sauchiehall-lane workshop, and was engaged by Mr. Graham. He stayed from the end of March to the end of April. His duty there was blowing lamp bulbs. While he was there the place was lighted with gas. He had seen one Maxim lamp in the workshop, on the wires running round the side of the workshop. He did not know what it was there for.

Mr. HENRY ELGIN, examined by Mr. HOPKINSON, stated that he was a clerk in the employ of Messrs. Crossley Bros., Openshaw, near Manchester. A 2-horse gas engine was ordered, supplied, and paid for.

Cross-examined by Sir HORACE DAVEY, witness stated that it was 2 H.P. nominal.

Mr. ROBERT WILSON, examined by Mr. HOPKINSON, stated that he was the London manager of Messrs. Crossley Bros. The capacity of their 2 H.P. nominal engines was from 24 to 28 lamps, assuming 16 c.p lamps. He had no experience with Maxim lamps.

Dr. JAMES THOMSON BOTTOMLEY was then examined by Mr. MOULTON. At the end of 1881 he was asked by Mr. Graham personally to come and assist at the lighting of the Fine Art Gallery. Mr. Graham was in a difficulty, and applied to witness to assist him. Neither at the Fine Art Gallery nor in the workshop at Sauchiehall-lane did he ever see an arrangement wherein a third main was taken back to the middle point between the two coils in series. The three-wire system was a novelty to him when he heard of Dr. Hopkinson's discovery.

Mr. MOULTON: Is the model S.P.T. 4 made in accordance with the direction of the specification?—Yes, I believe it is. I may say that I have not very intimately studied the specification. It has not been put before me.

Now will that work on an alternating system where not the whole, but only a portion, of the current passes through the thick coil?—Yes, this will work. I have seen it work.

In continuation, witness stated that with regard to the defendants' model (J.S.1), he should expect it to have the largest mutual induction; the disturbing element when the regulator was applied to alternating currents. He should expect one made according to Fig. 2 to work better than one made like J.S.1 on account of the arrangement of the coils. From his experiments with S.P.T. 4 he believed such an instrument would do the work that the patentee wanted it to do perfectly.

Cross-examined by Sir HORACE DAVEY, witness stated that he did not see the experiments which had been conducted the previous night.

Re-examined by Mr. MOULTON, witness stated that when they short-circuited the coil they exaggerated the mutual induction currents. There-

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fore, if mutual induction currents were sufficient to smother the action of the instrument, it would have been smothered. But it acted as a voltmeter perfectly.

Dr. JOHN HOPKINSON was recalled and further examined by Mr. MOULTON, and stated he was present the previous night when the experiments were being made with the working model S.P.T. 4. The total drop at the lamps when the complete current was on was 10 per cent. of the voltage. The lamps were working at about 50 volts, and the drop was 10 per cent., and, therefore, about 5 volts from one end of the conductor to the other. The action of the indicator would correspond to its action on an actual system.

Further cross-examined by Sir HORACE DAVEY, witness stated that the experiment was not arranged with such a relatively high resistance that the self-induction could not have any effect. He denied that in order to get sufficient main resistance to shunt with the coil of the regulator they would have to go outside the station.

Re-examined by Mr. MOULTON, witness stated that the model was not altered at all, the only current available was about 25 amperes. To change that to a working current of an installation on a large scale, they would have to change the 25 amperes to thousands of amperes.

Lord KELVIN, recalled and further examined by Mr. ASTON, stated that at the date of Dr. Hopkinson's patent the system of lighting by utilisation of three wires was, in his opinion, a novelty. He was not shown anything at the workshop at Sauchiehall-lane like the three-wire system of Dr. Hopkinson's. Looking at the two models (J.S.1 and S.P.T.4) before him, witness stated that S.P.T.4 corresponded absolutely with what he found in Dr. Hopkinson's, Fig. 2. The other one differed from the drawing in having the thick coil *outside* the thin coil. That was a material difference. It would largely increase the mutual induction between the two coils. He had that morning seen S.P.T.4 tried. He could now undertake to place it on any installation for public lighting, however large, and to make it work within a close percentage. He had not the slightest doubt that the apparatus as shown in Fig. 2 was a useful invention, and it was sufficiently described in the specification to enable it to be usefully worked with alternating and with continuous currents.

Cross-examined by Sir HORACE DAVEY, witness stated that he was not personally aware of any case in which the regulator had been put in practical operation. The resistance of the main and the wire which went round in the experiment was practically $\frac{1}{3\,6}$th and $\frac{1}{3\,0\,0}$th of an ohm respectively.

Mr. GEORGE BICKHAM DUNN, examined by Mr. HOPKINSON, said that he was in charge of the generating station at Sardinia-street, and gave evidence with regard to the "compensators" supplied by the Westinghouse Electric Company.

Cross-examined by Sir HORACE DAVEY, witness stated that they did not use the compensators now.

Mr. HOPKINSON: Because he does not want them!

Sir HORACE DAVEY: You do not use these compensators as you call them?—No, we do not use them.

Did you ever use them?—No, we never used them.

Do you use pilot wires?—No we do not.

Mr. JAMES SWINBURNE, recalled and further examined by Sir HORACE DAVEY, described what happend at the Westinghouse office the previous day in the presence of Mr. Harrison, Mr. Mordey, Dr. Hopkinson, Mr. Moulton, Mr. Alfred Hopkinson, Mr. Belfield, Mr. Hayward, and Mr. Owen, and one or two others. He saw the instrument coupled up on a temporary installation of lamps. There was a wire of platinum or high-resistance material put to represent the feeder. The fine wire was connected in the right way to the dynamo. He tested the working of the instrument, and under those circumstances he considered it worked well. The portion of the main was about ten times the resistance of the circuit which went round the coil, perhaps less; eight and a-half was what was suggested. The effect of increasing the resistance was to overcome the error due to self-induction. Supposing that the model installation had been converted into actual practice, preserving the same relative scale in every respect, it would not be a practical thing, because it involved taking the connections down about a third of a mile and adjusting them.

Cross-examined by Mr. MOULTON, witness stated that he could have told them that before if they had put the experiment to him in the witness-box the day before. He could have told them at once that the instrument might work under those circumstance, but that it would not work under practical circumstances.

Mr. ASTON: If your Lordship pleases that will be the plaintiff's case.

Mr. JUSTICE ROMER: Now we have all the evidence in.

Mr. MOULTON: We have.

Sir HORACE DAVEY: I think we have now.

Sir HORACE DAVEY, Q.C., in summing up the case for the defendants, said the case was an extremely simple one; it was merely the construction of a document. The question really was whether Dr. Hopkinson's specification was so framed as to comprise the case of a third wire used with lamps arranged in series, as well as in parallel, say two arc lights or two electromoters. If so, then it was admitted by Dr. Hopkinson that it was anticipated by the Inchicore arrangement, and his side said also by that used at the Alexandra Palace. If their construction was right then the invention was anticipated, or there was really no patentable invention in using incandescent lamps instead of arc, or "devices for consuming electricity," or in adding an additional number of bridges to the one already used. These two propositions were different—(1) The true construction of the specification comprised two arrangements, parallel as well as series. (2) Assuming this was wrong, then came the question whether a man could have a patent merely for substituting one lamp for another? But if the specification excluded all but incandescent lamps and any electrical appliance save when arranged in parallel, and the Court should think it was "subject matter" to extend the use of the third wire from arcs in series to incandescent lamps in parallel, then the patent would be valid. The first and primary question was then one of construction. Sir Richard Webster, in cross-examination of Prof. Silvanus Thompson, asked him if there was anything in the specification to lead a workman to use the third wire with two arcs or motors. An ingenious question adroitly put, but not the point. The real question was not whether there was anything *pointing* to the use of series, or motors, or other appliances, but whether the description did or did not *include* these things. The question was, whether the patentee's claim was couched in such language as to include these things. To say that the patentee had in his mind electric lighting by incandescent lamps in parallel did not answer the question. Had he not drawn his description to include other uses, and drafted his claim in such well-chosen terms as to cover other uses of his invention, such that installations like those at the Alexandra Palace and Inchicore would be an infringement had they been put up after and not before the date of the patent? That was the real question, and not the one put to Dr. Thompson. His question of construction was for the Court only. Experts' evidence was wholly irrelevant, and only given to throw dust in one's eyes. He protested against the doctrine that if an invention was not useful for a particular kind of installation that, therefore, such particular application of it was not within the patent. It was said that the three-wire system was of no use in series arc lighting, or arrangements other than parallel. The true conclusion from this premiss was not that series, &c., were excluded, but that if the specification properly construed applied to these cases, then the patent was valid. Or, to put it another way, they must *first* construe the specification before they considered the evidence whether a particular application of the invention were useful or not. He would now consider the specification more in detail, and in doing so note the way the case was opened. They were told by Sir R. Webster that the specification was confined to incandescent lighting. No more would be heard of that argument for three reasons: (1) Dr. Hopkinson admitted in the box that an electricity consuming appliance might be substituted for incandescent lamps; (2) he also told them it was to be applied to all kinds of uses; and (3) there was not a word in the specification so confining it. That was the way the other side presented their case. Would they adhere to it in reply? It was necessary to take the words of the specification in their natural meaning. What was the argument his opponents used as to the construction of the specification? They said that the first invention was for a regulator for working arrangements at a fixed potential, and that such was only required when they had an arrangement of incandescent lamps in parallel. He might admit that much, that the regulator was only useful when a fixed potential was required, and therefore only useful in such a case as parallel incandescent lighting. His opponents then went on to say, because it was applicable only when one wanted a fixed potential, and one wanted it only in this case of parallel lighting, therefore, people were to infer that the patentee confined the second invention also to where the potential was to be fixed, although when he described his invention he said nothing about confining it to parallel arrangements. It was the most fallacious argument that he ever heard. One might insert the words "at a fixed potential" in the second line of the specification, immediately after the word "maintaining," and read it, "maintaining at a fixed potential the electromotive force in a system of conductors for an electric supply;" otherwise "maintaining" had no meaning. The object of the regulator was to "keep the E.M.F. at a fixed potential," not merely to "keep it." Hence, "such conductors" meant simply conductors for electric supply, and not as the other side said, conductors for delivering electricity at a fixed potential. A little further down, in the disclaimed portion, patentee spoke of measuring the quantity of electricity drawn from "the system of conductors." Next he spoke of the necessity of keeping the potential at the delivery end constant, varying it when necessary at the generator. The words were all used there in the same way, not a word to confine it to a parallel system. He considered further down the economising of cost of conductors, and spoke of placing "*two* systems of lamps or other appliances consuming electricity of approximately equal capacity also in series." That was, one might use two arc lamps, say, in series, so that they could put one out; there was not a word there about either fixed potential or parallel arrangement. Take the case of two "electricity consuming appliances," say, motors—one was required to work at 9 H.P. and the other at 1 H.P. Here the third wire would convey the excess of current, so that the 1 H.P. machine was not "choked." Patentee next described the method of joining the wire between the two systems of appliances and the two dynamos. Suppose two arc lamps were put on Although both might be of the same capacity originally, yet, as a matter of fact, they would vary from time to time, and, therefore, a slightly different current would be required. The third wire conveyed that difference from or to the dynamo, as the case might be. They had the evidence in Prof. Thompson's illustration of the motors of approximately equal capacity, where he said the excess or deficiency would pass down the central wire. Mr. Swinburne and Prof. Kennedy gave evidence to the same effect. Take the case of the Alexandra Palace installation with Mr. Crompton's lamps. One could not be put out without putting both out, the third wire enabled this to be done. Similarly they could have six—three on each side; then three could be extinguished, and the other three left. Prof. Thompson's evidence on the sixth day of the trial was to the same effect. He spoke of the advantages of the new system. Three wires instead of four; again, they saved energy; people were familiar with the case of this in arc lamps, the third wire would have same effect if one of the lamps got more current than it ought to, it would convey the difference. Dr. Hopkinson on the second day said the same thing, only he thought it would not be useful; he said that the variation in the resistance of the lamps would be injurious, as it would make the lights unequal, the *operation* of the third wire to obviate this result would be the same as in his arrangement. Mr. Crompton's actual experience (spoken to on the fifth day) showed the same thing. Unless the central wire were used both lamps would go out when the "feeding" mechanism operated in one only.

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Lord Kelvin admitted that the Alexandra Palace installation was Dr. Hopkinson's three-wire system applied to two arc lamps. Mr. Swinburne's evidence as to the Inchicore installation was precisely to the same effect. In order to justify the construction contended for by the other side, they must say that the case of a *single* consuming appliance on each side of the middle wire was excluded There was nothing in the description to confine it to incandescent lamps or parallel arrangement. No doubt the patentee contemplated such, but he had not confined his specification to them. If he confined it to *several* series placed in parallel, why did he not say so? The fact that in one arrangement one derived more advantages from it than in another, was no ground for saying that the patentee meant to confine his invention to such arrangements. The same criticism applied to his description of Fig. 5. Not a word there confining it to a parallel arrangement. Nothing was said about the number of series. Where was the line to be drawn, at 3 or 2? If so, why? Where was the series excluded? He (Sir Horace Davey) had nothing to say to the "spirit of the specification," but must look at the words only. It was the same thing in principle whether applied to one series or one hundred. Undoubtedly the advantages were more and wider in the case of many lamps than of two as in the Alexandra Palace installation. But in that humble case there were still advantages derived from the invention.

At this stage the Court adjourned.

FRIDAY, NOVEMBER 25TH.

On the hearing of the case being resumed, Sir HORACE DAVEY continued his speech:—They now came, he said, to the consideration of the claims. The patentee here, in his second claim, spoke of a system of electrical distribution or *supply*." He (Sir Horace) would seek the essential features which the patentee emphasised—"the employment of three (or more) conductors in combination with two (or more) dynamo machines in series substantially as hereinbefore *described with reference* to Fig. 5 of the accompanying drawings," &c. Patentee did not say described in Fig. 5, but "with reference to" Fig. 5, that was by the letterpress which was *illustrated* by certain diagrams and drawings. It was to the letterpress, and not the diagrams, they must look. All that he really had claimed was a series of two or more electricity consuming appliances arranged in series and connected to two dynamos also in series by a third wire from a point between the appliances to a point between the dynamos. It was not the distinction between parallel and series, but between one series or more. The invention could not be confined to incandescent lighting because the patentee had himself extended it to others, nor could it be confined to more series than one, because the letterpress only spoke of one. The view taken by defendants was strongly supported by Prof. Kennedy's evidence, on which there was no cross-examination. Prof. Kennedy explained in the box fully how the advantages mentioned by the patentee were gained when his system was applied to a single series of two arc lamps. His figures as to saving of energy were uncontradicted. He was supported by the evidence of Mr. Lauckert, who made the dynamos which had been described. Mr. Lauckert's figures were also undisputed. He described the advantages gained in "the City of Berlin." His evidence proved two things—(1) actual saving of energy and therefore of coal and money, and (2) that there was really no invention in adding on any number of series when they were given one series of two lamps. As to the Alexandra Palace and Inchicore installations—the plaintiffs had ample notice and no evidence had been called to question their existence—they were not in dispute. Nor was it disputed that they were anticipations of the defendants' construction if the specification was the right one. Then, on the question of subject matter, Sir Frederick Bramwell said any electrician would have known in 1882 how to substitute one system, say a collection of multiple bridges for another, say, arc lamps. Use of third wire was known with two arcs in series. Could there be any patentable invention in merely multiplying the number of series? A word as to the last anticipation. Mr. Andrews' memory could be relied on for every detail, but his evidence went to prove that no invention was needed to change from a known arrangement to that described by the patentee. The dynamo was similar to that used at Inchicore—had the third collector ring. Mr. Andrews never thought there was any difficulty in arranging it for incandescent lamps in multiple parallel bridge. Mr. Rankin Kennedy's evidence supported the defendants' case. He said the construction of the dynamo was as described by Mr. Lauckert, and that there were three wires round the room. He differed from the defendants' witnesses when he said that the third wire was disconnected from the dynamo. Mr. Andrews was positive on that point, and he was in a better position to know. He was also a most disinterested witness, having no interest whatever in the case. His *bonâ fides* could not be doubted, but memory might be fallible. So, too, was Mr. Rankin Kennedy's. But the latter was there for a different purpose, and his attention was not called to the dynamo particularly. The other witnesses supported the defendants' view. The user was as open to the public as his (Sir Horace Davey's) house to his guests. If his guests saw an invention, would not that be publication? *Humpherson* v. *Syer* was the authority. As to the utility of the regulator, it had never been used. His witnesses had proved that it would not work with alternating currents. The other side had made their own experiment, choosing their own conditions, and had shown, according to Mr. Swinburne's evidence, that to translate their experiment to a working system would not produce a practicable machine. Nor was there in the specification any directions to the workmen to couple two alternating dynamos rigidly, which was admittedly necessary.

Mr. MOULTON, Q.C., then reviewed the evidence on behalf of Dr. Hopkinson. On the first claim, said Mr. Moulton, the only point made was that it was not useful, *i.e.*, would not work with alternating currents. This was not so. That form of regulator in which all the current went through the thick wire would work in all cases. The objection, then, only came to this, that they might if they tried a particular form, and one unsuitable find that it would not work. What were the facts? Dr. Hopkinson invented and constructed a machine which, by falsifying the record of pressure at the dynamo by a proper amount, would enable one directly to observe the pressure at the delivery end of the main where constancy was essential. It was very ingenious and useful. Lord Kelvin described it as a very useful instrument, and Mr. Belfield testified to its being used in a modified form throughout the United States. There was no serious attack on the utility of the instrument, except in the one case of alternating currents, where the whole current was not passed through it. It was no objection to say it had not actually been used, *e.g.*, the case of the vacuum brake, 1878, when it was proved that the whole thing had been fully described in 1851 and never used for 22 years. Even if the patentee thought it more widely useful than it really was, still he had not failed in his duty, made no false suggestion, but simply over-estimated some of its powers. Compare the case of an injector. Could it be said to be devoid of utility because it could be put into a boiler of such a construction as not to be of any use in that particular case? There was the direct evidence of Lord Kelvin, who said now that he had made experiments he had no doubt he could make it work on any system. The conditions of experiment, which his opponents made so much of, had nothing to say to the result. Of course, conditions in a laboratory were not those of outside work, but it was all the same if no modifications were made which interfered with testing the essential principles of the instrument. Lord Kelvin was a master of the method of scientific experiment. He (Mr. Moulton) relied on his experience and conclusions. The weight of evidence called by plaintiffs established the fact that the regulator would succeed. As to the attack on the second claim, he would take the minor point first, namely, the objection to the sufficiency of the specification. The other side said that it was insufficient, because if they took the case of alternating-current dynamos there were no directions that the dynamos must be rigidly coupled, and that in 1882 such directions were necessary to enable one to work two dynamos in series. Lord Kelvin said that a workman would see the necessity for it as soon as he fitted up the machine. As to his friends' law, they joined issue at once. The patent was one for setting up electrical machinery, and the specification was, therefore, directed to the engineer who planned the machinery. It was necessary for the other side to show that electrical engineers who designed plant and machinery required instruction on such a point. Witnesses naturally got a bias from having been occupied in looking at a case from the point of view of one side only; their judgment, in spite of themselves, became warped. The aniline dye case decided that specifications were to be read as addressed to that class of men who would be employed to carry out such work as described. If they put two dynamos in series to work at, say, 100 volts each, it was well known that the waves of current must keep time in the two machines. Hence the question was one purely for the mechanician to solve. Wilde pointed out an exception to this rule, namely, when they worked in parallel. All the witnesses said that the rigid coupling was an easy thing to do. He now came to the main point of the case, the second objection to the second claim, viz., want of novelty and subject matter. The main question was undoubtedly the construction of the specification. As to this Sir Horace Davey has attacked them for "torturing the English language." Now, all Sir Horace Davey's witnesses said that what they believed the patentee had in his mind was a parallel system of supply. No electrician was called who said otherwise. Now, in considering canons of construction, one must bear in mind that in most cases, although not in this, specifications were drawn by comparatively unlearned persons. It had always been held both for and against a patentee that they must consider what it was he had in his mind. Now that it was admitted by the defendants' witnesses that it was a parallel system of distribution the patentee had in his mind—that was, that he was confining himself to a parallel system—they must bear that in mind when putting a construction on doubtful points or expressions. Sir Horace Davey's contention was suited to the days of special demurrers, when he would have distinguished himself as much as he has done now.

Mr. JUSTICE ROMER: You must not think now of the anticipations.

Mr. MOULTON: His notion was that they must not assume that all these alleged anticipations were present to the mind of the patentee when drafting his specification. One started with the general knowledge of the time. One was entitled to find out the interpretation of terms of art, and to consider the electrical knowledge in the "background" of the mind of the patentee.

Mr. JUSTICE ROMER: Your difficulty is this—what did he confine himself to? The patentee has not referred to a parallel system!

Mr. MOULTON: The defendants said, Why did he not expressly refer to parallel? The plaintiffs said he *did*. Sir Horace Davey failed to appreciate the evidence of Mr. Swinburne on this point. He said that electricians knew what an "electric supply at a fixed potential" was. He (Mr. Moulton) said that phase was a term of art, and one well known in 1882, and meant supplied at a fixed pressure where the consumer took it. Mr. Swinburne admitted it was a well-known phrase. It was a far more accurate one than "parallel distribution."

Mr. JUSTICE ROMER: If so, what does maintaining refer to?

Mr. MOULTON: The E.M.F., which was synonymous with "potential." If they substituted for "an electric supply at a fixed potential" the words arranged in parallel, the meaning was quite clear and reasonable. It was a most accurate description. "Parallel system" would not do. It would not include a case of two lights. The real test was whether each consumer was to be supplied with electricity at a fixed potential. Dr. Hopkinson chose the more accurate differentia instead of the looser and more popular expression; he used the best electrical language. They dared not suggest it meant anything else. In a series system consumers could not have electricity at a fixed potential, it must vary throughout the series. No amount of "torturing" could make those words mean anything else. This was borne out by the word "such," in line 3. It was no objection to say it

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might mean something else, and hence it *did*. The references to "delivery" and "distribution" were consistent only with a parallel system. So, too, the reference to the meter. That would be absurd in a series system, as the same current went to each consumer, and must do so. In line 25, page 3, patentee referred to "service mains." He could not have used a term more indicative of the parallel system. In series there were no "branches." Again, in line 31, the patentee used "mains" as opposed to branches. Hence, they must have a parallel system. It was never suggested that this language was not suited to a parallel system. Prof. Silvanus Thompson said there was no reference whatever to direct one to apply it to a series system. Here the writer was a competent electrician, writing for electricians; all references were to parallel, and none referred to series only. The cable at the Alexandra Palace would be continuous. No electrician would ever have dreamt of "branches" in such a connection. In the three-wire system there was no saving on the branch conductors. They saw here the accuracy of the mind of the writer, not all conductors, but "main" only. Again, for commercial supply, meters were needed. He never mentioned any special system, it never entered his head to do so. Quantity varied in parallel system; in the series quantity must be maintained constant, and potential varied to suit consumption. The meters were only needed in the parallel system. The switching out or in of dynamo referred to in the disclaimed portion referred to parallel only. "Standard amount" of potential was meaningless when applied to series. "Network" could not refer to series. Page 5 evidently referred to parallel. [The learned counsel read and commented on many expressions in support of this view.] "System" did not mean a single case; *see* "Webster's Dictionary." "Distribution or supply" meant to many, not merely a single circuit. When the patentee said "substantially as hereinbefore described," "with reference to Fig. 5," he referred to letterpress, and as he (Mr. Moulton) had shown, the letterpress implied referred to a parallel system only. The concluding words, "as set forth," placed it beyond all doubt. The patentee had now no longer an interest in the patent. Writing as an electrician, his specification applied to parallel systems only.

At this stage the Court adjourned.

MONDAY, NOVEMBER 28TH.

On the hearing of this action being resumed on Monday, Mr. MOULTON, Q.C., continued his speech. What did the words "consistent with efficiency and safety" mean? They referred to the failure of the compound parallel arrangement, where there might be too little current, and, therefore, inefficiency on one side and too much or danger of breaking on the other. That was the real invention, namely, joining the middle of a compound parallel system to a split dynamo, or the middle of two dynamos in series. Why should not one set of two lamps be an instance of it? Because the essence of the invention was the joining of the middle points of two bridges. They could not have a single parallel line. In the Inchicore arrangement the additional lamps were to be put in series, and not in parallel. There was nothing there to suggest it to workmen. At the Alexandra Palace additional lamps might have been put on in many ways. If the Alexandra Palace case did not suggest to those who set it up, the plaintiff's invention, how could it inform the public? The only lamp, then, which would work in parallel was the Gülcher. Crompton's would not so work, and hence would draw him off the track of invention. Sir Horace Davey's argument about the rights of the public to substitute parallel for a single arc lamp was pure nonsense. Of course the public had the right to do what the plaintiff did, namely, invent this system; but no one did it. It was not fair in questions of subject matter to take an almost successful attempt instead of the standard public knowledge at the time. If one could, then Dolland could not have patented the achromatic glasses, because Newton had very nearly hit on it and had left a written record of his experiments. Prof. Thompson, in his lectures at the Crystal Palace, never thought of or suggested the three-wire system. The nearest approach to the invention was the compound-parallel arrangement. Dr. Hopkinson made the real invention. He knew of no case in which the alleged anticipations omitted an essential feature of an invention, and the inventor solved the problem, where it was held there was no subject matter. The Andrews arrangement was only the known compound parallel.

JUDGMENT RESERVED.

BOOKS, &c., RECEIVED.

"A Handbook of Electrical Testing." By H. R. Kempe. (London: E. and F. N. Spon.) Fifth Edition. 580 pp., demy 8vo.

"Electric Ship Lighting." By John W. Urquhart. (London: Crosby Lockwood and Son.) 300 pp., crown 8vo.

"Ueber das Entladungspotentialgefälle." By O. Lehmann. (Leipzig: J. A. Barth.)

"Modern Views of Electricity." By Dr. Oliver Lodge, F.R.S. (London: Macmillan and Co.) Second edition. 470 pp., crown 8vo. Price, 6s. 6d.

"Die Physikalische Behandlung und die Messung hoher Temperaturen." By Dr. Carl Barns. (Leipzig: J. A. Barth.)

"Hülfsbuch für die Ausführung Elektrischer Messungen." By Dr. A. Heydweiller. (Leipzig: J. A. Barth.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 11, 1892.

Electric Traction.—At the American Institute of Electrical Engineers last week three electric railway Papers, read at the Chicago meeting last summer, were discussed by railway engineers. Among those who took part in the discussion were Messrs. Sprague, Hutchinson, Emery, Leonard, and others. The general result of the discussion was that the series system of electric traction, very beautiful in theory though it might be, was not practicable, and could not in any way compete with the multiple system. Much severe criticism was made on Mr. Leonard's electric traction system, but he maintained his own part in the argument in good shape, and it was unanimously conceded that it would be time enough to decide on the merits of his system when the installation, which is now being made, had been given a practical test in actual service. Dr. Hutchinson resurrected some very uncomplimentary remarks made by Prof. Short about five years ago regarding the multiple series system of electric traction, and used them in a decidedly commercial way for maintaining his point, that the series system was not practicable.

The Niagara Falls Scheme.—It is announced that the Cataract Construction Company, which controls the water-power privileges at Niagara Falls, has settled upon the rates per horse-power to be charged to companies or individuals using power furnished for manufacturing purposes. The Niagara Falls Paper Company, using 3,000 H.P., is charged $8 per year per horse-power, and power may be used 24 hours in the day. The ordinary rates for power are $10 per horse-power for 5,000 or over, $11 for 4,000 H.P., and so on, down to $21 for 300 H.P. A 500ft. extension of the big tunnel has been determined upon, and is to be completed by February 1st.

NEW YORK, *November* 18, 1892.

The Meeting of the American Institute of Electrical Engineers.—The seventy-first meeting of the Institute was held on Tuesday, November 15th, and the Paper read by Dr. J. B. Williams at Chicago last June upon "Oil *versus* Air as an Insulating Medium," was brought up for discussion. A quadrant electrometer and other apparatus necessary for careful insulation tests had been set up, and the members were enabled to see various insulating substances subjected to practical tests. A number of oils were tested with layers of various thicknesses, and it was shown that paraffin oil was a very much better insulator than cotton seed oil, while rosin oil was far superior to either. The various manufacturers of insulated wire had sent in samples, and some of these were tested. On account of the lack of time and proper facilities it was impossible to make accurate comparisons between the various forms of insulation, and Dr. Williams offered to test all the samples in his own laboratory in the presence of such members of the Institute as cared to witness the tests, and report the results at some later date to the Institute. This offer was accepted.

Rapid Transit in New York.—It would appear that rapid transit in New York City is progressing slowly. The Rapid Transit Commission has issued the specifications and terms of sale of the franchise for the proposed underground road, the plans for which were published nearly a year ago. The franchise is to be sold to the highest bidder at the City Hall on December 29 next. The terms of sale, as announced by the commission, make it evident that they have taken special precaution that no stock-jobbing concern shall control the rapid transit facilities of the city. The terms of sale require 10 per cent. of the amount paid for the franchise to be paid in cash, and the remainder within 30 days. The successful bidder must deposit with the City Comptroller $1,000,000 in cash, and file a two-million dollar bond with the Mayor as security for the faithful peformance of this important work. The successful bidders may form a company to build and operate the road, the capital stock of which shall be $50,000,000, and it may issue bonds to an equal amount if found necessary. No one dares predict at the present time whether this franchise will find a purchaser or not, as many think that capitalists will

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not care to invest such an enormous amount of money in a system for rapid transit which will parallel so many existing lines fully equipped for the carrying of passengers, although, to be sure, at a much lower rate of speed. The specifications call for the operation of the road by some means which will not require combustion in the tunnel; and as the trains must run at a speed of 40 miles per hour this, of course, means that the motive power will be electricity, Here is a problem for American electrical engineers, the solution of which will require their best abilities, and for which the extensive experience in street railroading has given electrical engineers an excellent preparation.

Gilbert's "De Magnete."—While the Gilbert Club in England has been spending several years in the translation of "De Magnete," and have carefully stored away the guineas which English-speaking people in all parts of the world subscribed for the promised copies of an English edition of this famous work, an American author and publisher have got out an edition of the book, which is about to be placed on sale. The work is a translation of the 1600 edition made by Mr. P. F. Mottelay, and will be issued from the press of John Wiley and Sons at an early date. It may be of interest in this connection to note that copies of the original edition of Gilbert's work are now selling in this country for $65 and $70, a copy at the former figure being sold last week. The rarer edition of 1628 does not often turn up, but a copy was, we understand, offered a few days ago at slightly less than $100.

The Chicago Exhibition.—The American electrical public has been somewhat excited over the prospect of the closing of the World's Fair gates at seven o'clock in the evening. It is doubtful, however, if it was ever the intention of the authorities to make a cast-iron rule of this kind, but reports a week ago were abroad to that effect. It is highly probably that evening exhibits will be permitted, although many departments of the Fair will have to shut down at seven o'clock. Very little news is available at present regarding the exhibits to be made by American electrical firms, but it is evident that the General Electric Company will make a display commensurate with the business it carries on in this country. The temporary office has been opened by this Company in the Horticultural Building on the Fair Grounds, and Lieut. Spencer is in charge of the preparation and arrangement of the exhibits. Herr Carl Haller, the engineer of the Imperial German Commission for the World's Fair, has arrived in Chicago, and has taken up the work of looking after the engineering features of the exhibit made by the German Government.

CORRESPONDENCE.

EARTHING THE MIDDLE WIRE.

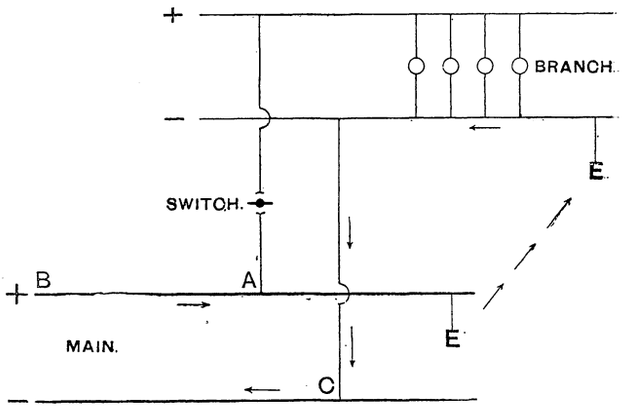
TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read with great pleasure Mr. Human's letter in your last issue. Many of us who, as electrical engineers, have to deal with these questions have long since come to the same conclusion, but up to the present it has seemed almost useless to mention the question of earthing one of the conductors in any system. Now, however, that a fire-office inspector himself broaches the question and is actually convinced that it is the right thing to do, I venture to trouble you with a few remarks, hoping that I may be of some small assistance to him in meeting the objections of his colleagues.

The real question of the day is of course that of earthing the middle wire in three-wire systems supplied from central stations. It is obvious that, with the middle wire put to earth, it is a matter of impossibility for any part of the circuit to be raised more than 100 or 110 volts (as the case may be) above the potential of the earth. With all wires insulated, however, it is possible through an accidental earth on one lead to raise the middle wire 100 or 110 volts above the earth, and the other wire 200 or 220 volts. It is a fact well known to those who have tried it, that the shock to be obtained under these circumstances is not pleasant, whereas with 100 or 110 volts it is scarcely perceptible. Again, it is obvious that a difference of potential of 200 to 220 volts is far more likely to find out weak places in insulation than 100 to 110 volts.

In a properly-arranged system with the middle wire to earth, any accidental earth contact, or partial earth contact, on either of the insulated mains would cause the local cut-out to fuse, immediately extinguishing the lights and localising the fault within fairly narrow limits. It would be a matter of impossibility to light these lamps again until the fault had been removed. Another point of very considerable importance is that half of the fuses at present *supposed* to be in use would be no longer necessary.

It is clear from Mr. Human's letter that fuses were not fitted in each lead or, at any rate, not on each pole at the root of the branch in question, otherwise the fire could not have been caused as he supposes. The usual rule that every branch must be protected by a fuse on each pole which will act before the smallest wire within its district of protection can have enough current passed through it to cause heating was not observed. Mr. Human omits all mention of fuses and, taking his letter literally, one might infer that he was content to put up with the danger which he points out whilst the switch was on and the lamps lighted so long as it ceased when the switch was off. Of course he does not mean this. Things must be made just as safe when the lights are on as when they are off.



Reproducing Mr. Human's diagram, if there were any fuse at all in the branch it must have been in the switch wire, probably at A. Assuming now that all the negative wires were already purposely earthed, the damage at E on the branch, whatever it might have been, would make no difference in any way. The earth at E on the main would, however, immediately blow out the main fuse at B and the lamps could not be again lighted until the fault had been rectified. This would appear to give about as great security from fire risk as anyone can wish to get.

Assuming on the other hand that neither of the wires were earthed and that the proper system of double pole fuses was in use, there would naturally be a fuse at C. Either E on the main or E on the branch might exist alone for any length of time without anything happening, but the moment the other appeared, the fuse at C would blow out; *not that at B.* An ordinary wireman, if sent to put things right, would naturally examine the fuses at the root of the branch in question before doing anything else; and finding C blown out, would test and discover the earth at E on the branch. Having set this right, he would replace the fuse at C, switch on the switch, see that the lamps lighted up and go away quite happy. The earth, E, on the main would thus be left to assist in many a similar accident.

The advantages in using concentric cables and fittings must be so obvious when once the principle is granted that I need not mention them here, but Mr. Human speaks of difficulties in using concentric systems in connection with existing installations on other systems. I presume the difficulties he refers to would arise in the existing installations and not in the newly-fitted concentric ones. The only difficulty, however, appears to me to be in regard to the fuses and possibly, also, to the switches. It certainly would be necessary that every house wired on the present system should be carefully examined

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throughout and all the switches and fuses arranged upon the insulated side. Doubtless this would be a somewhat troublesome business, but surely it is not insurmountable.

In conclusion, I wish to point out that the same complete system of fuses which is so obviously necessary in houses, would be a very great advantage if applied to all street mains. Every section of network between the feeding points should be protected at each end by fuses, and every branch street main proceeding from any section of network should again be similarly protected. An earth on any section or sub-section would then be automatically detected no matter where it occurred, and it would have to be set right before the supply through that section could again be started. The question of putting fuses in street mains would be of no interest to the fire offices, but would only be one of convenience to the supply companies. I believe, however, that some central station engineers have strong views against using them.—Yours, &c.,

Harlesden, N.W., Nov. 29, 1892. W. A. CHAMEN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have had the opportunity, through the kindness of Mr. Sheppard, of the North British Insurance Company, of inspecting the result of the fire in Regent-street, which has called forth the very able letter of Mr. Human. The woodwork of the columns to which the lights were fixed had been removed, and I found the leading wires entered the window at the roof within an inch of the top of the iron column, and proceeded toward the centre of the window, in casing, to a ceiling rose. From this rose flexible leads, I am told, were taken back to the lights on the columns. Everything being charred and destroyed, there is no direct evidence as to the origin of the fire, and there being current on only one wire at the time I could deduce no other cause for it than that given by Mr. Human. The installation, so far as I examined it, is carried out according to best modern practice, with wood casing, and, I am told, was examined and passed by Mr. Heaphy.

This is now the second important fire which has been laid to the charge of electric light in London, the other being Scott's restaurant, insured in the Phœnix Fire Office; and as both of these installations have doubtless been carried out in the best manner, so far as it is possible with wood casing, it must be obvious that the fault is radical to the system.

Mr. Human pays a tribute to the system I have nursed which, if it could but be universally introduced, would entirely overcome the risk. The suggestion to earth one of the mains is an unquestionable step in advance, and would at once open the field for introducing concentric wiring, and be a safeguard to existing installations. The first step must be taken by the supply companies efficiently earthing one of the mains and turning over the defective sides of house installations to the earthed main, and cutting off those with both sides defective. Earthing one of the mains even without changing over defective installations would not increase the danger of fire materially if at all beyond what it now is, because, as a matter of fact, both mains are now well earthed so that the change could with ease be spread over several days. The cost of the change would, I feel satisfied, be entirely outweighed by the saving of leakage and damages now taking place.

The next point is whether the existing degree of insulation provided on one wire is sufficient. Upon what basis are we to make our estimates, should it be the commercial value of the leakage or the ideal degree of perfection? It is well known that the majority of defects take place in the mechanical contrivances and joints, and but seldom in the wires, and also that mechanically rotten arrangements test electrically good at times, especially at first. If the mechanical details are good, a high degree of insulation will not improve the safety; we may therefore take it that the commercial value of the leakage should be the basis. I am told that with gas 5 per cent. leakage is not considered excessive. I do not, however, advocate this degree with electric lighting, but I can see no reason to suppose that because one side is earthed any increase of insulation is necessary on the non-earthed side. At the same time it is equally important that the earthed wire should remain substantially covered with insulation, unless it is made of large dimensions. I speak on this point from long experience of earthed land installations, both with double and concentric wiring. The installations, therefore, would be carried out according to present practice, with the exception that all switches and fuses must be inserted in the non-earthed wire. A double-pole switch should still be required for the purpose of testing.

I cannot close this letter without remarking on the able and lucid manner in which Mr. Human has opened this subject.—Yours, &c., J. D. F. ANDREWS.

London, November 28, 1892.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to point out that Mr. Human, in his letter on the above affair, is advocating the adoption of a remedy likely to prove worse than the disease. In a three-wire system it is doubtless a debateable point whether the middle wire should be earthed or not; because by so doing the maximum strain on the insulation of either of the mains is reduced one-half. But there is no such reason in a two-wire system.

The adoption of this plan would simply introduce the objectionable features of third-wire earthing, as for instance, that one fault on the unearthed wire starts a leakage current at once. Supposing the switches were rigidly placed on the unearthed wire (as they should be), then the plan simply stops leakage currents in houses when the lamps are switched off at the meter, and this is surely not sufficient compensation for the loss of one-half of the effective safeguard from leakage at all. If a voltmeter alternately earthed from each main is kept in circuit at the station, and a minimum deflection fixed, after which any increased leakage must be looked for, the best has been done in the matter of safety in my opinion.

Special low resistance voltmeters would be required if the minimum insulation resistance of any system was found to be anywhere much below a thousand ohms.

With a three-wire system unearthed and the insulation perfect, the voltage to earth is one-half the maximum across the outside wires, say (200/2) volts—with the insulation of one side very defective it is, of course, 200 volts—and the question is whether (granting a failing insulation somewhere) it is better to have 200 volts against sound cable, or 100 volts against failing cable.

If both sides are failing, the question is one of a pressure of 100 volts through the resistance of each fault (when the middle wire is earthed), or of 200 volts against the added resistances of both faults, and the one is as likely to break down as the other. If the faults are dead earths, the station should discover this and trace them.—Yours, &c.,

J. SAYERS.

Electrical Dept., Midland Railway, Derby,
November 28, 1892.

THE HOPKINSON METHOD OF CHARGING FOR CURRENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In common, I am sure, with all your readers I have been very much interested in Dr. Hopkinson's proposed alternative system of charging for current. I have not yet been able to work it out sufficiently in detail to see how it would affect the circuits in which I am most interested. But it occurs to me that it may be worth while pointing out that if such a system of charging for electrical energy should come into use, a necessary adjunct of the ordinary meter would be some form of maximum recording ampere meter.

It would obviously be impossible to take as a maximum the particular number of lamps or points of connection applied for by a would-be consumer. The mere fact that he could use 8 and 16-c.p. lamps entirely at will makes this impracticable. The notion of using the main fuse as a measure of maximum current is also obviously out of the question. But there would be no difficulty in requiring each customer to state (no doubt, usually with the aid of his wiring contractor) the maximum current which he intends to consume, and I cannot suppose that the many engineers who are at work on the design of elec-

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trical instruments would have any trouble in scheming a simple form of current indicator with a non return pointer which would be accurate within 2 or 3 per cent., as nearly as is necessary. —Yours, &c., ALEX. B. W. KENNEDY.

19, Little Queen-street, Westminster, S.W.,
November 25, 1892.

"EFFECTIVE" VOLTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Is it not high time that some definite agreement is arrived at respecting that unhappy word "effective" as applied to alternating E.M.F.? Dr. Fleming, in his Paper at present before the Institution, uses the term effective in exactly the same sense as Dr. S. P. Thompson applies to the term virtual. Dr. Thompson's definition of virtual being the square root of the mean square of either the maximum impressed volts or the maximum effective volts, according as impressed virtual or effective virtual is meant; Dr. Thompson meaning by effective the impressed volts, less the E.M.F. of self-induction.

But Dr. Fleming is not entirely consistent, for on p. 111, par. 13 of "Alternate Current Transformers," Vol. I., we are told that the effective E.M.F. driving the current is equal to the product of the ohmic resistance of the circuit and the cur rent at that instant in it—a definition precisely equivalent to Dr. Thompson's, as given above.

What must be the state of mind of the poor student between such conflicting statements can be better imagined than described.—Yours, &c., ROLAND S. PORTHEIM.

12, Station-terrace, Church-lane, Woolwich.
November 29, 1892.

[The words "virtual" and "effective" are both unsatisfactory; but the former is used to denote the value of the quantity (amperes or volts) as read by alternate current instruments. Our correspondent quotes a definition of the word virtual, which is not "precisely equivalent" to Dr. Fleming's, and we much doubt whether Dr. Thompson ever defined "virtual" as the square root of the mean square of a *maximum*.—Ed. *E.*]

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Some time ago an agitation was started and carried to a successful issue through the medium of your columns against the neglect of submarine cable and telephone interests in the Council of the Institution of Electrical Engineers. In consequence of that agitation the Council amended its ways, and recommended Sir James Anderson, Sir Henry Mance, Sir Albert Cappel, and Colonel Jackson, to fill the vacancies at the then pending election.

Since then two of these gentlemen have dropped out whether by their own desire, or by the working of the Society's rules, I am unable to say. But the point to note is that, instead of electing other gentlemen from the same professions to fill the places of Sir James Anderson and Sir Albert Cappel, the Council have reverted to their old loves, and have recommended still more electric light representatives. The good effected a few years ago is thus gradually being destroyed, and the Council is becoming what it was before, a close corporation of professors and electric light men, with a sprinkling of Government officials from the Post Office.

Your columns have recently echoed with the complaints of gentlemen who are dissatisfied with the composition of the Council and the neglect of their particular interests, and I am afraid that Prof. Silvanus Thompson's good-humoured fun, which he pokes at them, will be unable to get over the obvious facts or allay the discontent which has, with persistent obstinacy, "dogged the footsteps" of the Council for the last seven or eight years. They appear to have forgotten the lesson of the last agitation, and to have learned nothing in the interval. Is it too late to prevent the threatened extinction of the advantage we gained such a short time ago?—Yours, &c., C.

December 1, 1892

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

TENDERS INVITED.—The Belfast Harbour Commissioners invite tenders for the lighting of Queen's Quay, Abercorn Basin, and the Hamilton Graving Dock by electricity. Mr. George Combe, electrical engineer, of High-street, Belfast, will supply all information, and tenders must be sent in to Mr. W. A. Currie, secretary, on or before December 12th. Further particulars will be found in our advertisement columns.

——— The Directors of the North-Eastern Railway Company invite tenders for telegraph stores, including apparatus, wire, and line stores. Particulars can be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be in by noon on Tuesday next, the 6th inst.

——— Tenders are invited for the erection of an electric lighting plant at Villena, province of Alicante, Spain, and the lighting of the town for 50 years. Tenders to the Ministry of the Interior, Madrid, by the 15th inst.

——— In reference to the Note in our last issue relative to the proposed lighting of Santiago, Chili, by electricity, we may add that a specification and a plan of Santiago can be inspected on personal application at the Commercial Department of the Foreign Office, on any week-day between 11 and 6.

TENDER ACCEPTED.—The Staffordshire County Council have given the contract for the electric lighting of the Werrington Industrial School to the Electric Construction Corporation of Wolverhampton.

DISSOLUTION OF PARTNERSHIP.—Joseph Thorngate Woodham, Walter Smith, and Charles Henry Fuessli, carrying on business as electrical engineers and contractors, at Ducie-chambers, 57, Market-street, Manchester, as Woodham, Smith, and Co., have dissolved partnership so far as regards Charles Henry Fuessli.

BUSINESS CHANGES.—Arrangements have been completed for the transfer of the works at Swansea for copper smelting and rolling, yellow metal rolling and spelter making, and the goodwill of the business of Messrs. Pascoe, Grenfell and Sons (Limited), to the firm of Messrs. Williams, Foster and Co. (Limited), of Swansea and London, who will now carry on these works in addition to, and in conjunction with, their own Morfa Copper Works. The combined works of the Company will now form the largest establishment in the kingdom for rolling copper and yellow metal.

BELL'S ASBESTOS COMPANY (LIMITED).—The new premises of this Company are to be known as 59½, Southwark-street, instead of Southwark Bridge House, as formerly notified.

MESSRS. H. C. PARKS AND CO.—This firm send us their latest price lists of "Buffalo" Driving Belts, &c., for which they are agents in this country.

MR. F. M. NEWTON.—From the Newton Electrical Engineering Works we have received an illustrated price list and catalogue of the Taunton dynamos, Newton-Hawkins patent brush-holders, switches and switchboards, and the Newton arc lamp and transformer. This is another price list which shows great care in preparation, and the illustrations, printing, and binding are all that can be desired.

MESSRS. BARCLAY AND SON.—This firm have just completed an installation of the electric light at the large offices of the Bovril Company, in Farringdon-street, E.C.

E.P.S. STORAGE BATTERIES.—The Electrical Power Storage Company announce that during the past ten years no less than 10,000 tons of E.P.S. Storage Batteries have been manufactured.

RESIGNATIONS.—We are asked to state that Mr. E. J. Tumber has resigned the position of general manager to the Electric Stores (Limited).

——— Mr. A. Slatter asks us to state that he has retired from the Planet Electrical Engineering Company (Limited), and has joined Messrs. Julius Sax and Co. as their manager.

——— Mr. F. Dagger has resigned his position as Superintendent of the Plymouth District of the National Telephone Company, and his connection with the Company will cease on the 28th instant. Mr. Dagger has been 11 years in the telephone service, having served with the Lancashire and Cheshire Company and the Western Counties and South Wales Telephone Company, and finally with the National Company.

SMOKING CONCERT.—Messrs. Drake and Gorham's *employés* held their first smoking concert for the season on Wednesday last, at which more than one hundred of the staff were present.

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ARDROSSAN.—The electric light which has recently been utilised for harbour illumination at Ardrossan, in the West of Scotland, has proved a complete success. The loading and clearing of vessels at night is much facilitated, and the saving in time is considerable. Seventeen arc lamps are at present used in the installation, and reserve dynamo power will allow of three further lamps being installed when necessary.

HOTEL LIGHTING.—The installation at the Great Northern Victoria Hotel, Bradford, is now complete, and consists of about 600 lights. Wiring is carried out on the sub-circuit distribution plan. Two pairs of heavy main cables are carried up the side of the lift, from which two branch cables are run to the distributing boards on each floor. The wire casings are neatly run on the corridor walls under the mouldings, where they are hardly noticeable, and in the bedrooms the casings have attached to them an ornamental picture mould 18in. from the ceiling, upon which a small bent bracket with 18in. projection is fixed from a suspension fitting with lamp and shade drops. The hotel is also connected throughout with electric bells, with a new design of semaphore fixed outside each door. When the button in the room is pressed, a real flag drops out of a slot in a semaphore box, and indicates to the servant the source of the call without the necessity of referring to the indicator. This flag is replaced by hand. Telephones connect all the managerial departments. The installation throughout is complete, and has been carried out by the Woodhouse and Rawson branch establishment at Piccadilly, Bradford.

BARNARD CASTLE.—At the last meeting of the Local Board the Lighting Committee notified that their report respecting the installation of the electric light was in preparation. It was proposed that the committee continue their investigation with regard to the lighting of the town with electricity and the cost.

MILL LIGHTING, &c.—The Electrical Engineering Company of Ireland have recently installed the electric light at the York-street Flax Spinning Company's Mill in Belfast. This is the first trial in these mills of using the electric light over the looms, and it has given so much satisfaction that a considerable extension of the plant is contemplated. A Crompton dynamo is used.——The same Company have also just completed a large contract for Messrs. Clery and Co., in Sackville-street, consisting of 18 Brockie-Pell arcs and 50 incandescents, the current being taken from the Corporation's mains. Other large installations are in hand, and the Company report a satisfactory increase in electric lighting orders, several theatres, hotels, clubs, and assurance companies' offices being included in the work in hand. They have recently built for Messrs. Lafayette and Co. a photographic arc lamp giving an illumination of about 15,000 c.p. This is placed in a parabolic reflector, is also automatic in action, and has hydraulic raising and lowering gear. This arc lamp, we are informed, has proved a great success.

BOLTON.—The Electric Lighting Sub-Committee of the Gas and Lighting Department of the Bolton Corporation held a meeting last week, at which it was announced that the members had had an interview with certain manufacturers of electric lighting plant, though nothing definite was decided at the meeting. Some important lighting developments are likely to result.

BRISTOL.—The members of the University College Engineering Society were last week invited to Gloucester to visit the works of Messrs. Fielding and Platt, and amongst the many features of interest described by Mr. Platt, jun., were the Company's electric welding plant. The current is supplied by a Crompton dynamo driven by a 50-H.P. Fielding and Platt gas engine, and Thomson-Houston welding machines are employed. The electric light is used over a considerable portion of these large works, and also in many of the adjoining engineering yards, including those of the Bristol Wagon Company, over which the party were also shown.

BROMLEY (KENT).—The Local Board are asking those willing to take up the electric light to fill up forms intimating the extent of their requirements.

CHATHAM.—The Board of Trade have notified the Chatham Town Council that they are satisfied that the Chatham and District Electric Lighting Company are in a position to carry out their electric lighting undertaking.

TRAIN LIGHTING.—As notified in our issue of the 18th ult., the London, Brighton, and South Coast Railway Company have decided to augment the number of trains electrically lighted running over their system. We understand that the electric light has proved a great success, and has given the Directors of the Company much satisfaction. The trains meet the requirements of railway working better than gas-lighted trains, inasmuch as they are ready at any time for whatever service they may be required, whilst it is necessary for the gas-lighted trains to be shunted to convenient places for charging. Considerable additional expense is entailed in this latter arrangement.

DUNDEE.—The Property Committee of the Dundee Town Council have arranged for an installation of the electric light throughout the Town House buildings. The city architect is to invite offers for supplying the necessary apparatus. It is intended that the handsome electroliers which at present adorn the Town Hall should be utilised in the electric lighting installation. ——On Monday the Works Committee of the Corporation ordered the purchase of an engine, dynamo, and lamps for the electric lighting station, and a lightning conductor for the chimney stalk.

EDINBURGH.—At a meeting of the Town Council, on Monday, the Lord Provost gave an explanation of their position with regard to the Electric Lighting Order. The Sub-Committee had had the matter in hand, but the Town Council had been otherwise extremely busy, and he was anxious they should not travel too fast, as experience was being gained by other corporations, from which they would benefit. He proposed they should enlarge the powers of the Lord Provost's Committee, who were dealing with the subject, as they would now have to take prompt action. They must consider the system to be employed, and whether the work should be done by the Council or be leased to a Company. It would be necessary to select an expert, and it would be advantageous for a number of the members of the Town Council to inspect some of the best systems and stations. These suggestions were supported by Bailie Dunlop, who said he had been lately in the North of England, and had got more information when in Bradford than he could obtain from a whole volume of reports. It was agreed to appoint the deputation at the next meeting of the Council, and that extended powers should be granted to the Lord Provost's Committee.

FREUCHIE.—Messrs. Lowdon Brothers, of Dundee, are lighting the Eden Valley Works, Freuchie, for Messrs. W. Lumsden and Son. The installation is to consist of 100 16 c.p. lamps, an Elwell-Parker dynamo being used.

HARWICH.—The Public Health Committee recommend the Town Council to dispose of their rights under the Harwich and Dovercourt Electric Lighting Provisional Order to a private firm.

HEREFORD.—This town has not hitherto shown much energy in the introduction of the electric light; but Mr. Hancocks, of Wide Marsh-street, has set his neighbours a good example by introducing the light into his residence.

ILFORD.—A deputation from the Ratepayers' Association of Ilford has waited upon the Local Board to urge upon them the necessity of introducing the electric light, and complained of the quality of the gas supplied and the charge made for it. The Chairman said the Board would consider the question. He had made every effort to get the price of gas reduced, but without success.

KIMBERLEY.—At a large dog show held at Kimberley recently, Messrs. John Davis and Sons, of All Saints' Works, Derby, provided a successful installation of the electric light, the plant consisting of a 100-H.P. dynamo driven by a 7-H.P. portable engine, the work being completed within seven hours.

KINGSTON.—At the last meeting of the Town Council the Mayor informed the members that, the Lighting Committee having asked Mr. W. H. Preece to undertake the duty of advising them in the matter of the electric lighting of the borough, that gentleman had written stating that he was unable to undertake the work, notwithstanding that as a resident in the neighbourhood he took a great interest in the scheme. Under those circumstances, it was proposed that the Council be authorised to obtain a report from an electrical engineer to be selected by the Committee. They had already had a report from Mr. Shoolbred, but were desirous of obtaining all further information possible, and did not mind some additional cost being incurred.

LECTURES.—Mr. H. Hall, after delivering a lecture at Johannesburg, on "Electric Light and Electric Energy," notified his intention of pushing forward the subject of the study of electricity in Johannesburg and announced that, with that object, he had decided to start a series of lectures and classes, to which those who were unable to pay for a course would, under certain conditions, be admitted free.

——— Mr. R. A. Lehfeldt delivered the third of a series of lectures on electricity at Firth College, Sheffield, on Saturday last, the subject being "Systems of Distribution." The lecture proved interesting to a large audience, and at its conclusion Mr. Lehfeldt received hearty applause.

——— Mr. A. Balance delivered a lecture last week on "Practical Electric Lighting" before the members of the Hull Scientific Club, Hull. A large number of members of the Club attended, and a hearty vote of thanks was accorded the lecturer at the close.

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LECTURES.—Dr. Howard gave a lecture at the Picton Lecture Hall, Liverpool, on Tuesday last, entitled "The Distributon and Storage of Electricity."

——— Mr. H. L. Callendar, M.A., delivered a lecture at the Technical Schools, Plymouth, on Monday last, on "Dynamo Electric Generators," illustrated by lanterns, slides, and experiments.

LEDBURY.—Mr. J. C. Davies, of Fair Tree Farm, Ledbury, has installed the electric light at his brick works and residence, the necessary power being obtained from an engine used at the brick works.

LIVERPOOL —It has been decided to instal the electric light in the council chamber and ball room of the Town Hall, and the Corporation surveyor has received instructions to supervise the work. The estimated first cost is about £360. A cable is to be provided capable of being utilised should the Corporation decide to extend the installation. The Liverpool Electric Supply Company (Limited) have received the order for the work, for which, as far as possible, the gas fittings will be adapted.

LONDON COUNTY COUNCIL.—In connection with the decision of this Council to undertake their own contract work, it has been decided to appoint a chief of the new Works Department at a salary of £700 a year. The Council cannot be accused of erring on the side of liberality. As manufacturers of electric lighting plant, machinery, and apparatus are likely in the near future to have considerable business with the gentleman appointed to this onerous position, the trade should bring what influence it has to bear upon the selection of the right man.

MORPETH.—The introduction of the electric light to one of the large mills in Morpeth has given rise to a desire for a more considerable installation for general lighting. It is proposed by those who have the matter under consideration to utilise the motive power from the river, the plant for which could be erected at a comparatively small cost. The local press are taking the matter up, and it is probable that some steps will be taken shortly to advance the consideration of the subject by the proper authorities.

PRIVATE BILLS.—Only one application is down in the Private Bill List for the ensuing session of Parliament for a Provisional Order to supply electricity for public and private purposes in Scotland. This has been lodged by the Commissioners of Police of the Burgh of Partick, who ask for power under another Order to transfer their powers or liabilities to any other Local Authority, company, or person.

RAMSGATE.—The Corporation of Ramsgate have decided to oppose the bill of the Municipal Electric Lighting Company for a Provisional Order for lighting Ramsgate.

SELKIRK.—The extensive woollen factory of Messrs. G. Roberts and Co. has just been lighted by electricity, gas being entirely dispensed with; and the estate of Mr. S. Steel, at Philiphaugh, is also to have the electric light installed. There are 500 lights in the woollen factory installation, and these are giving entire satisfaction.

SWINDON.—At the last meeting of the Swindon Local Board it was decided to advertise for tenders for the laying of mains and services for lighting by electricity all streets in respect of which notices have been served, and that negotiations should be opened for the purchase of a site for an electric lighting station, and that tenders be invited for lighting by electricity Milton-road, Commercial-road, and Victoria-road, Swindon.

TEIGNMOUTH.—The Local Board have been requested to call a public meeting to discuss the question of lighting the town by electricity.

TELEPHONIC COMMUNICATION BETWEEN CASUAL WARDS.—The St. Marylebone Board of Guardians have again addressed a communication to the Local Government Board calling their attention to the desirability of placing the casual wards of the metropolis in telephonic communication; also suggesting that a conference should now be held of representatives from the several unions, and of the Board's inspectors, in order that an endeavour may be made to secure as far as practicable uniformity in the arrangement for the relief of casuals in London.

THETFORD.—At the meeting of the Thetford Board of Guardians last week it was decided to obtain estimates for both gas and electric lighting for the local workhouse. Reference was made to the recent calamity at the South Molton workhouse, and the desirability of selecting the safest possible illuminant.

WREXHAM.—At the meeting of the Wrexham Town Council on Tuesday it was resolved that negotiations should be re-opened with the Wrexham and District Electric Supply Company (Limited), with the object of the Council purchasing their undertaking.

PATENT RECORD.

The following list of applications for patents and specifications has been compiled for this journal by MR. J. C. CHAPMAN, *patent and registration agent, Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any available information may be obtained.*

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

November 3, 1892.

19,821. SIEMENS BROS. AND CO., LIMITED. London. Improvements in alternating current transformers for variable loads. (Messrs. Siemens and Halske, Germany.)

19,834. A. R. BENNETT. London. Improvements in and relating to telephonic switching apparatus.

November 4, 1892.

19,874. E. P. DAVIS and A. C. COLLINS. London. Improvements in means or apparatus for regulating the supply of electrical energy to lamps and other apparatus.

19,880. T. PARKER and A. E. ROBINSON. London. The manufacture or production of an improved anode for use in electrolytical processes.

19,881. P. W. D'ALTON and J. A. FLEMING. London. Apparatus for controlling electric pressure in alternating current circuits.

19,886. W. FULLER. London. Improvements in making house connections with electric lighting mains.

19,889. A. E. VIDAL and G. HERVIEW. London. An improved electric clock.

November 5, 1892.

19,910. P. G. EBBOTT and J. B. VERITY. Birmingham. Improvements in reflectors for electric and other lamps and lights.

19,916. C. T. J. VAUTIN. London. Improvements in electrical conductors and in means of making connection therewith.

19,919. G. F. DE SOLOMÉ. London. Electric light conductors.

19,927. J. KÖRNER. Liverpool. Improved means for lighting railway cars by electricity.

19,953. J. C. RICHARDSON. London. Improvements relating to the construction of electrodes for electrolytic purposes.

19,959. E. H. P. HUMPHREYS and W. FRIESE-GREENE. London. Improvements in the means or apparatus for measuring electricity.

19,960. E. H. P. HUMPHREYS and W. FRIESE-GREENE. London. Improvements in ammeters and voltmeters.

November 7, 1892.

19,992. R. PIPPETTE. London. An electric energy meter.

20,009. F. SHAPLEY. Sidcup. A portable microphone for the improvement of hearing in deaf persons, and adapted both for individual and general conversation.

20,056. N. DURAND. London. Improved electrical appliance to be adapted to clocks for giving an alarm.

20,057. E. A. KUMBERG. London. Improvements in the construction of phonographs.

20,064. R. H. COURTENAY. London. An improved method of and means for generating currents of electricity for promoting the growth of vegetation.

20,065. R. H. COURTENAY. London. Improvements in the construction of horticultural buildings; also with apparatus and means for forcing the growth of vegetation by electricity.

November 9, 1892.

20,214. A. J. BOULT. London. Improvements in electrolytical apparatus. (O. Knöfler and Fr. Gebauer, Germany.)

November 10, 1892.

20,254. H. BOWN and W. HABGOOD. London. Improved arc lamp for photographic purposes.

20,316. H. CLEGG. West Norwood. Improvements in electric lighting.

20,333. C. E. L. BROWN. London. Improvements in apparatus for protecting transformers and other electrical apparatus from lightning and from electric currents of excessive strength.

20,348. R. J. BLACK. Manchester. Improved electric-battery cells.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

22,708. HELLESEN. Porous carbon for galvanic batteries.

1892.

37. WEBB. Electric tricycles.

14,886. WRIGHT. Electric switches.

15.059. GOVER. Electric incandescent lamps.

17,222. THOMPSON (Coffin). Electric metal working.

17,226. THOMPSON (Coffin). Welding metals electrically.

17,227. THOMPSON (Coffin). Welding metals electrically.

17,242. NEWTON (Carruthers). Electro-medical appliances.

17,304. AHEARN. Electric heaters.

17.321. AHEARN. Electric water heaters.

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COMPANIES' MEETINGS & REPORTS.

National Electric Supply Company (Limited).

An ordinary general meeting of shareholders in this Company was held on Friday last at 119A, Fishergate, Preston. Mr. C. H. Cobbold, of Barnsley, presided. The CHAIRMAN moved the adoption of the report and statement of accounts as certified to Sept. 30th. The report gave an interesting *résumé* of the Company's operations in Preston. The machinery ordered, and in process of manufacture, will form a first instalment, with a capacity of 20,000 8-c.p. lights. It is estimated that, with the day and night service, the Company will be enabled to fix at least 35,000 8-c.p. lamps with this plant. Six miles of underground mains have been laid. A first-class central station in Bushell-street has been secured. It is to be thoroughly well equipped, and will be capable of supplying current to meet largely increased requirements at a small additional outlay. The expenditure on capital account amounts to £38,885, 8,045 ordinary shares have been subscribed for, and since the accounts were made up applications have been received for 2,380 additional shares. When these are fully paid, the share capital, including founders' shares, will be brought up to £52,625. As regards future prospects, the Directors consider they could not be more encouraging, there being an immediate prospect of remunerative business. The report of the manager and engineer, Mr. Bennett, went to show that, assuming the present rate of progress to continue, the result of the working for the three months ending December 31st will show a substantial profit.

The motion was seconded by Councillor MARGERISON, and unanimously adopted.

Mr. E. H. BOOTH moved, and Mr. HENRY CURWEN seconded, the re-election of Messrs. Titus Thorp and Ainsworth as auditors.

In accordance with a recommendation of the Board, Mr. John Booth, of Preston, was appointed a Director in place of Mr. Dan Rylands, who retired on account of his many engagements.

The CHAIRMAN, referring to the retirement of Mr. Rylands, said although that gentleman had a very heavy stake in the concern he had absolute confidence in the ability of the local men to manage the Company's affairs.

Mr. SEED (a shareholder) spoke in enthusiastic terms of the great success which had attended his application of electricity as a motive power in his own business.

Mr. F. F. BENNETT, the engineer, made a few remarks as to the prospects of the Company, and the meeting concluded with a cordial vote of thanks to the Chairman.

Swan United Electric Light Company (Limited).

The tenth ordinary general meeting of the shareholders was held at the Cannon-street Hotel, on Tuesday last, Mr. J. S. Forbes presiding.

The SECRETARY (Mr. H. Charles Gover) read the notice convening the meeting and the report of the Directors and accounts were taken as read.

The CHAIRMAN: Gentlemen—I think I will begin with the profit and loss account at once, because in explaining the items there I shall probably answer in anticipation some of the questions that might be put. First of all, let us take what we have sold. You will see that the sales, less commissions and allowances, amount to £9,498. 1s. 8d. I do not know if you have the same means as I have of getting at the facts, but if you refer to the accounts of last year you will find that the corresponding item at that time was £15,348. At the first blush, of course, it is rather a disturbing feature to find the sales in one year diminished from £15,348 to £9,498 in the following year. The figures look bad until they are explained. But the fact is that in 1891 we had quite a special sale of 100,000 lamps at a very fair price, and that came into the account of that year. Those lamps had been manufactured from time to time, and formed part of a large stock, and that favourable occasion offered itself to sell the block of 100,000, which we naturally did. If you take the realised price of those lamps you will see that the sales of lamps in connection with the local business, so to speak, of the Swan Company was about £5,348, and, therefore, bearing that in mind, the local or regular business has increased by about £4,000. Transfer fees and interest are slightly diminished, being £1,178, as against £1,290. From this it appears that people have not apparently been so anxious to transfer their interests in the Swan Company, and, as I dare say you are all aware, there is less money on interest account. This is a small item, but in this Company all small items have to be borne in mind. Dividend on shares in La Compagnie Générale des Lampes Incandescentes, less tax, amounts to £1,466, as against £1,168. This year that Company found itself enabled to pay 5 per cent. dividend, as against 4 per cent. in the previous twelve months. But I am enabled to say, incidentally, that, notwithstanding that the competition in France—I won't say has set in, because it has always existed—has set in with greater intensity, prices are coming down, and I think I may say that the current year shows that that Company will pay as good a dividend, and probably a larger one. That seems to be the opinion of our French colleagues. Dividends on shares in Edison and Swan United Electric Light Company (Limited) amount to £37,094, as against £34,799 in the corresponding period last year. That arose from the fact of the Edison and Swan, in a distribution, having been able to pay a larger dividend, and of course, as we have a very large share of our total capital invested in that Company, we participated in the improvement in its position. Now, stock is a matter of some moment, because upon the question of stock depends the final balance of the accounts, and I think when you understand it you will see the reason why we have paid, or rather propose with your permission to pay, 1 per cent. less than in the corresponding period last year. The stock brought forward was £18,449 in value, and this we have diminished to £14,654—that is a difference of about £3,800; so that if we had left the stock at its original figure we should have had this £3,800 to divide. But when I come to this question later I will tell you why we thought it right to reduce the value of the stock, and that question will naturally arise when we come to the opposite side of the accounts, namely, outlay. Purchases stand at £3,033; these mean the raw material in some cases, and in others manufactured material, but chiefly the former, which we work up into lamps at the factory. General charges include a variety of things—salaries, Directors' fees, rent, office expenses, income-tax, general and law charges—and amount to £3,6 .0. Wages and expenses at factory amount to £3,637, while sales ledger reserve is £300. The latter item we reserve to cover the risk of bad debts, because when the accounts are made up at the end of the year all our debts are not collected; but we find that a reserve of £300 leaves a fair margin to cover bad ones. The purchases include among other things the item of platinum. That is one of the elements, and that metal during the last two or three years has been a very errant quantity. Both the Edison and Swan and the Swan United were forewarned by competent judges that we should be wise to lay in a considerable stock of platinum, as the output of the metal, chiefly in Russia, was a very limited quantity and in the hands of a "ring," and, as its consumption, owing to the extension of the electric light, and, oddly enough, to the improvement of teeth on the part of American dentists, is enormously increasing. The course of trade is sometimes very singular, and many are the peculiarities that one finds out why this and that takes place in the market, and I must say I was surprised to find that the chief competitor with the electric lamp maker now is the American dentist. I can easily understand that in the particular article in which they deal—the continuity and preservation of teeth—it may be as valuable as it is in our lamps. However, we bought in advance upon the best advice we could get, and according to the best of our judgment a considerable quantity of platinum was bought. In the Edison and Swan Company we were fortunate enough to consume the greater part of it before a fall in the price of the metal had taken place. That, however, is not the case in the Swan United. We bought it at an average of about 60s., and we can now purchase it at 30s. In our short experience of ten years all sorts of fluctuations have taken place in the price; but, being face to face with the fact that our stock of platinum, from causes which I can only forecast—I cannot actually describe them—had fallen one-half, we thought it a prudent course to write it down by that amount in the balance-sheet. Very likely by this time next year we shall find that the price we have written down is less than the market value, in which case we may consider it desirable to write it up. Then again, we have, from the necessities of our business, a very large number of lamps in stock. Germany is a very big place, and we are obliged to keep lamps of a very great variety of types in stock. I have explained this many times before, but I must repeat it. In the different classes these amount to no great total, but when aggregated they reach a very large number, and you will readily see that this means a considerable amount of money locked up. We are face to face in Germany with severe competition—which I will tell you of presently—in this lamp business, as we are in France, and as, I suppose, we shall be in England sooner or later. We have written the lamp down from 9d. to 8d. Well, 1d. on 320,000 lamps is an appreciable sum, and those two items, together with some other matters of less moment, account for the slightly diminished dividend. Still we thought it more prudent to do that than to disburse 11 per cent., as we did last year. If we had been alive to the depreciation in the price of the lamp, or the price of the platinum, this time last year, we should have done then what we do now. What we have done is that we have put our balance-sheet on a sounder footing than before; we have brought it into line with the circumstances of the moment. Imagine what that means. In the production of a lamp, platinum at 60s. means 2½d., and at 30s. it means 1¼d., and when you are dealing, as we shall have to do, with hundreds of thousands of lamps that 1¼d. is a very material difference in the cost price of the article. We have established pretty well now that the greater the number of lamps we produce the less is the cost of production. In Germany what is going on at this moment is very German indeed. There are three companies who have resources enough, and knowledge enough, to carry on this lamp business. I suppose I am not treading on false ground when I say that, as far as we can ascertain, the universal opinion in Germany is that the Swan lamp—the one that we manufacture in Germany—is certainly as good and probably a better lamp than that of either of our competitors. We have to compete with Messrs. Siemens and Halske. Mr. Siemens' name we all know quite well in England in connection with electricity. His family are equally great in Germany. They are great manufacturers of dynamos, cables, &c., and are mixed up a great deal with the installation of the electric light, while amongst other things they make lamps, and they make these by some arrangement with the Edison Company and the Edison patents. Another great Company is the Allgemeine Elektricitäts Gesellschaft, who bought up Mr. Edison's patent for Germany, which we bought for Great Britain. As you know, the Swan Company bought Mr. Swan's British and Foreign patents, and the Edison Company, with whom we amalgamated, had only the British patents of Edison, and he sold his foreign patent to a combination. One meets with the lamps all over the Continent. The French have formed a Company of the Edison patent, and the German Edison Company are not only makers of lamps, but large installers of electrical stations. When Columbus made the egg stand on end on the table, a great many people, when they knew how, felt that they could do it too, so a great many people have learned "how," in these factories and emerge from them, get a little money together and start lamp making. The two companies that are our competitors have appreciated their position and have determined to kill all other little lamp makers. It is a horrible idea, unknown to us in England. What they call the survival of the fittest is going on in Germany, and my impression is that it will be a very efficacious process. When the fittest survive I suppose it is very

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likely they may combine, and then the price of the lamp, which is now very low, may be so—what shall we call it?—regulated as to produce rather better results. That is our hope. That is what we have gone through this last year, and that is why our accounts and sales show a less favourable result than they might have done if the prices had been equal to the price of the previous year. Of course it will not do in this world to sit still and be put out of existence. We are now fighting the amiable game of trying to survive, and I think we shall succeed. Another feature—of course this is more or less problematical, but it seems possible—is that, with the depreciation in the price of the lamp, there is a possibility that the relative demand will grow. If you have to pay 2s. 6d. for a thing, you are likely to be a little more careful about the use of it than if you paid 1s. 3d. Well, now, to us it may be in the long run a matter of indifference whether we sell three lamps at 9d. or one lamp at 2s. 6d., because a very curious thing in connection with the business is that the profit is determined by the number of lamps you make. If we doubled the production of our present number we should probably produce a lamp at 2d. less than the present price. If we trebled it we might be able to reduce the cost still more. It all turns upon the number of lamps which are to be divided into fixed expenditure The market price is easily ascertainable. It is greatly influenced by the question of rent, by mechanics' wages, and all those charges which are high, relatively, to a small number, and low, relatively, to a large number. Therefore, from the view on this side of the table, although I find from some letters which we have received that some shareholders are a little disquieted about the reduction of dividend, what I should be prepared to state as a proposition, which is defensible by argument, is that, although we pay less dividend, our position is really sounder than it was this time last year. If you will again refer to profit and loss account, you will see that the balance carried forward is £34,840, against £39,000 in the corresponding half of last year, that is about £4,000 less, but then that balance represented stock in hand amounting to over £18,000, against the present balance of £14,654, which goes a long way to account for the difference in the figures. I shall be happy to answer any questions or give any further detailed information on the subject. Now, what are we to do with that £34,840? Well, we propose a course to distribute it after retaining a reasonable reserve. The balance from the previous account was £8,000 odd, and while on this subject I may just as well say that the reason why we carried forward so much as that was that we foresaw then that this question of price and the rectification of the balance-sheet was imminent, and we thought it prudent to bring over that considerable sum of money out of the earnings of the preceding year. We have already distributed in respect of the first half-year an interim dividend at the rate of 8 per cent. for the six months amounting to £14,558. We propose to distribute a further sum at the rate of 12 per cent. for the half-year, and, therefore, making, if you authorise that treatment of it, a dividend at the rate of 10 per cent. for the year. This will enable us to carry over about £6,000. I had better explain one of the items in the balance-sheet. The share capital stands at exactly what it was any time the last three or four years. There are 19 750 shares of £5 each, fully paid, or £98,750, and there are 78,949 shares of £5 each on which only £3. 10s. has been paid, making £276,321. That makes the capital of the concern £375,000 odd. There is an item in the balance-sheet which has disappeared—the item of forfeited shares, £3,500, which has been brought forward from time to time on one side of the account. It is of no good bringing it forward any longer. The shares have been forfeited. The money represented by the shares belongs to the Company. Instead of carrying forward an item which is calculated to mislead, we thought it better to knock it out of the account. If you carry your eye across the sheet you will see that the cost of Patent Rights, &c., represented by shares in Edison and Swan United Electric Light Company (Limited), with £208,478 paid; shares in La Compagnie Générale des Lampes Incandescentes, with £30,489. 8s. 3d. paid; patents held by the Company for Germany, &c., as per last balance-sheet, £332,449. 3s. 5d., less amounts received on account of forfeited shares and costs from the Allgemeine Elecktricitäts Gesellschaft £3,885. 11s. 1d., or £328,563. 12s. 4d. —that embraces the item of £3,500, the value of the forfeited shares, and some few hundred pounds which our friends in Germany had the pleasure of paying us, as the cost of the litigation referred to in the report. We have written that off the asset standing at £332,449, we have written it down to £328,563. Then we have got certain other items, outlay on factory, plant, &c., as per last account £1,570. There is an item which I might enlarge upon. We have got a factory in Germany, we hired a part of the large factory, being very suitable premises, with certain standing machinery, such as boilers and so forth, at a certain rental, and we go on paying the rent, but in order to make that factory efficient we had to spend £12,000 or £14,000, and as prudent people we thought we should begin early to write that down and we have done so. The stock in hand is £14,654, and is put in the balance-sheet as regards platinum at the current prices. There it is locked up just like so much gold in a bank safe. Investment in Prussian Consols cost £5,120; investment in new 2¾ per Cent. consolidated stock cost £29,004. 19s. 6d.; cash on deposit and in hand is £26,413. 5s. Now that is the whole story. I do not know that I need enlarge upon it, but having gone into such detail I may sum it all up. The first paragraph of the report contains all that I may say I have talked about. The profit and loss account for the year shows a credit balance of £34,840. 11s. 11d., which, together with £8,010. 3s. brought forward from the last account, makes disposable the sum of £42,850 15s. 9d. An interim dividend in respect to the first half of the year amounting to £14,558. 9s. 8d. has already been paid. The Board proposes that a further sum of £21,467 8s. 4d. be divided free of income-tax, and that £6,824. 17s. 9d. be carried forward. We have got rather a peculiar distribution. We have two classes of shareholders, fully-paid £5 and partly-paid £3. 10s. The fully-paid are entitled, up to 5 per cent., to rank on the money with the £3. 10s. Therefore they are entitled to the first dip into the bag to the extent of 5s. per fully-paid share, against 3s. 6d. per partially-paid share. But then at the next dip each shareholder takes half—that is per share and not per cent. Therefore, to get at the dividend we have to know how much per cent. it is. After that the division is on the principle of half and half, which caused a great deal of abstruse calculation. The distribution of this amount in accordance with Clause 77 of the Articles of Association will work out at at 4s. 2⅝d. per share on the 78,949 ordinary shares of the Company, £3. 10s. paid, and at 4s. 11⅛d. per share on the 19,750, £5 fully-paid, being equivalent to 10 per cent. per annum on the partly paid, and of slightly under that rate upon the fully-paid shares. Now comes a paragraph of some importance. As long as we were in litigation in Germany we suffered under the disadvantage of not knowing where we were. We could not push our trade because the German law is rather terrible on the subject of damages. The German law proceedings—are they as protracted as those in England? Well, pretty well, and probably a little more so, and until you get a decision of the Court you do not know where you are on two vital points—first of all as to the validity of the patents or otherwise; and secondly, as to the damages—that is to say, how much they will mulct you if you go on after an action is commenced selling something which may turn out to be an infringement. Well, as prudent men, knowing that there were doubts which had to be solved in connection with this action which had been running on for several years, we did not force our trade with any very great vigour. We took what came, and made the best of it. Well, it turned out that we were not infringers, and we incurred no damages, and were thus left to go on without the fear of damages, and to push our article without this shadow of apprehension hanging over us. We have sold most of the Swan business in the case of the English Company, in the sense of having amalgamated with the Edison patents to the extent of £208,500, in round numbers, of our capital. Well, then, we had a French complication, and we thought we had better cross there than fight. We made an Edison and Swan Company in Paris, and we have some £30,000 odd of our capital invested in that enterprise, which I told you last year paid 5 per cent., and shows a possibility of future value. Our partners there are very powerful people. They are not only manufacturers of lamps with us, but they are people who have got the installation of the electric light over large parts of Paris, and are in a large way of business in other ways; and they have the opportunity of forcing their lamps, and they are getting a very good average price. That agreement precludes the Edison-Swan Company from travelling on to the Continent at all, except in respect of Germany. In Germany we are free, and there we have got a manufactory. Here I wish to say that German thrift and German intelligence—and I must say, having seen a good deal of it myself in Germany, though I do not admire the principle of compulsory military service—German discipline amongst the workmen will be a great fact with us some day. The greater intelligence and better discipline ingrained in them by that service will enable you to deal with your workmen on much more reasonable terms than with workmen who have not had that compulsory training, so that given the number we shall be able to turn out lamps in Germany scientifically and mechanically as perfect, and at a less price, I fancy, than in either France or Great Britain. That is a very important lever for us. For some time we supplied our French friends with lamps made in London at a price less than they could produce the article at. We can now supply the lamps made in Germany at a great deal less than they can be produced for in Paris. But then comes the question, you cannot keep up a separate establishment to do a limited trade at an undue cost. Here we are allied companies. A large portion of our capital is invested in the Edison and Swan Company. We have made a portion of it safe in the French Company, and we have got the German residuum. What is that worth? If we can only ascertain what it is worth there is nothing easier than to put it in the pot with the Edison and Swan, and work as partners, not only in Great Britain but in Germany, and it might and probably will end in lamps being manufactured in Germany by German workmen, and for the benefit of the latter, instead of in London, where wages, &c., make it impossible to live at a profit. We think that the time has come when this residuum had better be brought in to the big company. We have got the largest share in the Edison and Swan Company. We believe that the latter will be greatly strengthened if they can absorb this German business with its advantages present and prospective. One advantage which would follow immediately would be a reduction in the cost of conducting the German business, because, with a separate Board of Directors and what they call location and separate administration, there is a certain waste. We say:—"The litigation on the German patents of the Company having happily terminated, and the bulk of the capital of the Company being now invested in the Edison and Swan Companies in Great Britain and France, the Board believe that the time has arrived when a fusion of the residuum of the foreign business of the Swan Company with the British Edison and Swan Company may be effected with advantage to both interests, and negotiations are pending with a view to effecting some arrangement in this direction." It will make both Companies richer and stronger. Mr. Quilter and Mr. Swan represent two very powerful elements on this Board, and Lord Lichfield represents a potent one in the Edison and Swan Company, and he thought, and I thought, that we had better resort to another gentleman who was a Director of that Company—Sir John Lubbock—whose position and ability make him specially valuable in a matter of this sort, and that all these gentlemen should think the matter out, and that they should come to some arrangement, to be submitted to the proprietors of both companies, under which the Swan Company should be merged into the Edison and Swan. I am not in a position to-day to say what point has been reached. The negotiations are pending. They have made a considerable advance. The parties appreciate the principle and they appreciate the advantages, but they are traders after all, and I do not know that they have arrived at the precise figure. The theory is that the Edison and Swan Company will purchase this residuum of the Swan Company for a commodity to be called Debenture Stock, bearing some reasonable rate of interest, but the parties are not agreed as to what this

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interest should be. One party wants more than the other is inclined to give at present. I mention that in order that the proprietors may realise that there is something pending that will be greatly to the interest of the Company. Of course we shall have to call special meetings of both Companies before anything is done, and it will be for you to accept or reject the terms as you see fit. The next paragraph refers to the death of Mr. Leyland. Well, I will not enlarge on that. His death came on us so suddenly that it was almost tragic, and everybody connected with the lamp business and other businesses must have realised what a loss it would be to us. We felt it deeply, and in reference to the negotiations I have referred to I for one regret as far as I am concerned that we have not the support of that precise and clear intellect which was eclipsed in an instant. When he had gone we had to look round, and Major Flood Page, who had given us yeoman's service for a number of years, wished to be relieved of some of his more detailed labours, and we elected him to fill the vacant office in which he is now acting. Mr. Cuthbert Quilter was elected as Deputy-Chairman, who, of course, as everybody knows, is greatly responsible for the initiation of these companies, and whose valuable services I will not enlarge upon. Major Flood Page came on the Board in virtue of his knowledge. The Directors who retire by rotation are Mr. J. S. Forbes and Mr. W. E. Batt. Well, now, as I said, if you do not carry on this business as a separate business you will not want Mr. J. S. Forbes, Mr. W. E. Batt, Major Flood Page, and Mr. Quilter, and the machinery of administration and a separate office, so that there will be a sensible saving. I will not pledge myself to this, but I think that if the management of the Swan Company as it now stands, emerged from what makes a double Board of Directors essential, the expenses of administration would be reduced by £2,500 a year. That would make an important difference in the cost of the lamp. Further, I have told you the indirect benefits. Meanwhile the machinery must be carried on. I assume that if we do come to terms it will be on the theory of the Swan Company being fused into the Edison and Swan immediately, or as early as may be. A very convenient time would be, of course, on the issue of a balance-sheet for the complete year, and I fancy that it may turn out in this way. Meanwhile you must continue the machinery. I have made a rather long statement, but I trust not too long for the importance of the occasion, and having made it I shall be ready to answer any questions or give any further explanations that shareholders may desire. I now move

"That the report and accounts for the year ended September 30, 1891, be and the same are hereby received and adopted."

Mr. W. CUTHBERT QUILTER, M.P., seconded the motion.

The CHAIRMAN, in answer to Mr. Skipworth, said that in anticipation of any criticism he had told them that the expenses of the direction and the machinery were beyond all measure out of proportion to the work done. If the work of the Directors had been confined to the manufacture of lamps, the outlay certainly would be so; but up to almost recently their work had been to defend the legal position of the Company in a series of very difficult questions of law, and to save its capital. Take as an illustration—he agreed that the charge of £3,620 was a very large tax on so small a sale business as £9,498. Nobody could contest it; but then the attention of the Directors had not been confined to the manufacture of so many lamps. That was a very simple process. Their business had been to guide the policy of the Company and to prevent the property from being thrown away, which it would have been unless they had contested the actions in Germany. Now that was all over. The main *raison d'être* of their existence was at an end. Out of the £3,520 charged for salaries, Directors' fees, &c., the Directors got £1,500. They could, therefore, estimate whether that was a very extravagant reward to five gentlemen, individually or collectively, for a year's work of harassing litigation. He personally was the principal culprit, having received £500, but he was ready to forego it because he knew he was not now wanted, and his colleagues were in the same boat. The occasion was passed, and they wished the shareholders to have the benefit of every economy.

The motion was then carried *nem. con.*

The CHAIRMAN: I beg to move

"That in addition to the £14,558 9s. 8d. already distributed in respect of the six months ended 31st March, 1892, a further sum of £21,467 8s. 4d. be divided free of income-tax; to be distributed in accordance with the provisions of Clause 77 of the Articles of Association, making the total distribution for the year of £36,025 18s."

Mr. CUTHBERT QUILTER, M.P., seconded the motion, which was carried unanimously.

Mr. QUILTER then moved that Mr. J. S. Forbes be elected a Director of the Company, which was seconded by Major FLOOD PAGE, and carried unanimously.

Mr. FORBES having expressed his acknowledgment, moved that Mr. Edward William Batt be elected a Director of the Company, which Mr. CUTHBERT QUILTER, M.P., seconded, and it was carried *nem. con.*

Mr. DAVEY proposed, and Mr. BETTS seconded, the reappointment of the Auditors, Messrs. Welton, Jones and Co., and the motion was agreed to.

The CHAIRMAN said that he had received a letter from a stock and share broker, asking him to explain certain particulars in regard to the Company. The first point was "That lamps are now being manufactured under royalty and sold cheaper than the prices obtained by the Swan Company. Are they durable, and if such is the case, why are the lamps dearer, as I understand they are?" Now, as far as they knew, no lamps were being manufactured, certainly none under royalty. If there were any being manufactured they were infringements, and the Directors would prosecute the infringers. As to whether the lamps were durable or not he could not say, because he had not seen any, for no lamps were being sold under royalty. "If they are not durable can you account for the sale, as when the patent expires the other competitors will manufacture them to be sold even cheaper, as there will be no royalty?" That question was answered by the other, since the lamps were not manufactured. "Are the interests of the Directors still as large as before the depreciation set in, as from the transactions that have taken place recently it appears some heavy selling has been made?" The innocence of his mind was so great that he could not induct an insinuation from that. If he did it might be a little unkind. However, the holding of the Directors was the same. (Mr. Quilter: Rather larger). "Also when the royalties cease will the Swan Company not only feel this loss but also the keener competition, and to what extent are those royalties?" He did not know what that meant. Having the intention to force their wares they might feel the effect of competition, but he thought that they might look forward with hope and confidence to the future.

On the motion of Mr. WILSON a vote of thanks was accorded to the Chairman, who briefly returned thanks, and the proceedings terminated.

International Okonite Company (Limited).

The annual general meeting of this Company was held yesterday at the Cannon-street Hotel. Sir Alexander Armstrong, K.C.B., F.R.S., presided in the absence of Mr. S. Pope, Q.C.

A circular, which accompanied the notice calling the meeting, and which was signed by Mr. Samuel Pope, Q.C. (the Chairman of the Company), after stating that the report and accounts would be formally laid before the meeting, continued as follows:—"Since these accounts have been audited your Directors have been made aware of serious difficulties which have arisen in the administration of the Manchester factory, and which will necessitate their immediate and resolute interference. In addition to this, important engagements will prevent me from being able to be present at the meeting. It will therefore be proposed that the meeting formally held shall be at once adjourned until January 10, 1893. At that date it is hoped the whole of your Directors can be present to meet the shareholders, who will have had time to consider the accounts and report, and a complete reorganisation of the Manchester factory be accomplished and thoroughly explained to the shareholders."

Mr. JOHN C. WYLDE, the Secretary, read the notice calling the meeting, and the above circular.

The CHAIRMAN: Gentlemen—The letter of the Chairman will have prepared you for the motion which I am now about to make, viz.:

"That this meeting be adjourned until the 10th of January."

You will then have ample opportunity of fully considering the balance-sheet and of going into details, and the Chairman will then be in the position of affording you more information than I can do. I will therefore move that this meeting be now adjourned.

Mr. TOD seconded the motion.

Mr. JOHN KENYON (Manchester) wished to move an amendment that the business of the meeting be proceeded with.

Mr. GLADSTONE seconded the amendment.

Several shareholders desired to ask questions, but the Chairman said that he did not think it advisable at that meeting to go into details. The meeting had been called, in accordance with the requirements of the law, within 12 months of the last meeting, and it was now proposed that they should adjourn till January 10th, when full details would be given to the shareholders by the Chairman, Mr. Samuel Pope, Q.C.

Mr. MATHERS wanted to go into the figures of the accounts.

The CHAIRMAN declined to do so.

Several other gentlemen, including certain late servants of the Company, attempted to address the meeting, but

The CHAIRMAN ruled the remarks out of order, as being inimical to the interests of the Company.

A proposal to substitute some firm of auditors in Manchester in lieu of the Company's present auditors was ruled out of order by the CHAIRMAN, who declined to put it, on the ground that the re-election of auditors was not before that meeting, but would form part of the business for the meeting on January 10th. The Board had perfect confidence in their present auditors, Messrs. Price, Waterhouse, and Co.

Mr. GLADSTONE maintained that the business ought to be proceeded with at once (hear, hear, and no, no).

Mr. GRIFFITHS intimated his intention of taking action against the Company because the statements of the prospectus had not, he said, been borne out. He must not by his appearance at that meeting be taken as waiving his right to take action.

The CHAIRMAN said that there was no foundation in the statement that in the six weeks from now to January 10th the Company would go on making losses. He deprecated the action shareholders were taking. He promised to afford all information to the shareholders that could reasonably be given at the Company's offices.

After some personal discussion the amendment was put and declared lost by the Chairman.

The motion to adjourn until January 10th was then put and lost on a show of hands.

The CHAIRMAN then put in the proxies the Directors had received in favour of adjournment, and declared the resolution carried. He formally stated the meeting was adjourned until January 10th.

Mr. GLADSTONE challenged the proxies and their validity.

The Chairman allowed him to inspect them, and he found that they were quite legal.

The meeting then adjourned.

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NEW COMPANIES, STATUTORY RETURNS, &c.

ARCAS PLATING COMPANY (LIMITED).—This Company was registered on November 21st, with a capital of £80,000 in £1 shares. The objects (amongst others) are to adopt and carry into effect an agreement, dated November 15, 1892, between the London Metallurgical Company (Limited) and Sherard O. C. Coles and Harold R. Braid on behalf of the Company, for the acquisition of certain patents and patent rights, particulars of which are not given ; to use, exercise, develop, grant licences in respect of, sell, or otherwise turn to account the said patents, and to carry on the business of plating in all or any of its branches, and any allied or kindred businesses.

AUTOMATIC ELECTRIC RAILWAY SIGNAL COMPANY (LIMITED).—This Company was registered on November 26th, with a capital of £10,000, in £1 shares. The objects are to acquire certain patents and apparatus for railway signalling, &c., and in particular to carry into effect an agreement dated November 25, 1892, between Reginald B. Annesley, George R. Leyland, Walter Emmott, and Robert W. Brown and Thomas Woodfine (on behalf of the Company), to establish and work automatic electric signals for railways and grant licences for that purpose, and generally to carry on the business of engineers, railway, tramway, and other signal manufacturers and dealers in railway, tramway, and other signalling apparatus, engines, and machinery. The first subscribers are : J. Bushby, Robert W. Brown, William H. Potter, Frederick T. Loftus, John Charnley, R. B. Annesley, and George R. Leyland, all of Liverpool.

ELECTRICAL AND GENERAL CONTRACT CORPORATION (LIMITED).—This Company was registered on November 25th, with a capital of £50,000, in £5 shares. The objects are to enter into or acquire by purchase or otherwise, and carry out contracts or concessions, or other grants in any part of the world, for making, purchasing, or working railways, tramways, telegraph and telephone lines, electric and other lighting, electric, hydraulic and other works, and for the equipment of such works with electric or other plant, stock or apparatus ; to carry on the business of contractors in any part of the world, and also the business of electrical and mechanical engineers, electricians, suppliers of electricity and electrical plant, and manufacturers of and dealers in electrical apparatus. The subscribers are:—

	Shares.
J. F. Mieville, 12, Angel-court, E.C.	1
W. S. Graff Baker, 35, Parliament-street, S.W.	1
Alfred de Turckheim. 35, Parliament-street, S.W.	1
H. Chester Masters, 1, Jeffrey-square, E.C.	1
Dillwyn Parrish, 2, Copthall-buildings, E.C.	1
George E. Church, Dashwood House, Old Broad-street, E.C.	1
Frederic Manuelle, 101, Leadenhall-street, E.C.	1

L. ALWYN (LIMITED).—This Company was registered on November 24th, with a capital of £2,000, in £1 shares. The objects are to establish and carry on the business of agent to the Brush Electrical Engineering Company (Limited), in the City of Bristol, and the neighbourhood thereof, and in such other cities and places as the Company shall deem expedient, such agency or agencies being for the wiring and fitting of premises and the erection and installation of machinery, and the sale of the same, incidental to electric lighting, as apart from all central station plant ; generally to manufacture or purchase, supply, sell and deal in all apparatus and things necessary for the electric lighting of shops, houses, and all other premises, apart from central station plant, and to carry on any other electrical engineering agency subject to the approval of the Brush Electrical Engineering Company (Limited).

R. C. CUTTING, DOUGLASS, AND COMPANY (LIMITED).—This Company was registered on November 22nd, with a capital of £12,000, in £5 shares. The objects are : To acquire the goodwill, plant, trade marks, and stock-in-trade, and take over as a going concern the business of electrical engineers and manufacturers of lightning conductors carried on by R. C. Cutting, Douglass, and Company (Limited), at Doctors'-commons, London, E.C., and to carry on the said and other businesses. The signatories (with one share each) are :—A. M'Keand, 11, Pancras-lane, London, E.C. ; G. W. Grosvenor, "Holywell," Lewin-road, Streatham, London, S.W. ; W. Bartholomew, Wardrobe-chambers, Queen Victoria-street, E.C. ; S. J. Skilton, Wardrobe-chambers, Queen Victoria-street, E.C. ; S. F. Alderson, 2, Nunhead-lane, S.E. ; J. Clark, 62, Finsbury-pavement, E.C. ; Stephen Graham, 1, Mary Villas, Hoe-street North, Walthamstow.

SIR JAMES FARMER AND SONS (LIMITED).—This Company was registered on November 23rd, with a capital of £50,000, in £10 shares, to carry on the business of machinists, mechanical and electrical engineers, machine and engineering tool makers, boiler makers, iron and brass founders, millwrights, metallurgists, and metal workers, carried on by the firm of Sir James Farmer and Sons at the Adelphi Ironworks, Salford, Manchester.

MONTE VIDEO TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to November 14th, has been filed. The Company was registered on July 31, 1888, with a capital of £180,000, divided into 24,000 preferred shares and 12,000 ordinary shares of £5 each. The capital of the Company was, in 1889, raised to £220,000 by the creation of 8,000 new shares of £5 each, of which new shares 5,000 were preference and 3,000 ordinary. 3,000 ordinary and 3,000 preference, considered as fully paid up, were allotted to the vendors in consideration for premises and property. At the time of making up, 28,000 preference and 15,000 ordinary shares had been taken up, and 3,000 of each class of shares issued as fully paid. Upon the remaining 25,000 preference and 12,000 ordinary shares the full amounts have been called, resulting in the payment of £185,000

PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—The statutory return of this Company made up to November 2nd has been filed. All the shares in the capital of £100,000 in £10 shares have been taken up. £2 per share called, and all calls paid. At extraordinary general meetings of the members of this Company, held on October 19 and November 16, the following special resolution was duly passed and confirmed, viz. : "That the share qualification of a director, as provided by Article 59, shall not apply to Sir John Pender, G.C.M.G., M.P., who may at any time hold the office of and act as director without being the holder of any shares in the Company, and shall be eligible for election as a director, and may retain and exercise that office notwithstanding he may not be the holder of any such shares, and that the Articles of Association relating to the appointment and qualification of Directors be read and construed accordingly."

PETROLEUM ENGINE COMPANY (LIMITED).—The annual return of this Company made up to November 2nd has been filed. The Company was registered on March 26, 1888, with a capital of £100,000, in £5 shares. At the time of making up 18,261 shares were taken up, all of which had been issued as fully paid. Share warrants to the value of £485, comprising one share each, are outstanding.

RAILWAY ELECTRIC READING LAMP COMPANY (LIMITED).—The statutory return of this Company, made up to November 1, 1892, has been filed. Only seven shares of a capital of £100,000, divided into 16,000 ordinary and 4,000 deferred shares of £5 each have been taken up, the full amounts called and all calls paid (£35).

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—This Company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended September 30th last, payable on the 21st inst. The Company's transfer books will be closed from the 15th to the 20th inst. inclusive.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—Mr. J. B Braithwaite, jun., has been elected Chairman of this Company in succession to the late Duke of Marlborough, and has accepted the appointment for a period of one year.

CHILI TELEPHONE COMPANY (LIMITED).—Application has been made to the Stock Exchange Committee for a quotation in the Official List of 4,000 additional shares, Nos. 40,001 to 44,000.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The Stock Exchange Committee appointed yesterday (Thursday) a special settling day in this Company's Six per Cent. Preference Shares, Nos. 1 to 20,000, and have ordered them to be quoted in the Official List.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended November 27th were £893, as against £806 for the corresponding period of last year, being an increase of £87. The total receipts for half-year amount to £17,900, against £16,173 in the corresponding period of 1891, being an increase of £1,727.

COMMERCIAL CABLE COMPANY.—This Company have opened a branch office in East India-avenue, Leadenhall-street, E.C., where messages are sent direct over the Company's system.

EDINBURGH ELECTRIC SUPPLY CORPORATION (LIMITED).—This Company are inviting applications for £80,000 in 16,000 shares of £5 each. The authorised capital is £100,000. The Company has an influential Board of Directors, and is established to supply electric light and power in Edinburgh, Leith, and elsewhere. The Directors calculate upon the probability of the Edinburgh Town Council asking for tenders for lighting Edinburgh, and desire that the Company shall then be in a position to tender. The amounts payable are as follows : – 5s. on allotment, and no further calls unless the Company proceeds to business, in which case, with two months' notice, calls are not to exceed £2 per share. If the Company does not proceed to business the allotment money will be returned in full, the Directors bearing the preliminary expenses. Issued with the prospectus is a lengthy list of persons who have offered to become shareholders in the Company.

EVERED AND CO. (LIMITED).—The Stock Exchange Committee have ordered the £10 paid shares, Nos. 1 to 6,744, and the £7 paid shares, Nos. L1 to L9,750, in this Company to be quoted in the Official List.

NATIONAL TELEPHONE COMPANY (LIMITED).—The Stock Exchange Committee have appointed to-day (Friday) a special settling day in this Company's Third Preference Shares, Nos. 1 to 90,950, and have ordered these shares and the additional Ordinary shares, Nos. 447,235 to 454,747, to be quoted in the Official List.

ONCKEN PATENT STAVELESS BARREL COMPANY (LIMITED).—At the statutory meeting of the shareholders of this Company, held on Wednesday, the Chairman (Mr. F. B. Maddison) announced that satisfactory progress was being made with the Company's business.

REUTER'S TELEGRAM COMPANY (LIMITED).—The Stock Exchange Committee have ordered 1,000 additional shares, Nos. 10,803 to 11,802, to be quoted in the Official List.

RIVER PLATE TELEGRAPH COMPANY (LIMITED).—The Second Division of the Scotch Court of Session, on Friday last, ordered intimation and advertisement of a petition by the River Plate Telegraph Company (Limited), of 188, St. Vincent-street Glasgow, for leave to alter the memorandum of association of the Company. The Company own a land

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telegraph line from Buenos Ayres, in the Argentine Republic, to Monte Video, in Uruguay. They ask powers to let or hire out their property, or to amalgamate with other companies, the object of the alteration being to enable them to work in conjunction with the Brazilian Submarine Telegraph Company, whose line extends from Lisbon to Pernambuco, and with the Western and Brazilian Telegraph Company, whose line extends from Pernambuco southwards to Monte Video.

RICHARD HORNSBY AND SONS (LIMITED).—The balance-sheet of the Company at September 30th last shows a balance for the year of £19,234 10s. 7d., which, after paying interest on debentures and calls paid in advance, and dividend on preference stock, leaves the sum of £8,019 10s. 7d. available for dividend. Of this £3,750 was paid as interim dividend on June 15th. As already announced, the Directors propose the payment on December 15th next of a further dividend of 2s. 6d. per share, making, with the interim dividend, 5s. per share, carrying forward a balance of £519. 10s. 7d. to next account.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Nov. 25, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,079.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 23.		Price Wednesday, Nov. 30.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 30.	
								£ s. d.		Highest.	Lowest.
			TELEGRAPHS								
£1,247,720	Stock	12/6	Anglo-American	50½	51½	49⅞	50⅛	4 19 0	Jan., Apr., July, Oct.	50½	50
£2,876,140	Stock	25/0	Do. Preferred	91	92	90⅝	91⅝	5 16 4	" "	92	90⅝
£2,876,140	Stock	5/0	Do. Deferred	11¼	12	10¾	11¼	..	" "	11⅛	11¼
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	4/0	Brazilian Submarine xd and bonus	10¾	11¼	10⅞	11⅛	5 15 7	Mar., June, Oct., Dec.	11⅛	1⅞
£68,200	£100	5%	Do. 5 per Cent. Bonds	101	104	101	104	4 16 2	January and July	..	
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	106	110	106	110	4 10 11	June and December	110	.
$7,716,000	$100	$1¾	Commercial Cable Capital Stock	183	185	178	182	3 16 11	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11⅛	12⅛	11⅛	12⅛	6 19 2	February and August	12⅛	..
6,000	10	10%	Do. Preference 10%	17½	18½	17⅛	18⅛	5 8 1	" "	..	.
12,931	5	1/7½	Direct Spanish (£4 paid)	3	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10%	9	10	9	10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11¼	11¾	11⅜	11⅝	6 0 2	Jan., Apr., July, Oct.	11⅞	11⅛
400,000	10	2/6	Eastern	14⅜	15	14⅜	15	4 6 8	" "	15	14⅛
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16¼	..
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109	112	109	112	3 11 5	May and November	111	109½
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107	110	107	110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	14⅜	15	14⅞	15⅛	4 12 7	Jan., Apr., July, Oct.	15	14⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109	112	109	112	3 11 5	February & August	110	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104	107	104	107	4 13 6	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	104	107	104	107	4 13 6	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	104	..
180,227	10	1/0	Globe Telegraph and Trust	9⅜	10	9⅜	10	4 15 0	Jan., Apr., July, Oct.	10	9⅞
180,042	10	6%	Do. 6 per Cent. Preference	14⅞	15⅛	14⅞	15⅛	3 19 4	" "	15	14⅞
150,000	10	5/0	Great Northern	19	19½	19	19½	4 7 2	Jan., April, and July	19¼	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104	107	104	107	4 13 6	March & September	106¼	..
17,000	25	12/6	Indo-European	43	45	43	45	5 11 1	May and November	..	..
38,348	10	4/0	London Platino-Brazilian	6	7	6	7	5 14 4	" "	..	.
£100,000	100	6%	Do. 6 per Cent. Debentures	107	110	107	110	5 9 1	March & September	..	..
10,802	8	4/0	Reuter's	7½	8½	7½	8½	4 14 1	April and October	..	..
3,381	£100 Cert.	30 0	Submarine Cables Trust 6%	116	120	116	120	5 0 0	" "	118	.
15,609	10	5/0	West African Telegraph	6½	7½	6½	7½	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	102½	10 ¼
30,000	10	2/0	West Coast of America	2½	3½	2½	3½	..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	103	107	103	107	7 9 7	June and December	..	..
88,321	10	6d.	West India and Panama	1½	1½	1½	1½	..	" "	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10⅜	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8	9	6 13 4	" "	9	..
64,242	15	3/0	Western and Brazilian	7¾	8⅛	7⅛	7¾	5 15 11	" "	8	7½
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5¾	6½	5½	6	6 5 0	" "	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2	2½	1½	2	..	" "	2⅛	1⅞
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106	109	106	109	5 10 1	February & August	..	
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106	109	106	109	5 10 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120	125	120	125	5 12 0	May and November	..	
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100	103	100	103	5 16 6	March & September	..	
			TELEPHONES.								
40,000	£5	10/0	Chili Telephone	3	4	3	4	..	..	..	..
22,500	14/0	1¼d.	Consolidated Telephone Const. & Maintenance	¼	⅜	1/16	1/8	7 16 5	May and November	..	
220,000	£1	4⅜d.	Oriental (11s. paid)	7/16	1/16	1/16	1/16	7 18 2	Yearly	..	
438,984	5	3/6	National	4⅜	5⅛	4⅜	5⅛	5 17 1	June and December	5 1/16	1⅛
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14	15	14	15	4 0 0	" "	14⅞	14 9/16
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13⅜	14½	13⅜	14½	4 4 3	" "	14⅛	13⅜
420,000	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112	114	112	114	3 18 11	January and July	113⅛	1 3/16
48,000	£10	..	New Telephone, Limited (£2 paid)	3⅞	4⅛	4⅜	4⅝	..	..	4 1/16	3⅛
58,000	5	1/0	United River Plate	2½	3	2½	3	..	January and July	..	2⅝
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	—	..	
			ELECTRICITY SUPPLY COMPANIES.								
30,152	£10	—	City of London Electric Lighting (fully paid)	10½	11	10¼	10¾	..	—	10⅜	10⅜
19,900	£5	..	Electricity Supply Co. of Spain	..		..		..	—		
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	..	..	.
8,332	£5	..	House to House Electric	2½	3½	2½	3½	..	—	.	
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5	5½	5	5½	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	5½	5⅝	5½	5⅝	..	January and July	..	..
30,000	£5	4½% '91	Liverpool Electric Supply (£3 10s. paid)	3 7/16	3 9/16	3 7/16	3 9/16	3 15 9	March	.	.
10,000	£5	4½% '91	Do. (fully paid)	5 1/16	5 1/16	5 1/16	5 1/16	4 6 9	March	..	..
111,000	5	..	London Electric Supply	⅜	⅝	⅜	⅝	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½	7	6½	7	..		7	..
£50,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	103	106	103	106	4 14 4	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5	6	5	6	—	—	..	..
18,680	£5	2/6	St. James' and Pall Mall	8	8½	7¾	8¼	—	—	..	..
7,900	£5	7%	Do. 7% Preference	8	8½	8	8½		—	8⅝	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5¾	6¼	5¾	6¼	2 8 0	—	5 1/16	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	1/9⅜	Brush Electrical Engineering	3⅛	3⅜	3	3⅛	..	—	3⅜	..
69,996	2	6%	Do. 6 per Cent. Preference	2⅛	2⅜	2⅛	2⅜	5 1 1	..	2¼	..
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼	5⅝	5¼	5⅝	6 7 3	January and July	5¼	..
12,139	5	17%	Edison and Swan United	..	..	..	..	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	2¾	3¼	2¾	3¼	..	—	..	..
45,000	10	12/0	Electric Construction	3⅛	4	3½	4	..	—	3 1/16	3⅜
70,000	2	10/0	Elmore's Patent Copper Depositing	1⅜	1⅝	1¼	1½	—	—	1 1/16	1⅜
20,000	5	..	Fowler-Waring Cables (fully paid)	2	3	2	3	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21	22	5 13 6	February & August	21¼	21⅛
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½	3½	2½	3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6	7	6	7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	4/0	4/6	4/0	4/6	..	..	..	..
78,949	5	2/9⅜	Swan United (£3. 10s. paid) xd	3¼	3¾	3	3½	10 0 0	May and November	3⅛	3⅛
37,350	12	12/0	Telegraph Construction and Maintenance	45	47	45	47	5 2 2	March and July	46½	45⅝
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103	106	103	106	4 14 4	January and July	..	..
—	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	⅝	¾	⅝	¾	..	—	..	..
—	£5	8%	Do. Preference (fully paid)	2½	3	2½	3	..	—	..	..
			RAILWAYS AND TRAMWAYS.								
50,000	£10	½%	City and South London Railway	3	4	3	4	1 5	—	3 1/16	3⅜

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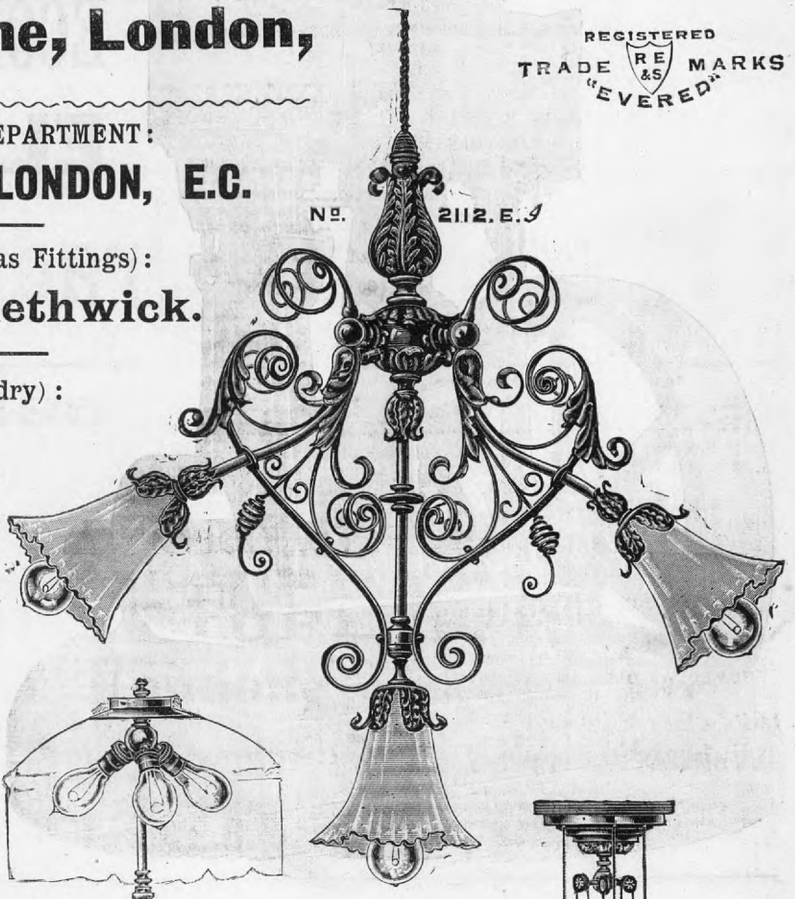

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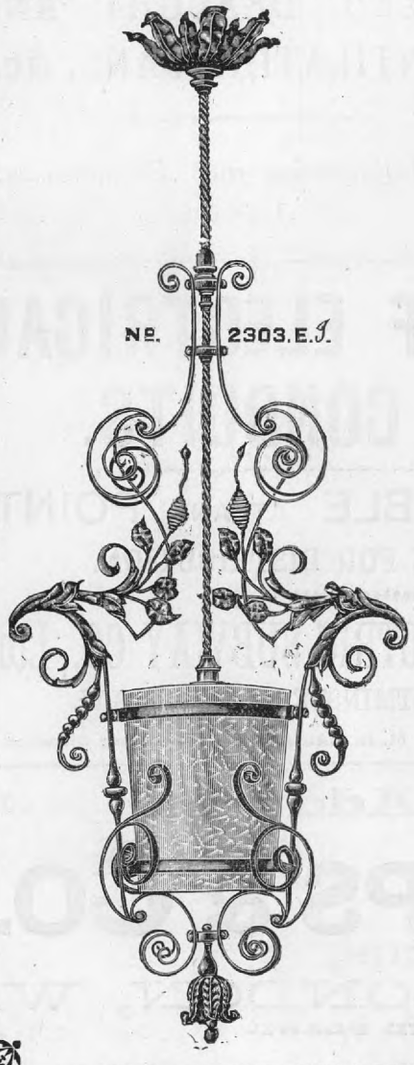

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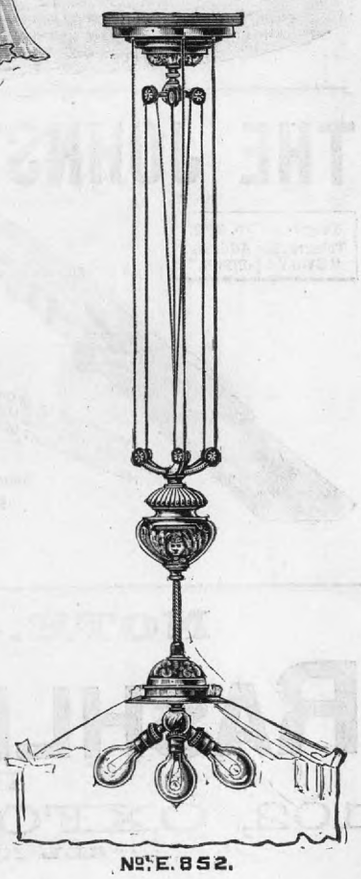

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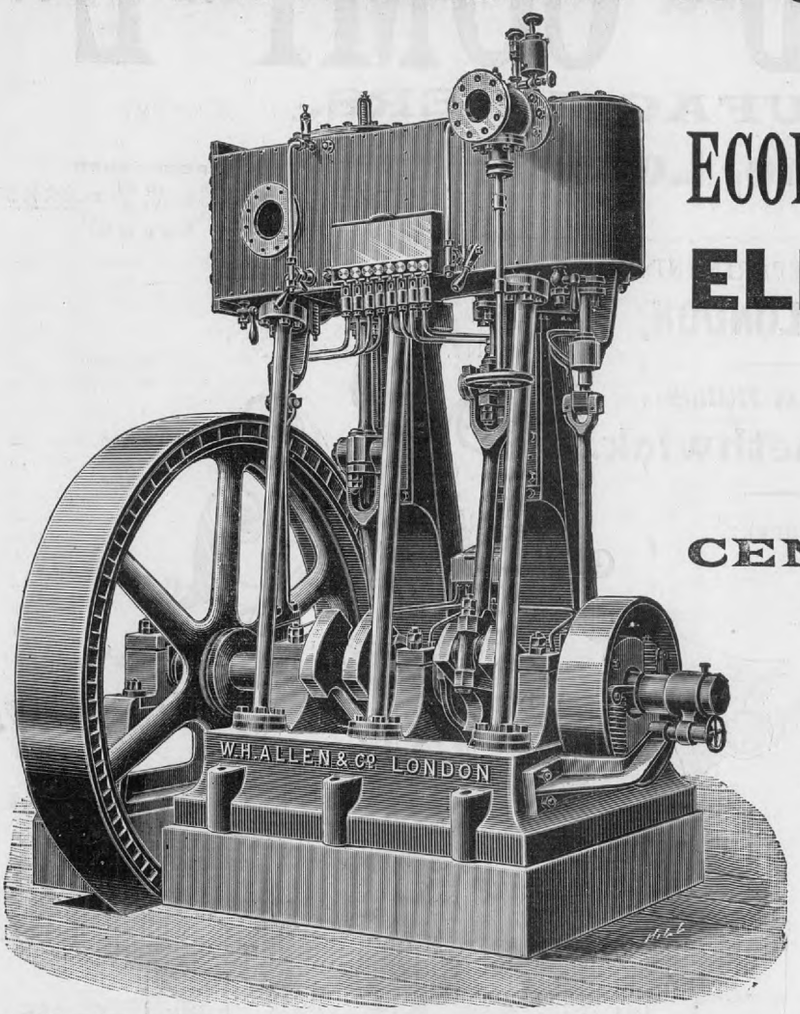

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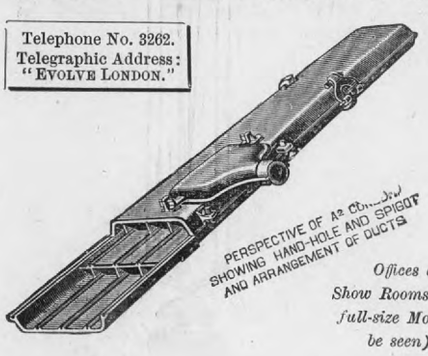

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ALEXANDER HELLARD, Town Clerk.

Town Hall, Portsmouth, 6th December, 1892.

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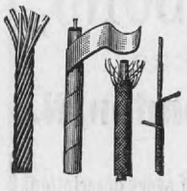
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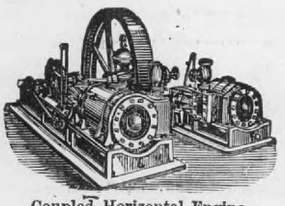

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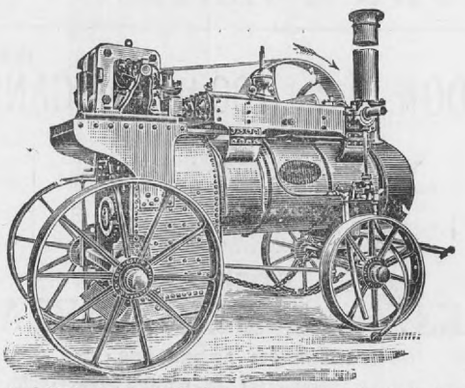

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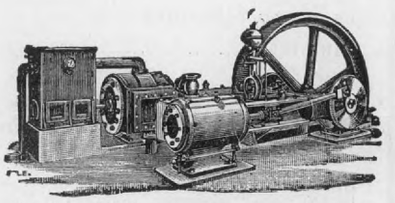

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No. 760.—Vol. XXX. FRIDAY, DECEMBER 9, 1892. PRICE FOURPENCE.
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NOTES.

The experiments shown by Messrs. Rimington and Wythe-Smith at the last meeting of the Physical Society presented several features which are worthy of consideration by those who are interested in the nature of electricity. The displacement of the fan of images in Fig. 2 of the illustrations, which will be found in another column, and the relation between the number of these images and the speed, afford means for studying the effect of definite changes of potential on gaseous dielectrics; previous experiments with Tesla tubes having given only qualitative results. The closed ring of light, in an exhausted bulb, when surrounded with a few turns of a Leyden jar circuit, has been studied by Prof. J. J. Thomson, Prof. Elihu Thomson, and others; and while called "a discharge" by the former, and a "luminous band" by the latter (*Electrician*, Vol. XXVII., p. 296), the authors of the present Paper speak of "a circuit," and of "generating a current in such a circuit." After the meeting at the Physical Society a repetition of Prof. Elihu Thomson's experiment with an open coil of wire round a straight tube was tried, and a luminous spiral was plainly seen. The tube was filled with a pale glow, but there was no indication of a closed circuit. It is highly probable that if a straight wire were placed in contact with an exhausted bulb, a short and nearly straight luminous band would appear within it. The word "current," which is ever to be regretted, as fastening the material, if not the "single fluid" theory of electricity upon the science, is evidently unsuitable here, and if no synonym can be found for the term in everyday work, it might at all events be avoided in these cases.

Mr. Campbell Swinton has been engaged on some very interesting experiments on high frequency and high pressure discharges, using a modification of the simple apparatus employed by Prof. Elihu Thomson. He takes a current from the St. James' and Pall Mall Company, and using six 50 c.p. lamps in parallel running at a bright red, as a resistance, he works a powerful Apps coil, capable of giving a 10in. spark. Condensers are arranged in the usual way with the primary, and allow the contact breaker to work without heating or sparking. A short spark gap of about $\frac{1}{4}$in. is generally employed. Two Leyden jars are connected across the secondary circuit, which excites the primary of a simple induction coil immersed in oil. On a recent occasion we had an opportunity of seeing many of the Tesla and other brilliant experiments carried out with this apparatus, but one new effect of a peculiarly interesting character deserves special notice.

On placing the hand near one of the terminals of Mr. Campbell Swinton's coil, a few sparks shoot out from the brilliant violet brush discharge which envelopes them; the sensation is similar to that produced by short sparks from a Wimshurst machine. On approaching or touching a terminal with a piece of metal, or after grasping it, no sensation is felt. Mr. Swinton took an ordinary 5-candle 100-volt glow-lamp, and putting one terminal to earth through his body, presented the other to a terminal of the coil. At first the bulb became filled with a violet light, but on approaching, sparks shot into the terminal of the lamp, and the filament at once glowed to the extent of some two or three candle-power. A variation of the experiment is to connect one terminal of the lamp to earth by a wire, and to complete the circuit from one terminal of the coil to the lamp by the hands. A 32-candle 100-volt lamp was brought to full redness in the same way. If a complete circuit is not made, the bulb only glows.

At first sight it appears that about one-fifth of an ampere must pass in order to raise the filament to incandescence, and according to a common but extremely unscientific explanation the current becomes harmless because the frequency is high. Mr. Campbell Swinton, however, offers a very attractive theory and one which should be applied to all Teslaic and other high frequency experiments. He argues that by reason of the high frequency, the current is merely skin deep; the resistance is therefore high, since only a very small part of the filament acts as a conductor. The volts are high, and not easily measurable, and though the current is small, the watts spent on the filament are sufficient to raise it to incandescence. The lamp becomes, as he puts it, not a 100-volt lamp, but a 100,000-volt lamp. The whole of the high-frequency-and-therefore-harmless theory is thus completely exploded, and a most interesting, and, we believe, new hypothesis is put forward, and one which, if not original, is not likely to have been already "published" in some mathematical Paper. If any tolerable estimate of the fall of volts could be arrived at, the current which has hitherto defied all measurement might be deduced by photometric tests from the known watts per candle-power.

An able contribution to the subject of current curves has been made by Major Hippisley in a Paper printed in the

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last number of the *Proceedings* of the Royal Society. The ordinary analytical method of determining the shape of these curves fails when the circuits possess iron cores, since the magnetism of the latter is not proportional to the current. The curves may be drawn by graphic methods if the connection between the magnetism and the current is known, and such processes have usually been resorted to when these curves have been obtained from theory. Major HIPPISLEY, however, has taken the **B H** curve, split it up into portions so that each part can be represented by analytical expressions, and has succeeded in obtaining the shape of the current curve after successive integration of the original current equation round the different portions of the **B H** curve. The method is difficult and lengthy, but it is interesting to find that the curves obtained by it compare fairly well with those obtained in other ways. Unfortunately, the author has taken the case of iron magnetised far beyond the saturation limit, a condition which, of course, does not exist in transformer cores and the curves are for this reason unlike those which actually represent the variation of the magnetising current of transformers. The effect of eddy currents in the core is also neglected. The curves, however, strikingly show the effect of hysteresis in disturbing their symmetry, and also bring out the effect of the extra currents which occur just after applying the alternating potential to the circuit.

A LARGE amount of work has been done during the last two or three years in connection with very rapid oscillations, but, since the experiments of BLASERNA and BERNSTEIN twenty years ago, little advance has been made in our knowledge of the comparatively slow oscillations occurring in circuits possessing ordinary amounts of inductance or capacity. It seems desirable just now that further experiments in this direction should be made, as Dr. FLEMING, in his Paper on Transformer Testing, read before the Institution of Electrical Engineers, has pointed out one or two cases in which the currents and potentials in ordinary alternate current circuits appear to be momentarily raised far above their normal amount, owing to the sudden closing or opening of a switch. An interesting communication by M. P. JANET on this subject will be found in another column. The student will find it profitable to compare these experimental curves with the theoretical ones worked out by Messrs. BEDELL and CREHORE, and given in *The Electrician* for November 4, 1892, p. 5. It remains for some skilled experimentalist to discover means for investigating the secondary current of an ordinary induction coil. Until this has been accomplished medical men must remain in ignorance as to the real character of that which they are pleased to call Faradic currents.

THE difference between a well-organised exhibition which supplies a long-felt want and one that no one needs is set forth in our Notes columns this week. The net outcome of the Edinburgh Exhibition of 1890 has been a call of nearly £27,000 upon the guarantors and a payment of 17s. 2d. in the pound to the creditors. At Frankfort subsidies have been repaid, and the exhibitors have received back about 5s. out of every pound paid for space.

IT is a matter of common knowledge, unsupported, we believe, by a single tittle of experimental evidence, that the worm will turn in the end, and that the last straw breaks the camel's back. Something of the kind appears to have happened to the Gas Light and Coke Company in connection with Col. HAYWOOD's thoughtful suggestion with regard to the City lighting. Glow-lamps indoors and arc-lights out of doors can be tolerated, says the gas Colossus, but combination gas and electric posts are things of naught. Seriously speaking, however, it was hardly to be expected that the gas people would fall in with the proposal that matters should be so arranged in the City alleys that gas could come to the rescue in the event of electricity failing. If the polite refusal of the Gas Company has the effect of putting the Electric Light Company on its mettle, and rendering breakdowns impossible, good will have come out of what was meant to be an evil.

THE moment the State undertakes commercial ventures things become mixed. The old Société Générale des Téléphones paid the Paris Municipality a handsome annual rental in return for being allowed to run its wires in the municipal subways. The Government, however, decline to follow this precedent, on the ground that since it has taken over the telephones, telephonic wires have been "translated," and are now *d'intérêt général*, and, therefore, exempt from taxation. The sum now owing to the Municipality looms large (in francs), amounting, as it does, to 737,000fr. A law suit is pending.

A CORRESPONDENT writes to us from New York to repudiate, on behalf of dynamo makers generally, the ironical criticisms which we recently reproduced from *Industries*. He fails to see the point of the remarks upon the extensive bed-plate, suitable enough for bolting to a rock, but ridiculous when hoisted on to two little slides. A planing machine is often occupied all day on the bottom of a bed-plate, which, after all, bears on four small surfaces; and yet we have only once seen a bed-plate designed to concentrate the weight on the slide rails. Our correspondent's argument for weight *versus* bolts is unsound, and is bad engineering. The eye-bolt seems to be a relic of the old Gramme and other dynamos. There were such strong temptations to lift them by rope slings round the upper magnet bars, that the provision of a convenient handle was imperative; but is this sufficient to account for its appearance on dynamos and on no other class of machinery?

Taunton.—The application of the Town Council for an Electric Lighting Order is to be inquired into by Sir T. W. P. Blomefield and Major Cardew, on Tuesday, the 13th inst.

Accrington.—The Town Council have decided to apply to the Local Government Board for sanction to borrow £10,000 for the establishment of an electric lighting central station.

Hertford.—The Town Council have resolved to put into operation the powers obtained more than a year ago, and to supply the electric current for public and private lighting.

The Durham College of Science.—On Monday last the Earl of Durham laid the foundation stone of a new wing of this College, and subsequently presented prizes to successful students.

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Telephone Amalgamation.—The *Glasgow Herald* of Tuesday last gives currency to some further rumours regarding the amalgamation of the National and the New Telephone Companies.

Patent Record.—A Correction.—In reference to Patent No. 19,886 in the list of applications for patents given in our last issue, we are asked to say that the patent was applied for by W. Fuller, *Cambridge*, and not London, as stated.

Personal.—Major C. B. Waller, late manager and secretary of the London Electric Supply Corporation, has been elected to a seat on the Board, and Mr. R. Stuart Bain has been appointed secretary while still acting as acccountant.

City and Guilds of London Institute.—The prizes and certificates in connection with the above Institute will be distributed by Dr. W. Anderson at the Merchant Taylors' Hall, on Monday next, December 12th, at 7:30 p.m. The Lord Mayor will preside.

The American Philosophical Society.—This Society proposes to celebrate next year the 150th anniversary of its foundation. Meetings are to be held in Philadelphia May 22nd to 26th, at which Papers may be offered by such delegates as may honour the Society with their presence.

Royal Institution.—At the general monthly meeting of this Institution, on Monday last, Mr. Nikola Tesla was elected a member. The special thanks of the members were returned to Mr. Ludwig Mond for a donation to the fund for carrying on investigations on liquid oxygen.

Windsor.—We learn that the local Electric Lighting Company are proceeding with the work of laying their mains in spite of the fact that they expose themselves to penalties for so doing without having previously put themselves in order with regard to both the Board of Trade and the Town Council.

Cheltenham.—At the last meeting of the Town Council reports were presented by the Electric Lighting Committee covering 25 demy 8vo pages. Prof. Ayrton, adviser to the Corporation, recommended the adoption of the alternate current system. After a long discussion the meeting adjourned until January.

Stafford.—At the monthly meeting of the Town Council on Tuesday last the report of the Electric Lighting Committee was presented. It recommended the Council to take active steps for the provision of electric light for the borough. The cost of an installation of 3,000 lights would be £20,000. The report was adopted.

Worcester.—On Tuesday last the Watch Committee's recommendation to purchase the Powick Mills, and land adjoining, for £5,000, for the purpose of utilising the stream for generating electricity; and that the Council should enter into a contract with the Brush Company for carrying out the work for a sum not exceeding £23,109, was carried.

The Royal Commission on Coast Communication.—The Queen has by Warrant under Royal Sign Manual, dated November 26th, placed the name of Mr. W. H. Preece, in lieu of that of Mr. Edward Graves, deceased, upon the Royal Commission to inquire into the question of telegraphic communication with lighthouses and light-vessels around the coasts of the United Kingdom.

The Edinburgh Exhibition of 1890.—The Edinburgh Exhibition Association of 1890 has been dissolved by order of the Court. The liquidators' note stated that it had been necessary to call up the guarantee fund of £26,559. The total assets recovered amounted to £44,943, including £26,099 of the guarantee fund, and £10,966 for buildings. A total dividend of 17s. 2d. per pound had been paid to creditors.

Electrical Communication with Lightships.—Mr. Houghton, superintendent of the New York Maritime Exchange, is, says *Industries*, urging the Lighthouse Board to have the lightships and outlying lighthouses connected with the life-saving stations on shore by telegraph, telephone, or otherwise. It is stated that at the coming Session of Congress a Bill will be introduced appropriating a sum of £10,000 to cover the expense of the necessary experiments.

The Frankfort Exhibition of 1891.—The Managing Committee of this Exhibition recently issued its final financial statement. The total disbursements were £64,400, and the total receipts £69,200, thus leaving a balance profit of £4,800. Of this balance 15 per cent. was handed over to Herr Oscar von Miller, in accordance with his agreement; and the surplus was devoted to repaying subsidisers and exhibitors, the latter obtaining about 25 per cent. of the sums originally paid by them for space.

Cable Interruptions and Repairs:

	Interrupted.		Repaired.
Macao-Hong Kong	Nov. 29, 1892	.....	Dec. 3, 1892
Nagasaki-Shanghai.....	Dec. 2, 1892	.....	Dec. 8, 1892

THE FOLLOWING CABLES ARE ACTUALLY INTERRUPTED:

	Date of Interruption.
Bolama-Bissao (communication with)	September 9, 1892
Cayenne-Vizeu	September 24, 1892
Ceara-Maranham	November 9, 1892
St. Thomé-Loanda *	November 24, 1892
Penang-Medan.....	December 1, 1892

* Communication with South Africa is still maintained by the East Coast route.

The Marseilles Telephone Service.—The Marseilles telephone exchange was lately moved into a new building, and ever since the unfortunate subscribers have suffered severely, the lines, says *La Lumière Electrique*, being entirely unserviceable. In addition, the new multiple switchboard was found to be defective in several respects. A few days ago 300 subscribers held an indignation meeting, the upshot being the nomination of a committee with instructions to force on a telephone strike unless satisfactory assurances are forthcoming of better service in the immediate future, together with a reduction of rentals. The subscribers on strike are to abstain from using the telephone, and to refuse to pay for services *not* rendered.

Nottingham.—At the meeting of the Town Council on Monday last the electric lighting question came up for consideration. The Special Committee recommended that £44,755 should be expended on land, buildings, and plant in connection with a 10,000 light plant. Mr. H. Talbot, electrical engineer to the Corporation, recommended in his report to the committee the adoption of the three-wire system in combination with storage batteries and continuous current transformers. He also recommended the use, wherever possible, of bare copper conductors and culverts, the contractor to be required to keep them in a satisfactory condition for three years at his own expense. The Town Council deferred any discussion on the matter.

Birmingham.—At the last meeting of the Town Council the Mayor stated that, as to the question of electric lighting, the Committee had carefully considered the matter, and had come to the conclusion that at present there was not sufficient evidence to enable them to decide whether it was advisable that they should proceed to obtain a Provisional Order for the purpose of electric lighting in the city at large, and until they had been able to come to a conclusion on that point they did not think it desirable to allow any Company to obtain further rights for the city. They also desired that the electric light should be at the disposal of the inhabitants at an early date, but they considered that if they were to come to a premature conclusion now they might do that which would hamper the town for all time.

The City and South London Railway.—At the last meeting of the Lambeth Vestry the General Purposes Committee reported that the Railway Company had given notice of their intention to commence the construction of their extension to Clapham Common, authorised by the Act of 1890. The Committee recommended that all reasonable facilities should be given to the Company to carry out their work, as the Company would then be able to complete their works as soon as possible. A memorial was, however, read from residents near the Swan protesting against the Electric Railway Company being allowed to erect a hoarding there to the damage of local trade. Eventually, the Committee's recommendation, together with the memorial, was referred back to the Committee for further consideration.

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The Telephone in Austria.—As previously stated in these columns, the Austrian Government will take over as from January 1st next the telephone exchanges in ten Austrian towns, now the property of the Telephone Company of Austria. The Government have decided to take over two additional towns since the last arrangement was reported, viz., Linz and Brünn, and negotiations are being carried on respecting the exchanges in Vienna, which, it is hoped, will result in an agreement placing the whole of the Austrian telephone system in the hands of the Government. Vienna possesses one single exchange, capable of serving 8,000 subscribers, all wires being underground. Up to the present time 6,500 subscribers are connected up, and the number of new subscribers averages from 150 to 200 per month.

Brighton.—At the meeting of the Town Council, on Thursday last week, the proposed extension of the electric lighting area in the town came up for discussion. Alderman Moon moved the adoption of the special reports of the Lighting and Works Committees, which together recommended an expenditure of £35,000. Mr. Arthur Wright presented a detailed account of the manner in which it was proposed to light the sea front, and also gave the estimated profits at the end of the first year's work as £108, in addition to £900 put by as a sinking fund. After a long discussion, the reports were adopted with only four dissentients. It is proposed to light the sea front by means of 40 arcs, to convert the Brighton system into a three-wire network, and to lay down additional engine, boiler, dynamo, and battery power.

Coventry and Electric Traction.—The General Works Committee of the Coventry Town Council have recently issued a report with regard to Mr. Graff Baker's proposed introduction of the overhead trolley system of electric traction into that town. A deputation visited Walsall and Leeds. The committee are of opinion that the poles and overhead wires would be such an obstruction, and would so much disfigure the streets of Coventry that they strongly advise that consent be refused to such a system in Coventry under any circumstances. Of the two systems, that at Walsall was by far the least objectionable. —— On Tuesday the report of the Committee was discussed with considerable heat, one member remarking, "If it was to be a question of steam or electricity with overhead wires then, by heavens, let them have electricity!" Ultimately the matter was adjourned.

A Monument to Gauss and Weber.—We have received a circular soliciting support on behalf of a scheme for erecting a monument in Göttingen to Charles Frederick Gauss and William Weber, world-renowned co-workers in the then but little explored field of electricity and magnetism. It is needless to say that this proposal to perpetuate the memory of the life's labours of Gauss and Weber deserves the ungrudging assistance of all physicists and especially of all electricians. The acting committee is composed of Prof. Klein, E. v. Meier (Curator of the University), F. Merkel (Pro-rector of the University), G. Merkel (Over-burgomaster), Profs. E. Riecke, E. Schering, W. Schur, W. Voigt, H. Weber, and S. Benfey (banker), and it is to the last-mentioned that subscriptions should be addressed (S. Benfey, Bankgeschäft, Göttingen). The list will remain open until April 1, 1893.

"The Electrician" Contributors' Dinner.—On Thursday evening last week a dinner was given at the Hotel Métropôle by the proprietors of *The Electrician* to past and present contributors. Sir John Pender presided, and, in addition to the proprietors and editorial staff, amongst those present were the Marquis of Tweeddale, Sir George Elliot, Mr. W. H. Preece, Prof. D. E. Hughes, M. Despecher, Mr. George Draper, Mr. H. C. Fischer, Mr. J. C. Lamb, Major Flood Page, Mr. John Muirhead, Mr. J. B. Verity, and other guests. Letters of regret were received at the last moment from Prof. Ayrton, Prof. Silvanus Thompson, Mr. Fletcher Moulton, Mr. Sydney Morse, Mr. J. Wilson Swan, Mr. Frank Bailey, and Mr. Shelford Bidwell. The contributors included Lord Kelvin, Lieutenant Bacon, R.N., Messrs. G. L. Addenbrooke, B. Blount, E. T. Carter, J. C. Chapman, C. W. S. Crawley, R. E. B. Crompton, Prof. J. A. Fleming, Prof. J. Perry, Messrs. W. Geipel, G. H. Robertson, H. A. Saunders, G. F. C. Searle, Dane Sinclair, A. T. Snell, Dr. W. E. Sumpner, Mr. J. Swinburne, &c.

The City Lighting.—At the meeting of the City Commissioners of Sewers on Tuesday, Colonel Haywood said he had applied to the Gas Light and Coke Company with regard to utilising the existing lamp-posts in the side streets for incandescent lights in such a way that if the electric light should fail the gas would still be available. The Company had replied, pointing out the difficulties under which they at present were carrying on the street lighting. They were being prosecuted by the City authorities for the impurity of the gas supplied to some of the lamps, which impurity was due to the presence of sulphuretted hydrogen owing to the stagnant gas in the disused gas pillars and pipes. Again, lamps were continually being lighted by unauthorised persons in consequence of the failure of the electric light, and by mischievous people passing on omnibuses. The Company thought the Commissioners would recognise the fact that they had done all in their power to facilitate the improved lighting of the streets even at considerable cost to themselves, and notwithstanding that the concessions made from time to time were in favour of an opposition mode of lighting. The Company could not allow their fittings to remain as suggested, but they proposed, as soon as the lamp-posts were utilised for the electric light, to vacate them altogether. The letter was referred to the Streets Committee.

Electricity in South African Gold Mines.—At the second ordinary general meeting of the shareholders in the Champ d'Or (Transvaal) French Gold Mining Company, on Friday last, the Chairman, Mr. E. Montfort, made the following interesting statement:—"Amongst other things, we might mention to you that we have been the pioneers of the introduction of electricity as a motive power for mines in the district. In the month of September last we introduced on our mine the first permanent plant for the electrical transmission of power, and since that time it has been running without stopping either night or day. Since its inauguration the plant has been increased, and now consists of two dynamos, driven from the mill countershafting, and connected by overhead copper wires to the motors at the reservoir, which is 700ft. from the mill. These motors drive the pumps and supply water for the whole mill. A starting switch at the mill allows the motor pump to be started, stopped, or regulated in speed, so that no attention is required at the motors or pumps. Thus a considerable saving of labour and wear and tear is effected. Previously the pumps had been driven by a wire rope, which was always giving trouble, and necessitated frequent stoppages of the mill for repairs, and it also wasted considerably more power. The estimated saving and gain from this source alone is reckoned at the rate of nearly £4,000 per annum."

Electric Lighting in Berlin.—The report of the Berliner Elektricitätswerke gives the following table, showing the consumption of current from its stations since its commencement in August, 1885:—

—	Private lighting (lamp-hours).	Street lighting.	Motors for factories (kilowatt-hours).
Aug.-Dec., 1885..	635,800	—	—
1886	5,052,024	50,890	—
1887-88, 1½ years.	11,932,000	104,682	—
1888-89	19,563,000	332,674	12,956
1889-90	41,850,000	361,052	69,591
1890-91	59,240,000	363,438	274,457
1891-92	80,524,000	361,808	186,611

The falling off in the item, "Motors for factories, &c.," is due to the fact that a large undertaking which formerly used the current has given up its factory in Berlin. The following figures refer to the total number of lights installed in Berlin:—

Date.	Arcs.	Glow lamps.
December 31, 1890	4,944	80,788
December 31, 1891	6,203	108,258

The increase in the number of lamps installed, taking arcs in proportion to their candle-power, is about 32 per cent. as against 29 per cent. last year. The increase in the consumption of gas during the same period was about 17 per cent.

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ELECTROMAGNETIC THEORY.—XL.

BY OLIVER HEAVISIDE.

(*Continued from page 61.*)

§ 174. In the last paragraph I came dangerously near to overstepping the imposed limits of my treatment of vectors, which is meant to present the subject merely in the form it assumes in ordinary physical mathematics. If we were to ignore the physical applications, and treat vector algebra as a branch of pure mathematics, regardless of practical limitations, there would be no bounds to the investigation of the subject. It will now be convenient to wind up with a few remarks on the previous, and on the nature and prospects of vector analysis.

Since we live in a world of vectors, an algebra or language of vectors is a positive necessity. At the commencement of this chapter, §§ 97 to 102, I made some general remarks on the nature of cartesian analysis, vector analysis, and quaternions; and the reader is recommended to read them again from a more advanced point of view. Then, he was supposed to know next to nothing about vectors. Now, although he need not have absorbed all the special applications of vector algebra that have been given since, it may be presumed that he has acquired a general knowledge of the principles of the subject. There is no longer any question as to the desirability and utility of vectorial analysis. The present question is rather as to the form the vector algebra should take. On this point there is likely to be considerable difference of opinion, according to the point of view assumed, whether with regard to physical applications, or abstract mathematical theory. Let us then, to begin with, summarise the leading points in the algebra given above.

First, there is the idea of the vector as a distinct entity. Nearly everyone nowadays knows and appreciates the idea. And it is a noteworthy fact that ignorant men have long been in advance of the learned about vectors. Ignorant people, like Faraday, naturally think in vectors. They may know nothing of their formal manipulation, but if they think about vectors, they think of them *as* vectors, that is, directed magnitudes. No ignorant man could or would think about the three components of a vector separately, and disconnected from one another. That is a device of learned mathematicians, to enable them to evade vectors. The device is often useful, especially for calculating purposes, but for general purposes of reasoning the manipulation of the scalar components instead of the vector itself is entirely wrong.

In order to facilitate the reading of vector work, the vector has its special type, thus **E**. This Clarendon, or any very similar neat black type (not block letters), is meant to mark the vector, always the vector, and never anything else, with the obvious exception of headlines that speak for themselves. Also, to economise letters, and ease the strain on the memory, the same letter suitably modified serves for the tensor, the ort, and the three scalar components. Thus E is the tensor, or size, and $\mathbf{E}_1$ the ort (signifying the orientation) so that $\mathbf{E}=\mathrm{E}\mathbf{E}_1$; whilst the scalar components referred to rectangular axes are E_1, E_2, E_3. The physical dimensions may be most conveniently merged in the tensor E. Every vector has its species. The one we are most familiar with is the space vector, or straight line joining two points, or more strictly the displacement from one point to another. But all kinds of vector magnitudes are formally similar in having size and ort, and therefore, when considered vectorially, obey the same laws. The properties of the space vector therefore supply us with the rules or laws of vector algebra.

The addition and subtraction of vectors is embodied in the assertion (whose truth is obvious) that the sum of any number of vectors making (when put end to end) a circuit is zero; or, in another form, all the various paths by which we may pass from one point to another are vectorially equivalent, namely, to the vector straight from point to point. Every vector equation therefore expresses this fact. Every term is a vector; and if all the vectors be put on one side, with zero on the other, we express the circuital property; whilst if we have vectors on both sides of the equation, we assert the vectorial equivalence of two paths.

Any vector **A** and its reciprocal $\mathbf{A}^{-1}$ have the same ort, and their tensors are reciprocal to one another.

Coming next to combinations of vectors of the nature of products, we find they are of two kinds, scalar and vector. The scalar product of **E** and **F** is denoted by **EF**, and the vector product by V**EF**. Their tensors are $\mathrm{EF}\cos\theta$ and $\mathrm{EF}\sin\theta$ respectively, θ being the included angle. The scalar product is directionless; the ort of the vector product is that of the normal to the plane of **E** and **F**. The tensor and ort of V**EF** are $\mathrm{V}_0\mathbf{EF}$ and $\mathrm{V}_1\mathbf{EF}$.

The justification for the treatment of the scalar and vector products as fundamental ideas in vector algebra is to be found in the distributive property they possess, thus,

$$(\mathbf{a}+\mathbf{b}+\ldots)(\mathbf{c}+\mathbf{d}+\ldots)=\mathbf{ac}+\mathbf{ad}+\mathbf{bc}+\mathbf{bd}+\ldots, \quad . \quad (155)$$

$$\mathrm{V}(\mathbf{a}+\mathbf{b}+\ldots)(\mathbf{c}+\mathbf{d}+\ldots)=\mathrm{V}\mathbf{ac}+\mathrm{V}\mathbf{ad}+\mathrm{V}\mathbf{bc}+\mathrm{V}\mathbf{bd}+\ldots, \quad (156)$$

which hold good for any number of vectors. In the first equation the manipulation is as in common algebra, in all respects. In the second, in all respects save one; for the reversal of the order of the vectors in a vector product negatives it, thus, $\mathrm{V}\mathbf{ac}=-\mathrm{V}\mathbf{ca}$.

Here we have very complex relations of geometry brought down to elementary algebra. As Prof. Gibbs has remarked, the scalar and vector product, which consist of the cosine and sine of trigonometry combined with certain other simple notions, are "incomparably more amenable" to algebraical treatment than the sine and cosine themselves.

When we go on to combinations in threes, fours, &c., we find it is the same thing over again in various forms. Thus **c.ab** and **c**V**ab** and V**c**V**ab** define themselves by the above, being **ab** times **c**, and the scalar and vector products of **c** and V**ab** respectively.

Similarly with four vectors, as in **dc.ab**, the product of **dc** and **ab**; **dc.**V**ab**, which is **dc** times V**ab**; **d.c**V**ab**, which is **c**V**ab** times **d**; **d**V**c**V**ab** and V**d**V**c**V**ab**, which are the scalar and vector products of **d** and V**c**V**ab**; V**dc**V**ab** and VV**dc**V**ab**, which are the scalar and vector products of V**dc** and V**ab**. Combinations of two vectors are universal, and those of three are pretty frequent, but those of four are exceptional. But it should be noted that the scalar and vector product of two vectors are involved throughout, no new idea being introduced when more than two vectors are concerned.

When we pass on to analysis, we find just the same vector algebra to be involved. Vectors are differentiated with respect to scalars to make new vectors in the same way as scalars, and the ideas connected with differentials (infinitesimal) and differential coefficients are essentially the same for vectors as for scalars. We never require to differentiate a vector with respect to a vector, and there is a very good reason for it, because the operation is an indeterminate one.

The fictitious vector ∇ is omnipresent in tridimensional analysis. It only differs from a vector in being a differentiator as well, so that it follows vector rules combined with other functions. With it are associated the ideas of the slope of a scalar, and the divergence and curl of a vector, with corresponding important theorems relating to the transition from line to surface, and from surface to volume summations. The theory of potentials in its broad sense is also involved in the mathematics of ∇, including the relations, direct and inverse, of potential, slope, curl, and divergence.

As for the linear operator, that is only the scalar and vector product system again in a special form. Professor Gibbs's dyadic is a useful idea, and I have modified his notation to suit the rest.

It is neither necessary nor desirable that a student should know all that is sketched out above before he makes practical use of it. For vector analysis, like many other things, is best studied in the concrete application. The principles may be very concisely stated, being little more than explanations of the scalar and vector product, with some conventions about notation. A student might learn this by heart, and be little the better for it. He must sit down and work if he wants to assimilate it usefully. He may work with scalar products only to begin with, for quite a large ground is covered thereby. When familiarised with the working of vectors by practice so far as the scalar product goes, the further introduction of the

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vector product will come comparatively easy. The former knowledge is fully utilised, and also receives a vast extension of application. For the vector product is a powerful engine, which, with its companion the scalar product, is fully capable of working elaborate mathematical analysis in a concise and systematic manner. The student need not trouble about linear operators at first. He will grow into them. It is far more important that he should understand the operation of ∇ as a vector, and its meaning in the space variation of functions.

§ 175. Now, a few words regarding Quaternions. It is known that Sir W. Rowan Hamilton discovered or invented a remarkable system of mathematics, and that since his death the quaternionic mantle has adorned the shoulders of Prof. Tait, who has repeatedly advocated the claims of Quaternions. Prof. Tait in particular emphasises its great power, simplicity, and perfect naturalness, on the one hand; and on the other tells the physicist that it is exactly what he wants for his physical purposes. It is also known that physicists, with great obstinacy, have been careful (generally speaking) to have nothing to do with Quaternions; and, what is equally remarkable, writers who take up the subject of vectors are (generally speaking) possessed of the idea that Quaternions is not exactly what they want, and so they go tinkering at it, trying to make it a little more intelligible, very much to the disgust of Prof. Tait, who would preserve the quaternionic stream pure and undefiled. Now, is Prof. Tait right, or are the defilers right? Opinions may differ. My own is that the answer all depends upon the point of view.

If we put aside practical application to physics, and look upon Quaternions entirely from the quaternionic point of view, then Prof. Tait is right, thoroughly right, and Quaternions furnishes a uniquely simple and natural way of treating *quaternions*. Observe the emphasis.

For consider what a quaternion is. It is the operator which turns one vector to another. For instance, we have

$$\mathbf{B} = \mathbf{A}.\mathbf{A}^{-1}\mathbf{B} + \mathbf{B} - \mathbf{A}^{-1}.\mathbf{AB}$$
$$= \mathbf{A}^{-1}\mathbf{B}.\mathbf{A} + \mathrm{V}\mathbf{A}\mathrm{V}\mathbf{B}\mathbf{A}^{-1},$$

identically. Or,

$$\mathbf{B} = (\mathbf{A}^{-1}\mathbf{B} + \mathrm{V}.\mathrm{V}\mathbf{A}^{-1}\mathbf{B})\mathbf{A}. \quad . \quad . \quad . \quad (157)$$

Here the operator in the brackets, say q, depends upon **A** and **B** in such a way that it turns **A** to **B**; thus, $\mathbf{B} = q\mathbf{A}$. It is a quaternion. It has a scalar and a vector part. The general type of a quaternion is

$$q = w + \mathrm{V}\mathbf{a}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (158)$$

where w is any scalar, and **a** is any vector. Since we know the laws of scalar and vector products we may readily deduce the laws of quaternions should we desire to do so. But we shall find that the above notation, though so well suited for vectors, is entirely unfitted for displaying the merits of quaternions. To do this we must follow Hamilton, and make the quaternion itself the master, and arrange the notation and conventions to suit it, regardless of the convenience of the vector and the scalar. The result is the singularly powerful algebra of Quaternions. To give a notion of its power and essential simplicity we may remark that the product of any number of quaternions, p, q, r, s, say, in the order named, is independent of the manner of association in that order. That is,

$$pqrs = p(qrs) = (pq)(rs) = (pqr)s. \quad . \quad . \quad (159)$$

This remarkable property is the foundation of the simplicity of the quaternionic algebra. It is uniquely simple. No algebra of vectors can ever match it, and Prof. Tait is quite right in his laudations from the quaternionic point of view.

But when Prof. Tait vaunts the perfect fitness and naturalness of quaternions for use by the physicist in his inquiries, I think that he is quite wrong. For there are some very serious drawbacks connected with quaternions, when applied to vectors. The quaternion is regarded as a complex of scalar and vector, and as the principles are made to suit the quaternion, the vector itself becomes a degraded quaternion, and behaves as a quaternion. That is, in a given equation, one vector may be a vector, and another be a quaternion. Or the same vector in one and the same equation, may be a vector in one place, and a quaternion (versor, or turner) in another. This amalgamation of the vectorial and quaternionic functions is very puzzling. You never know how things will turn out.

Again, the vector having to submit to the quaternion, leads to the extraordinary result that the square of every vector is a *negative* scalar. This is merely because it is true for quadrantal versors, and the vector has to follow suit. The reciprocal of a vector, too, goes the wrong way, merely to accommodate versors and quaternions.

And yet this topsyturvy system is earnestly and seriously recommended to physicists as being precisely what they want. Not a bit of it. They don't want it. They have said so by their silence. Common sense of the fitness of things revolts against the quaternionic doctrines about vectors. Nothing could be more unnatural.

Are they even convenient? Not to the physicist. He is very much concerned with vectors, but not at all, or at any rate scarcely at all, with quaternions. The vector algebra should satisfy his requirements, not those of the quaternion. Let the quaternion stand aside. The physicist wants, above all, to have clear ideas, and to him the double use of vectors, as vectors and versors, combined with unnatural properties of vectors to suit quaternions, is odious. Once a vector, always a vector, should be a cardinal axiom.

If the usual investigations of physical mathematics involved quaternions, then the physicist would no doubt have to use them. But they do not. If you translate physical investigations into vectorial language, you do not get quaternions; you get vector algebra instead. Even Prof. Tait's treatise teaches the same lesson, for in his physical applications the quaternion is hardly ever concerned. It is vector algebra, although expressed in the quaternionic notation.

Vectors should be treated vectorially. When this is done, the subject is much simplified, and we are permitted to arrange our notation to suit physical requirements. This is a very important matter. Most calculations are, and always will be, scalar calculations, that is, according to common algebra. The special extensions to tridimensional space involving vectors should therefore be done so as to harmonise with the scalar calculations, and so that only one way of thinking is required, instead of two discrepant ways, and so that mutual conversion of scalar and vector algebra is facilitated. The system which I expound I believe to represent what the physicist wants, at least to begin with. It is what I have been expounding, though rather by example than precept, since 1882. There is only one point where I feel inclined to accept a change, viz., to put a prefix before the scalar product, say Sab instead of **ab**, to balance Vab. Not that the S prefix is of any use in the algebra as I do it, but that mathematical writers on vectors seem to want to put the scalar and vector parts together to make a general or complete product, say $\mathrm{Q}\mathbf{ab} = \mathrm{S}\mathbf{ab} + \mathrm{V}\mathbf{ab}$. The function Q**ab**, however, does not occur in physical applications, which are concerned with the scalar and vector products separately. If I could omit the V as well as the S I would do so; but some sign is necessary, and the V of Hamilton is not very objectionable.

Gibbs denotes the scalar and vector products by $\alpha.\beta$ and $\alpha \times \beta$, using Greek letters. In my experience this is not a good way when worked out. It is hard to read, and is in serious conflict with the common use of dots and crosses in algebra, which use has to be given up. I use dots in their common meaning, either as multipliers or separators.

Prof. Macfarlane, who is the latest vectorial propagandist, denotes the scalar and vector products by cos **ab** and Sin **ab**. The trigonometrical origin is obvious. But, on this point, I would refer the reader to the equations (155) (156) above, and to the very trenchant remark of Prof. Gibbs which I have already quoted, as to the incomparably greater amenity of the scalar and vector product to algebraical treatment than the trigonometrical functions themselves. The inference is that vector algebra is far more simple and fundamental than trigonometry, and that it is a mistake to base vectorial notation upon that of a special application thereof of a more complicated nature. I should rather prefer sca **ab** and vec **ab**. Better still, Sab and Vab, with the understanding that the S may be dropped unless specially wanted.

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Macfarlane has also a peculiar way of treating quaternions, about which I will express no opinion at present, being doubtful whether, if the use of quaternions is wanted, *the* quaternionic system should not be used, with, however, a distinction well preserved between the vector and the quaternion, by special type or otherwise.

I am in hopes that the Chapter which I now finish may serve as a stopgap till regular vectorial treatises come to be written suitable for physicists, based upon the vectorial treatment of vectors. The quaternionists want to throw away the "cartesian trammels," as they call them. This may do for quaternions, but with vectors would be a grave mistake. My system, so far from being inimical to the cartesian system of mathematics, is its very essence.

(To be continued.)

EXPERIMENTS ON SLOW ELECTRICAL OSCILLATIONS.

In a recent number of the *Comptes Rendus* appears an article by M. P. Janet, describing an investigation of the electrical oscillations occurring in conductors when the circuit, of which they form a part, is subjected to some sudden change.

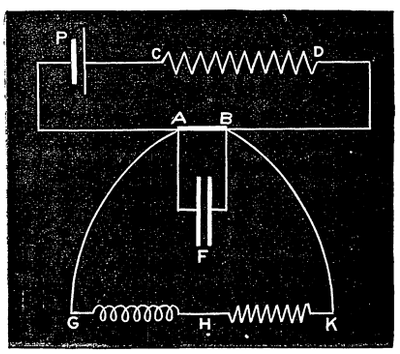

FIG. 1.

The arrangement of apparatus used by M. Janet is indicated in Fig. 1. A battery, P, was joined up in circuit with a high

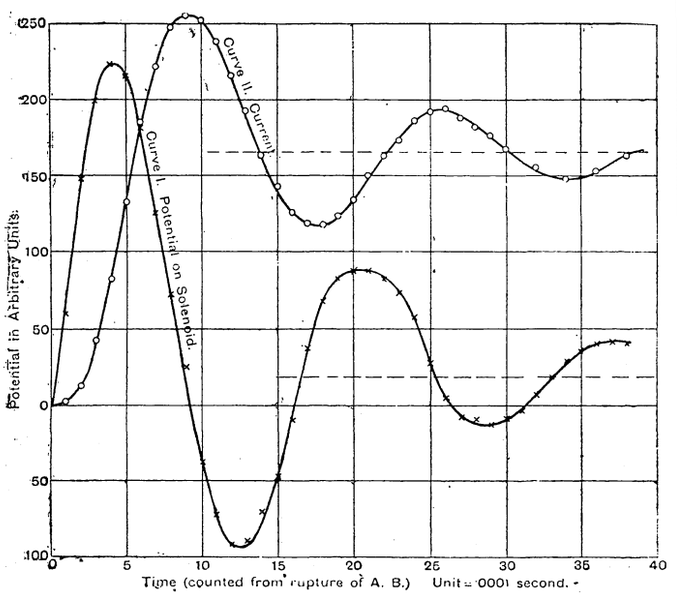

FIG. 2.

resistance of about 20,000 ohms between the points C and D, and also with a short-circuiting connector, A B. The points A B were connected with the terminals of a condenser, F, of about one-tenth of a microfarad, and also with a series combination of a solenoid, G H, and a non-inductive resistance, H K. The resistance of the solenoid was 228 ohms, and its self-induction 0·6 henry. The resistance of H K was 272 ohms.

When the short-circuit piece A B is removed, electric oscillations are set up in the circuits, and these have been investigated by M. Janet with the aid of a special contact maker, devised some years ago by M. Mouton, and used by him in his well-known induction researches. This apparatus is worked at a regular rate by a water motor, and makes two contacts periodically at an interval of time from each other, the amount of which can be adjusted at will. The first contact was arranged to remove the connector A B, and the second to connect the terminals of a condenser to two points of the circuit whose potential was under investigation. The charge of this condenser, measured subsequently in the usual way with a ballistic galvanometer, indicated the instantaneous value of the voltage existing between the points to which the condenser had been momentarily connected. The interval between the two contacts was varied in different experiments from 0·0001sec. to 0·0038sec., and the measured potentials (in arbitrary units) between the points G H and H K are plotted as ordinates in the curves shown in Fig. 2, the abscissæ denoting the time interval after the rupture of the contact A B. As the resistanee H K was non-inductive, the voltage between these points represents the current flowing in the conductor G H K. This current is represented by Curve II., the voltage on the solenoid being denoted by Curve I. The dotted lines represent the steady value attained by the potentials after the electrical oscillations have subsided. The curves show that the oscillations die out after about 0·004sec.

THE COST OF ELECTROLYTIC ALKALI AND BLEACH.

Seeing that the whole industrial importance of the numerous schemes that are now "in the air" for the production of alkali and bleach by electrolysis depends upon the cost of the products as compared with those manufactured by the older purely chemical processes, it is not a little significant that some mistiness has hitherto enveloped this most vital point. It is, therefore, with satisfaction that we welcome the estimate made by Messrs. Cross and Bevan, who have been intimately associated with this matter for some time past, and put forward in a Paper read by them before the London Section of the Society of Chemical Industry on December 5th. The figures which we are about to give, have, we understand, been derived from the data afforded by the working of the Le Sueur process on a scale of half a ton of bleach per day. The other method dealt with in the Paper was the Greenwood process, and in its description nothing novel to the readers of *The Electrician* was given, but its rival having been less freely brought into public notice, a short description of the peculiarities of the plant may not be superfluous. In the first place the diaphragm is horizontal, or nearly so, unlike that used by Greenwood, which is vertical, and below it is the cathode, which takes the form of an iron ring filled in with iron wire gauze. Although more nearly horizontal than vertical, and therefore justifying the distinction which we have drawn, the cathode has sufficient slope to facilitate the escape of the evolved hydrogen, which is always more or less a trouble in processes for the electrolysis of brine, and would be better suppressed if a good plan for so doing could be devised. The only other points claiming notice are the nature of the diaphragm, composed of parchment-paper, and asbestos, cemented together with coagulated blood albumen, and the anode, which is made of retort scurf, not cut to any regular size or shape, but used in rough rods fused into a leaden cap in the manner commonly adopted for making certain primary battery connections. Both the anode and the diaphragm are not claimed to be permanent parts of the plant upon which depreciation only has to be reckoned, as they need renewal every six or eight weeks and every 48 hours respectively.

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The estimate of cost deals first with that of a horse-power hour, and in view of the considerable discussion as to what this really is or might be, we append the figures given by Messrs. Cross and Bevan. The plant is one of two engines of 1,200 I.H.P. each, and the cost per 24 hours is thus made up:—

Coal, 2·5lb. per horse-power hour, 64 tons at 10s.....	£32	0	0
Labour, 8 day men and 8 night men at 30s. per week.	4	0	0
Depreciation at 10% for 300 days per year—on engines £10,000, on boilers £7,000.....	5	14	0
Oil, waste, &c.	1	0	0
	£42	14	0

Therefore, this sum being the cost of 2,400 H.P. for 24 hours, the cost of 1 H.P.H. comes out at 0·178d., a result fairly concordant with Dr. John Hopkinson's estimate of one-third of a penny as the price at which Board of Trade unit should be produced.

The loss incurred in the conversion of mechanical into electrical energy and by leakage of current is taken as 17 per cent., so that 2,000 E.H.P. would be delivered at the terminals of the electrolysers. The pressure necessary for economical working is 4·5 volts, which is nearly double that which would be predicted from *a priori* considerations. This means a sacrifice of something like one-half of the possible amount of chemical decomposition, but with the internal resistance of the electrolytic cells as high as at present, it seems inevitable. In short, just as in the electrolytic refining of copper, either power must be wasted, or much capital locked up, and there is a certain intermediate position, varying with local conditions, that will be best to adopt. Reverting to the estimate, it is plain that 2,000 E.H.P. will provide 331,555 amperes at 4·5 volts, so that there are for the work of decomposition, 7,957,320 ampere-hours available in the day of 24 hours. As each ampere-hour is theoretically capable of producing 0·00292lb. of chlorine and 0·00331b. of caustic soda, it follows (taking an efficiency of 80 per cent.) that the output per day of 24 hours will be 8·3 tons of chlorine, equal to 22·43 tons of bleaching powder and 9·378 tons of caustic soda. The bleach, at the present selling price, £7. 10s. per ton, would be worth £168, and the caustic soda, reckoned at £12 per ton, £112. 10s., so that the total value would be £280. 10s. Having regard to the fact that in the Le Sueur process it is not proposed to turn out bleach but carbonate, by precipitating the liquor containing the caustic, with carbon dioxide, the value of the 12·428 tons of carbonate produced would be (at £5. 15s.) £71. 10s., and the total price of the products £239. 10s. The cost of production of these quantities may be arrived at from the figures given below:—

18 tons of salt at 12s.....		£10	16	0
12 tons of lime at 12s. ...		7	4	0
Power, 57,600 horse-power hours at one farthing		60	0	0
Labour		10	0	0
Casks and packages.....		18	0	0
Depreciation at 10 per cent. for 300 days on—				
Electrolysers	£12,000			
Dynamos	8,000			
Tanks, pumps, buildings.....	10,000			
	£30,000	10	0	0
Superintendence		1	0	0
General expenses.....		4	0	0
		£121	0	0

This does not include the cost of renewal of the diaphragms and anodes of the Le Sueur process, which is stated to reach what seems the extravagant sum of £30 per day, bringing the total cost of production up to £151, or £153, if the cost of carbonating the caustic liquor be taken into account.

Whatever may be thought of the items of this estimate, and some of them are, we conceive, debatable enough, it is at least the most serious and straightforward attempt that has yet been made to ascertain what is actually the margin of profit in electrolytic alkali making, using data that are of higher grade than those products of the imagination which so frequently adorn the pages of a prospectus, and have even been known to find their way into documents of less admittedly *ex parte* character

THE BOARD OF TRADE ELECTRICAL STANDARDS COMMITTEE.

SUPPLEMENTARY REPORT TO THE PRESIDENT OF THE BOARD OF TRADE.

Subsequently to the presentation of our former report* to Sir Michael Hicks-Beach in July, 1891, we were informed that it was probable that the German Government would shortly take steps to establish legal standards for use in connection with electrical supply, and that, with a view to secure complete agreement between the proposed standards in Germany and England, the Director of the Physico-Technical Imperial Institute at Berlin, Prof. Von Helmholtz, with certain of his assistants, proposed to visit England for the purpose of making exact comparisons between the units in use in the two countries, and of attending the meeting of the British Association which was to take place in August in Edinburgh. Having regard to the importance of this communication it appeared desirable that the Board of Trade should postpone the action recommended in our previous report until after Prof. Helmholtz's visit.

That visit took place early in August, and there was a very full discussion of the whole subject at the meeting of the British Association in Edinburgh, at which several of our number were present. The meeting was also attended by Dr. Guillaume, of the Bureau International des Poids et Mesures, and Prof. Carhart, of the University of Michigan, U.S.A., who were well qualified by their scientific attainments to represent the opinion of their respective countries. It appeared from the discussion that a few comparatively slight modifications of the resolutions included in our previous report would tend to secure international agreement. An extract from the report† of the Electrical Standards Committee of the British Association embodying the results of this discussion was communicated to us by the Secretary, and will be found in the Appendix to this report.

Having carefully reconsidered the whole question in view of this communication, and having received the report of the subcommittee mentioned in Resolution 14 of our previous report, we now desire, for the resolutions contained in that report, to substitute the following:—

Resolutions.

1. That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by Her Majesty in Council as Board of Trade standards.

2. That the magnitudes of these standards should be determined on the electro-magnetic system of measurement with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade.

3. That the standard of electrical resistance should be denominated the ohm, and should have the value 1,000,000,000 in terms of the centimetre and second.

4. That the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass of a constant cross sectional area, and of a length of 106·3 centimetres may be adopted as one ohm.

5. That a material standard, constructed in solid metal, should be adopted as the standard ohm, and should from time to time be verified by comparison with a column of mercury of known dimensions.

6. That for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed, which should be periodically compared with the standard ohm.

7. That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and submultiples of the ohm.

8. That the value of the standard of resistance constructed by a Committee of the British Association for the Advancement of Science in the years 1863 and 1864, and known as the British Association unit, may be taken as 0·9866 of the ohm.

9. That the standard of electrical current should be denominated the ampere, and should have the value one-tenth (0·1) in terms of the centimetre, gramme, and second.

10. That an unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the specification attached to this report, deposits silver at the rate of 0·001118 of a gramme per second, may be taken as a current of one ampere.

11. That an alternating current of one ampere shall mean a current such that the square root of the time average of the square of its strength at each instant in amperes is unity.

* See *The Electrician*, Vol. XXVII., September 4, 1891, p. 491.

† This extract consists of four resolutions and some addenda, which were published in *The Electrician*, Vol. XXIX., August 26, 1892, p. 462.

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12. That instruments constructed on the principle of the balance, in which by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current whether unvarying or alternating.

13. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

14. That the electrical pressure at a temperature of 15°C. between the poles or electrodes of the voltaic cell known as Clark's cell, prepared in accordance with the specification attached to this report, may be taken as not differing from a pressure of 1·434 volts by more than one part in one thousand.

15. That an alternating pressure of one volt shall mean a pressure such that the square root of the time-average of the square of its value at each instant in volts is unity.

16. That instruments constructed on the principle of Lord Kelvin's quadrant electrometer used idiostatically, and, for high pressures, instruments on the principle of the balance, electrostatic forces being balanced against a known weight, should be adopted as Board of Trade standards for the measurement of pressure, whether unvarying or alternating.

(Signed) COURTENAY BOYLE. | G. CAREY FOSTER.
KELVIN. | R. T. GLAZEBROOK.
P. CARDEW. | J. HOPKINSON.
W. H. PREECE. | W. E. AYRTON.
RAYLEIGH. | T. W. P. BLOMEFIELD

November 29, 1892. (*Secretary*).

SPECIFICATION REFERRED TO IN RESOLUTION 10.

In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time the time average of the current, or if the current has been kept constant, the current itself can be deduced.

In employing the silver volatmeter to measure currents of about one ampere the following arrangements should be adopted. The kathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 cm. in diameter, and from 4 to 5 cm. in depth. The anode should be a plate of pure silver some 30 sq. cm. in area, and 2 or 3 mm. in thickness. This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plate at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the kathode, the anode should be wrapped round with pure filter paper, secured at the back with sealing wax. The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

Method of Making a Measurement.

The platinum bowl is washed with nitric acid and distilled water, dried by heat, and then left to cool in a desiccator. When thoroughly dry it is weighed carefully. It is nearly filled with the solution, and connected to the rest of the circuit by being placed on a clean copper support to which a binding screw is attached. This copper support must be insulated. The anode is then immersed in the solution so as to be well covered by it and supported in that position; the connections to the rest of the circuit are made. Contact is made at the key, noting the time of contact. The current is allowed to pass for not less than half an hour, and the time at which contact is broken is observed. Care must be taken that the clock used is keeping correct time during this interval. The solution is now removed from the bowl, and the deposit is washed with distilled water, and left to soak for at least six hours. It is then rinsed successively with distilled water and absolute alcohol, and dried in a hot air bath at a temperature of about 160°C. After cooling in a desiccator, it is weighed again. The gain in weight gives the silver deposited.

To find the current in amperes, this weight, expressed in grammes, must be divided by the number of seconds during which the current has been passed, and by 0·00118. The result will be the time-average of the current, if during the interval the current has varied.

In determining by this method the constant of an instrument the current should be kept as nearly constant as possible, and the readings of the instrument taken at frequent observed intervals of time. These observations give a curve from which the reading corresponding to the mean current (time-average of the current) can be found. The current, as calculated by the voltameter, corresponds to this reading.

SPECIFICATION REFERRED TO IN RESOLUTION 14.

Definition of the Cell.

The cell consists of zinc and mercury in a saturated solution of zinc sulphate and mercurous sulphate in water, prepared with mercurous sulphate in excess, and is conveniently contained in a cylindrical glass vessel.

Preparation of the Materials.

1. *The Mercury.*—To secure purity it should be first treated with acid in the usual manner, and subsequently distilled in vacuo.

2. *The Zinc.*—Take a portion of a rod of pure redistilled zinc, solder to one end a piece of copper wire, clean the whole with glass paper, carefully removing any loose pieces of the zinc. Just before making up the cell dip the zinc into dilute sulphuric acid, wash with distilled water, and dry with a clean cloth or filter paper.

3. *The Zinc Sulphate Solution.*—Prepare a saturated solution of pure ("pure re-crystallised") zinc sulphate by mixing in a flask distilled water with nearly twice its weight of crystals of pure zinc sulphate, and adding zinc oxide in the proportion of about 2 per cent. by weight of the zinc sulphate crystals to neutralise any free acid.* The crystals should be dissolved with the aid of gentle heat, but the temperature to which the solution is raised should not exceed 30°C. Mercurous sulphate treated as described in 4 should be added in the proportion of about 12 per cent. by weight of the zinc sulphate crystals, and the solution filtered, while still warm, into a stock bottle. Crystals should form as it cools.

4. *The Mercurous Sulphate.*—Take mercurous sulphate, purchased as pure, and wash it thoroughly with cold distilled water by agitation in a bottle; drain off the water, and repeat the process at least twice.* After the last washing drain off as much of the water as possible. Mix the washed mercurous sulphate with the zinc sulphate solution, adding sufficient crystals of zinc sulphate from the stock bottle to ensure saturation, and a small quantity of pure mercury. Shake these up well together to form a paste of the consistence of cream. Heat the paste, but not above a temperature of 30°C. Keep the paste for an hour at this temperature, agitating it from time to time; then allow it to cool; continue to shake it occasionally while it is cooling. Crystals of zinc sulphate should then be distinctly visible, and should be distributed throughout the mass; if this is not the case, add more crystals from the stock bottle, and repeat the whole process. This method ensures the formation of a saturated solution of zinc and mercurous sulphates in water. Contact is made with the mercury by means of a platinum wire about No. 22 gauge. This is protected from contact with the other materials of the cell by being sealed into a glass tube. The ends of the wire project from the ends of the tube; one end forms the terminal, the other end and a portion of the glass tube dip into the mercury.

To set up the Cell.

The cell may conveniently be set up in a small test tube of about 2 cm. diameter, and 6 or 7 cm. deep. Place the mercury in the bottom of this tube, filling it to a depth of, say, 1·5cm. Cut a cork about 0·5cm. thick to fit the tube; at one side of the cork bore a hole through which the zinc rod can pass tightly; at the other side bore another hole for the glass tube which

* See Notes.

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covers the platinum wire; at the edge of the cork cut a nick through which the air can pass when the cork is pushed into the tube. Wash the cork thoroughly with warm water, and leave it to soak in water for some hours before use. Pass the zinc rod about 1cm. through the cork.

Clean the glass tube and platinum wire carefully, then heat the exposed end of the platinum red hot, and insert it in the mercury in the test tube, taking care that the whole of the exposed platinum is covered. Shake up the paste and introduce it without contact with the upper part of the walls of the test tube, filling the tube above the mercury to a depth of rather more than 2cm. Then insert the cork and zinc rod, passing the glass tube through the hole prepared for it. Push the cork gently down until its lower surface is nearly in contact with the liquid. The air will thus be nearly all expelled, and the cell should be left in this condition for at least 24 hours before sealing, which should be done as follows :—

Melt some marine glue until it is fluid enough to pour by its own weight, and pour it into the test tube above the cork, using sufficient to cover completely the zinc and soldering. The glass tube should project above the top of the marine glue.

The cell thus set up may be mounted in any desirable manner. It is convenient to arrange the mounting so that the cell may be immersed in a water bath up to the level of, say, the upper surface of the cork. Its temperature can then be determined more accurately than is possible when the cell is in air. In using the cell sudden variations of temperature should, as far as possible, be avoided.

Notes.

The Zinc Sulphate Solution.—The object to be attained is the preparation of a neutral solution of pure zinc sulphate saturated with $ZnSO_4$, $7\,H_2O$. At temperatures above 30°C. the zinc sulphate may crystallise out in another form; to avoid this 30°C. should be the upper limit of temperature. At this temperature water will dissolve about 1·9 times its weight of the crystals. If any of the crystals put in remain undissolved they will be removed by the filtration.

The amount of zinc oxide required depends on the acidity of the solution, but 2 per cent. will, in all cases which will arise in practice with reasonably good zinc sulphate, be ample. Another rule would be to add the zinc oxide gradually until the solution became slightly milky. The solution when put into the cell should not contain any free zinc oxide; if it does then, when mixed with the mercurous sulphate, zinc sulphate and mercurous oxide are formed; the latter may be deposited on the zinc and affect the electromotive force of the cell. The difficulty is avoided by adding, as described, about 12 per cent. of mercurous sulphate before filtration; this is more than sufficient to combine with the whole of the zinc oxide originally put in, if it all remains free; the mercurous oxide formed together with any undissolved mercurous sulphate is removed by the filtration.

The Mercurous Sulphate.—The treatment of the mercurous sulphate has for its object the removal of any mercuric sulphate which is often present as an impurity. Mercuric sulphate decomposes in the presence of water into an acid and a basic sulphate. The latter is a yellow substance—turpeth mineral—practically insoluble in water; its presence at any rate in moderate quantities has no effect on the cell. If, however, it is formed the acid sulphate is formed also. This is soluble in water, and the acid produced affects the electromotive force. The object of the washings is to dissolve and remove this acid sulphate, and for this purpose the three washings described in the specification will in nearly all cases suffice. If, however, a great deal of the turpeth mineral is formed it shows that there is a great deal of the acid sulphate present, and it will then be wiser to obtain a fresh sample of mercurous sulphate rather than to try by repeated washings to get rid of all the acid. The free mercury helps in the process of removing the acid, for the acid mercuric sulphate attacks it, forming mercurous sulphate and acid which is washed away.

The cell may be sealed in a more permanent manner by coating the marine glue, when it is set, with a solution of sodium silicate and leaving it to harden.

PHYSICAL SOCIETY.

At a meeting of the Physical Society on November 25, 1892, the following Paper was read :—

"Experiments in Electric and Magnetic Fields, Constant and Varying."

By E. C. Rimington and Wythe Smith.

The object the authors have in bringing these phenomena before the Society is not to establish any new theory, nor to show imperfections in present theories, but to exhibit experiments which help the actions, taking place in a dielectric under stress, to be more easily grasped.

The experiments are divided into two sets :—(1) Performed in varying electric fields. (2) Performed in varying magnetic fields. Although these two fields cannot exist separately, their effects are isolated.

Set 1.—*Constant Electric Field.*

A constant electric field was produced by two charged metal discs + and −, each of which was struck on the outside of a glass plate (Fig. 1). The object of the glass plates was to prevent brush discharges between objects placed in the field and the plates.

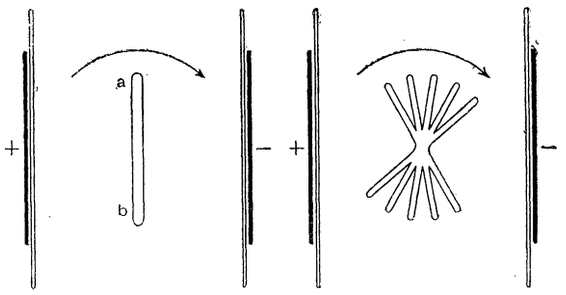

Fig. 1.

Fig. 2.

Fig. 1, *a*, *b* represents a partially exhausted electrodeless tube, placed in the uniform electric field. In the position shown, the tube is at a uniform potential. Now let it rotate in the direction of the arrow; the potential of *a* will fall, and *b* rise until the potential difference between the ends is sufficient to break down the tubes. There will then be a displacement current equalising the potential, during the continuance of which the tube will glow. On rotating still further a similar action will take place. The effect of these actions is to produce a double fan-shaped set of images, as shown in Fig. 2. The number of images in the fan depends on the intensity of the field. This phenomenon is intensified by constricting the middle part of the tube.

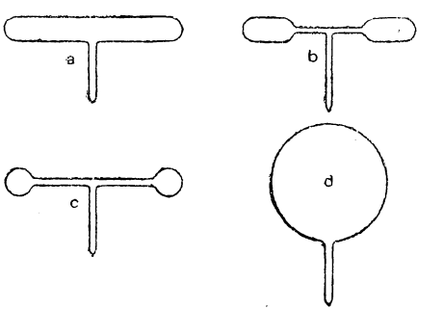

Fig. 3.

In designing the tubes for these experiments, care was taken to have the point where they were connected to the pump in such a position that there was no tendency for discharge to take place at these points when in use. The tubes used in this experiment are shown in Fig. 3 (*a*, *b*, *c*, and *d*). The stem was used to connect them to the whirling motor. The surfaces of these tubes should be fairly clean and dry, and it is advisable with a new tube, or one left unused for some time, to excite it between the knobs of an influence machine. In the double fan-shaped set of images one end will be seen to be brighter than the other, the current passing from the dull end to the bright end. Not only is this effect visible with a straight tube, but on rotating an exhausted bulb in the field a stationary luminous region will be seen.

Varying Electric Field.

Instead of rotating the tube a similar effect is produced by varying the field in which the tube is placed. The tube should be

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placed with its longer axis in the direction of the lines of force. The plates in this case may either be charged and discharged by influence-machine and dischargers, the latter sparking, or by an induction-coil, with or without sparking. When an induction-coil is used, very long tubes will glow when brought near.

SET 2.—*Magnetic Field.*

The authors were of the opinion that, by taking advantage of the action of the Geissler tube, one might show Hertzian phenomena to fairly large audiences. They therefore substituted a Geissler tube for the spark-gap in the resonator. This was very successful with a Leyden-jar oscillator. The oscillator and resonator consisted of two similar small Leyden jars for capacity, and a single convolution of thick copper wire for the conductor-circuit. The Geissler tube was placed as a shunt to part of the conductor-circuit of the resonator (*see* Fig. 4).

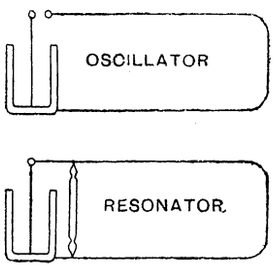

FIG. 4.

But although they designed special tubes, they were unable to get good results with the ordinary forms of Hertz oscillator and resonator. They next made a resonator of the following form :— Two metal plates, *a* and *b* (Fig. 5), give capacity, and the wire self-induction. An electrodeless exhausted tube was placed as dielectric between the plates. When a fairly large Hertz oscillator was used, this tube glowed brightly, even when taken to considerable distances.

Glow Produced in Varying Magnetic Fields.

Instead of, as in the last set of experiments, having a secondary composed partly of a metallic conductor and partly vacuum-tube, the whole circuit may be composed of rarefied gas. It is evident that, in order to generate a current in such a circuit, a large induced E.M.F. would be required ; this would have necessitated either a very strong magnetic field, or one which changed very rapidly. The former was out of the question, the latter was obtained by taking abvantage of the phenomenon of oscillatory discharge in the following manner :—

P (Fig. 6), a primary consisting of a very few turns of gutta-percha covered wire, was placed in a Leyden-jar circuit, as shown. As a secondary an exhausted bulb, or annular tube, was placed near P. On sparks passing at D, a bright ring of light appeared in the scondary. In the actual experiments a metallic secondary, S, was also wound with P and exactly similar to it. On short-circuiting S, the induced current in this circuit will weaken the magnetic field so as to completely extinguish the Geissler secondary.

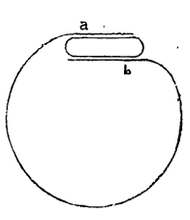

FIG. 5.

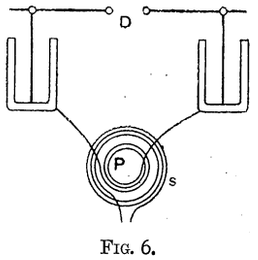

FIG. 6.

If S is connected to a third coil, this coil will behave in a similar manner to P, with weaker effects ; P and S in this case form a one to one transformer. The wire of the coil P is itself luminous when S is open ; short-circuiting S will stop this effect.

(Since the authors started their researches some of these latter experiments have been shown by Prof. Thomson.)

DISCUSSION.

Mr. SWINBURNE thought some of the effects shown were not Hertzian, but merely cases of ordinary mutual induction. He inquired whether the vacuum tubes would still glow if the Leyden jars were removed from the so-called resonating circuits. He was also of opinion that in the magnetic experiments the surfaces of the bulbs, and not the enclosed gases, took the charges.

Mr. WATSON asked if the authors had tried screening off the long waves by a wet cloth. If the effects still existed, this would prove that they were Hertzian.

Mr. BLAKESLEY wished to know if the images of the rotating tubes were at equal angular distances.

Mr. SMITH pointed out that these distances were not equal, but corresponded to equal changes of potential.

Prof. AYRTON remarked that the only cases where the materials of the bulbs, tubes, &c., did not influence the results were those in which discharges were produced by varying magnetic fields.

Mr. E. T. CARTER thought an induction coil a more efficient machine for producing the glow in tubes than the alternator, &c., used by Mr. Tesla.

Prof. S. P. THOMPSON said he first noticed that sparks passed between pieces of metal in the vicinity of an induction coil, sparking into a condenser in 1876, when he was showing some experiments on telegraphic apparatus before the Society ; but unfortunately he did not pursue the subject. Long before Mr. Tesla's investigations, Dr. Bottomley had shown that exhausted tubes could be caused to glow ; but it was not until Tesla produced such phenomena on a large scale that people recognised how much light could be got in that way.

Mr. RIMINGTON, in replying, said that the explanation why, in the experiments performed in varying magnetic fields, the bright parts of the luminous discharges were near the wire, appeared to be, that the E.M.F. was greatest in these places. Although he had not tried the experiment, suggested by Mr. Swinburne, of taking off the Leyden jar, he felt sure that doing so would stop the glow.

HUMAN DYNAMICS ; OR THE STUDY OF MOTIVE AND CHARACTER.

On Wednesday evening last week, at the Finsbury Technical College, Mr. Ll. B. Atkinson, A.M.I.C.E., delivered his presidential address to the Old Students' Association. Mr. Esson, Past-President, briefly introduced the new President, who delivered the following address :—

It is now about ten years ago since I used to attend in this lecture hall as a student of the Technical College, and I had very little suspicion then that it would ever fall to my lot to stand up in the same room, I will not say as a professor, but, at all events, as a lecturer. I have had some little difficulty in deciding what subject I should bring before you, but I have arrived at the conclusion that the best thing to do would be to give you some of the ideas that have occurred to me since I left the College with regard to the success or the failure of technical education, and in what way I think it might be improved in the future.

I.—First of all, what are the objects and scope of technical education as at present understood : let us consider for a moment the history of technical education. For a great many years, of course, science has been known in all its varied aspects, and we have had science taught and studied at the Universities, and at various colleges, and science has been also largely studied by amateurs, using the word amateurs in the sense of people who study science simply for its own sake. It has been studied simply as dealing with the methods and laws of nature, and never going any further than finding out what those laws are and learning them ; that in fact is *pure science.* The stage comes, however, when people begin to find out that, by studying these laws of nature, they can really do more than record the facts, that is to say, they find that they can make use of them, that they can learn to *control* nature by studying the laws of nature, and control her to their advantage. It was discovered, however, that the persons who had studied science in the way that it was then taught did not, for some reason or other, seem to be in a position to apply science to practical life—to make any use of it. It is notorious that nearly all modern improvements—the improvements, in fact, by which the nineteenth century had been marked, improvements of a material nature depending on scientific facts—have not been made by scientific men. It is true, for example, that the safety lamp in one form was invented by Davy, but it is also true that it was disputed whether he or George Stephenson, the pitman, really first discovered the principle. The inventors of the steam engine—the early inventors, certainly—had very little scientific knowledge in the sense that they had studied science and deliberately set to work to apply the laws they had discovered to the use of man. For this reason, therefore, it has been thought wise to start schools and colleges of *technical* education, in which science would be taught with the direct object of applying it to the use of man, by controlling the forces of nature for his benefit, and it was doubtless with that object that this college and the other colleges in London and the country have been formed. A very great deal has now been done in the direction of teaching science in its useful aspect, and all old students of this college recognise I supposed personally what has been done for them in that direction. Still there remains one thing more. I have spoken of *pure science,* and of *technical science,* but, after all, science is no use, unfortunately or fortunately, in the present day unless we regard its *commercial aspect.* "Can a scientific problem be made to pay?" That is the question we have to face at every turn. It is no use for us to devise ingenious and clever contrivances, chemical processes, electrical processes, or mechanical arrangements, unless by

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them we can supplant something already existing, and this can only be done if the new scheme shows a lower rate of cost. That I take to be the *commercial* side of technical education, and that appears to me to be the side of technical education which is overlooked in the technical education which I went through, and there are many I think, who were with me at that time who felt the same. It so happens that in the course of a year I see a very large number of students who have passed satisfactorily through various courses at different colleges, and as far as scientific knowledge and technical and practical knowledge is concerned, are all that could be desired. On the other hand, I know that when they apply for situations or posts, they are met with the question whether they have had any *practical experience.* Taking the industry with which I am connected, electrical engineering, so far as practical experience went, I frankly admit that the majority of these students have practical experience, in the sense that they can carry out almost any experimental work, and knew everything that was or ought to be done, say with electrical machines or instruments, very nearly as well as those who have been in the trade a very long time. The nature of the courses at this college, and of the tests, with apparatus at their disposal, with regard to machinery and engines, enables the students to know very nearly as much in some cases as they would if they had been in a works for two years; but what they do lack in the way of practical experience is that they are utterly ignorant of the fact that they have to do the work in a way to make it pay. In dealing with it as a matter of cost, what they wanted to know is, how is cost to be kept down? what are the differences in operating machinery that occasioned expense? what is it, in fact, that is entailed by what is broadly termed *management?* It is at this point—and I base my opinion on the observation of a large number of students—that technical education fails. Students do not realise the fact that scientific work must be done so as to make it pay. What they have to learn is not only that scien e means controlling *matter*, but that commercial science means controlling *human agents* also, and it is this element of human agency that is entirely neglected in all technical education, so far as I am aware. It is an element of the very greatest importance, because, after all, commercial scientific processes are carried on through a human agent or agents, such as managers, foremen and workmen. The question arises, is it impossible to teach what I will call this practical experience (and by practical experience, I mean the relation of men and women to the scientific operations that have to be carried out) in a college. It seems to me that technical education at the present time tends to produce a race of inventors, people who are always devising some brilliant scheme, but who forget the element of cost. It is notorious that inventors do not often succeed in making money out of their inventions, the idea goes into the hands of somebody else who makes the money, while they have the trouble of making the invention. I believe that this can be overcome to a very large extent by treating human agency, or, as I prefer to call it, *human dynamics* as a scientific subject, just as we treat mechanics, electricity or hydrostatics as a scientific subject. For instance, to teach mechanics we have a class in which all the laws of mechanics are laid down and shown, and, as far as they can be, proved on the black board; the student then passes into the laboratory, and in a few hours convinced himself that in the main the facts stated are correct. He does not go into the laboratory to find out for himself every law of mechanics. Why should not the same apply to human dynamics? I do not say that every fact in connection with experience of men can be taught in a class-room, but the laws that are likely to hold good can be so taught, and the student might be left to a short laboratory class in the laboratory of the world to satisfy himself of the truth of those laws, to find out to what extent they are correct. This course would put a student when he left a college much more in a position to deal with men as well as with matter than under the present system. I am aware that by suggesting this I may perhaps bring upon myself a charge which used to be considered one of great gravity, that of treating men from a very materialistic point of view, but, after all, we either directly or indirectly admit that men are controlled by some kind of laws, as are other things in the world of nature. In this case there is a greater uncertainty about the results of these laws, because it is much more difficult to find out the causes, and we have to endeavour to be in a position, with a few points in an orbit of comparatively unknown form, to predict the rest of the path—in other words to form an opinion as to what any man will do under any given circumstance. When a student leaves a technical college he has a very fair idea as to what stress can be put upon a steel wire without breaking it, or as to when it will break, but very few students when they leave have the slightest idea as to what inducements or temptations a man may be subjected before he will rob his employer. I believe that to some extent the one can be predicted in the same way as the other, if we take the trouble to find out the connection between cause and effect. We may, if we like, deal with the matter from a point of view that is very common in these class-rooms, draw a curve of human progress; that curve if it was simply in two dimensions—though I think it would have to be in n dimensions to make it really complete—may represent any one motive in a man's life; and taking a series of curves we may show what at any period in a man's life would be the effect of a given motive on his character, what action would result. If we take the *slope* of that curve, its differential coefficient in mathematical terms, it will represent the rate at which a man was improving or the reverse. If we take the area contained between the curve and its ordinates that area will practically represent what his habits are, because it will represent the summation of the various motives and actions which have operated on his character up to that date. What are really the simpler elements in the consideration of human dynamics, I think they may be taken in this way. Most people have some specific tendencies, or marked points in their character; everybody also has certain motives from time to time acting upon them, and the result of these two quantities is that we get a third quantity, a definite line of action.

Let us briefly consider what line such a study of human dynamics will take. The ordinary educationalist in dealing with youth begins with the assumption that all youth is naturally vicious and bad, and that all grown up people when they reach a certain age are perfection; and that duty of the educationalist is in the meantime to keep the youth under control till he arrived at the stage of perfection. Of course we know that this is all humbug, and that the fact is that people of all ages have certain vices and virtues, weaknesses and fads, and so on, and the aim, at all events, of the educationalist at a technical college would be to point out these virtues and vices, these strong and weak points in men's characters; how they have to be dealt with; how they can be made use of; and how they can be avoided, in relation to their use in the workshop of the world. The independent quantities that I would suggest for such teaching are *motive, character,* and *action,* corresponding in mechanics to force, mass, and motion, or corresponding in electricity to electromotive-force, resistance, and current. To bring the subject within the lines of a scientific argument, I suppose it will be said that we ought to have units of measurement of these quantities. I am afraid in the present state of the science however, so far as I am aware such units are not in existence. I may suggest the possibility of making measurements in some units; for instance, any youth knows that he ought not to burn a letter which was the property of somebody else, even if it was of no advantage to himself to have it burnt. Let us find out as our measurement the number of shillings which it would be necessary to give that youth to break down the barrier and get him to burn the letter. This would be a very simple problem. A rather more complicated one would be to find out how many shillings must be offered to a youth to persuade him to rob an orchard; there we have to consider whether the youth does or does not like sour apples, and his knowledge of the probability of the owner catching him in the act. I admit that all such considerations would make the system a complicated one, and I am not prepared this evening to lay down any units of measurement. How, then, are we to get at the result we want, namely, to find out the motive which is acting at any moment on a man, and to find out his character, and what he will do under given circumstances? To answer that we must consider what are, broadly speaking, the motives that weigh with people. Of course, first of all, there are what may be termed the animal motives, that exist even in a savage, such as *hunger, desire for comfort, love, self-preservation,* those are motives which affect every man and every race. As the scale of civilisation advances we come to *mental* and *moral motives,* such as *esteem* and *respect for others, pride* of name or family—which is often a very strong motive—*ambition,* and *desire for fame.* Then there are religious motives, and also what are termed altruistic motives. Religious motives may be really animal, being, in fact, simply the desire to avoid or gain certain pains or benefits which any particular religion happens to indicate. Altruistic motives, in a sense, are really selfishness in its highest form, where the desire to please others whom we may not even know is greater than the desire to please ourselves; but still, after all, it is an endeavour to put the highest personal pleasure as the point to be aimed at. Napoleon summed up all motives in two very short ones: he said that all men were governed either by self-interest or fear; he had heard that there was another motive—love, but this, he said, he had discovered to be an infatuation, and merely temporary. I do not think we can bring motives into quite so narrow limits as that; but the fact remains that the motives which move people to action are really very limited. You will have noticed that I have left the question of money as a motive out of question, the reason being that money, strictly speaking, is only a motive of action as being exchangeable for some of the other motives I have mentioned. There are a few people in the world called misers, with whom money itself is an object, but they are very rare, and are not often found, I suppose, under fifty years of age. Of all these motives, what I have termed the animal motives are the most general; they exist practically everywhere, and must always be counted upon. The mental and moral motives, and the religious motives that I have indicated, vary enormously, and are very much more complicated, and it is more difficult to decide whether and to what extent they exist; in fact, they can only be found out by a careful study of individuals in a manner which I will presently indicate briefly. So much for what might be termed the impressed forces in our law of motion. The second thing we have to deal with is character. Character, of course, strictly speaking, in the English language is a mental department, and I think we ought, therefore, to combine with character temperament, because what we have to deal with is the action of a motive, not only on the mental organisation, but on the physical organisation, or temperament. We must never forget the importance of dealing with the physical as well as the mental aspect of this question. Two men may be of exactly similar mental characteristics, but what they would do in a particular circumstance will depend very largely on their physical organisation; whether to one man it will be physical trouble or not to do a certain thing, often completes the balance of action. For instance, there might be two men of equally hot temper, whom we will suppose to have been insulted; the one, of small physical organisation, would probably take it quietly, where the other, of a large and powerful organisation, would probably knock his insulter down. At all events, those would be the two directions in which I should expect the action to take place in the two cases. Seeing that human motive and human temperament are so complicated a subject, how are we to find out what are the elements in the problem? First of all, I think we cannot neglect the influence of heredity, taking it not only in its personal aspect as regards the family or group of families, but also as regards a race or nation. There are various expressions in the English language which indicate that this is partly recognised by people. We hear people speak of a man as a "thorough Jones," meaning that all the Joneses act in a certain manner under certain circumstances; or we hear the expression, "a regular Englishman," which means that under particular circumstances Englishmen act in a particular way. We know what it is when a man

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acts as a "typical Scotchman." These expressions really indicate that people, without thinking of it, have studied human dynamics, and summed up certain types and characteristic, on which they base their opinion as to what a man will do under certain circumstances.

Let us consider for a moment some of the results of a study of human dynamics. The men who have made the greatest successes in the government of men in every instance have been those who have made a study of motives and character, with a view of predicting beforehand the action which the men they chose for certain posts would take. It used to be said of Napoleon —who was a great student of character—that he never chose a man for a general who had not large nostrils, whatever his other merits might be ; the reason was that he thereby estimated that the man was of a large physical and lung capacity, and could therefore stay in the saddle for a long time without suffering exhaustion, and thereby was capable of leading his armies under the very great stress of circumstances in which they were often placed. In that example—which I believe to be a true fact—we see how necessary it is to consider not only the mental, but the physical character of a man selected for special objects. If we look through the history of men of business, men who have founded colonies, who have organised railway systems, men of every class who have had to carry out work which they could not carry out entirely themselves, we find that the success of these men has been due to their choosing the right men to do the work they wanted doing. Probably each of these men worked, so far as his study of human dynamics was concerned, on lines of his own, and found out by experience certain rules which he thought would guide him, and which he relied upon. It is a fact of common knowledge which can be denied by none, that the choice of the right man for the right place has made the success of most of the leaders of the great departures of the nineteenth century ; indeed, it is hardly an exaggeration to say that the greatest discovery of the nineteenth century is the discovery or the production of a race of natural organisers, instinctive choosers of men to properly fill any given post. Now, in my view, a Technical College should take cognisance of this fact in its teaching. The whole success in the management of men in carrying out scientific and industrial operations consists in not trying to teach people to do things which they are not intended by Nature to do, but in selecting such people as are intended by Nature, or are suitable for carrying out any particular operation, to carry it out. I have spoken of the independent quantities leading to action, of *motive* and *character*. I have tried to impress on you the importance of a knowledge of these ; it remains to consider how we may discover these quantities. A little earlier on I mentioned the integral or summation of character and action in the general term habit. Now, to find out a man's character we really have to differentiate his habits with respect to time and motive. This may appear speaking in an involved manner ; what I want to express is this : if you want to know what a man will do, see what he has done before, what he is doing now. That is the whole secret. Every movement a man makes, every glance of the eye, how his hair grows on his head, the shape of his jaw, how he carries his head, every wrinkle on his face, his hands, how he wears his clothes, and what clothes he wears, how he writes, how he speaks—these and more are really habits, are indelible records of what he has done before, of what he will do again. It is in the study of these records that the integral quantity in human dynamics, the sum of actions, is to be found ; differentiate it with respect to one motive, and character remains, combine character with a fresh motive and action can be calculated. Some success has been attained in some branches of the subject in reducing them in some degree to a scientific basis. Darwin has made a study of the "expression of the emotions," which he reduces simply to the question of what muscular movements are involved in the expression of different emotions ; and these movements, if reproduced continually, leave their marks in permanent lines in the features of a man. If a man, for instance, is constantly engaged in deep and abstruse thought you will invariably find him with contracted eyebrows, and certain lines in the forehead between them, the reason being, as Darwin has shown, that in carrying out abstruse thought we naturally draw back the eyes and contract the eyebrows. If, therefore, we want to employ a man to carry out abstruse considerations we should never employ a man with a perfectly smooth face, indicating that he does not habitually contract his eyebrows in thought, for such contractions cannot be made without leaving their marks. That in its broad lines forms the science of physiognomy—the study of the face of a man as the record of his character, and the motives and actions which have gone beforehand. We may, in fact, say that men of certain features have certain characteristics. I maintain that it may easily be taught what those features and characteristics are—what a man with one set of features will do under particular circumstances, and what a man with a different set of features will do. These are things that may be taught in a class-room, and which everybody may verify for himself practically as he goes about the world. Phrenologists also have attained some considerable success in indicating the characteristics, character, and capabilities of men from an examination of the shape of their heads. In handwriting, again, I think that everybody, by taking a little trouble, may have a very large guide to character. I have recently had placed before me about 200 letters from applicants for an important post that I might give my opinion as to which I thought the most suitable man. I selected one of the letters, partly from the handwriting and partly from the style of the letter, though there was very little information in it. There was a great sorting out of these applicants, and finally seven or eight of the most suitable were brought up to London and interviewed by a board of directors. The result was that they selected the man whom I had selected from his handwriting, though I had not told them the name. That might perhaps be attributed to a lucky shot, but I am convinced of the great advantage of the study of handwriting in relation to character, the results of which can be applied to the selection of people to carry out any particular class of work. A great deal might be done before students started in their professions if there were a professor of human dynamics to tell them what they were likely to be successful with, and what they were not likely to be successful with. I was struck very much the other day when I happened to be in the Law Courts how every barrister in the room had one marked set of features ; there were none who differed from this in any large degree. The meaning of that was that the men who went into the profession who had not that class of countenance were not successful, and dropped out, and it might have been told them years before, at the beginning of their studies instead of at the end, that they would never make a success at the Bar. This subject of human dynamics is a subject which, quite apart from the class-room, we may all study. I find myself, the moment I get into a railway-carriage, speculating as to what every man in the carriage is, what is his profession, and what his errand, and I assure you that after a little study one could guess these things very closely. I find myself also, when asking anybody a question, rapidly predicting the answer, in words sometimes, and you would be surprised to know how very often the nature and the direction of the reply can be told. It really brings the matter down to the stage almost of being an amusing game. Where in whist, for instance, you play for a trick simply on the merits of the trick, without any consideration of what has gone before, the game is not worth playing ; but if you consider it in relation to all that has gone before, and all that your partner has had or is likely to have in his hand, whist is a very interesting game. So it is in dealing with people : if in asking a man a particular question, you look to what has gone before, and to the man's character, and endeavour to forecast his reply, there is an additional interest. It may be said that if a man is guided by rigid rules, and will almost invariably act in a particular direction under certain circumstances, that this seems to deprive him of the attribute of free will. Without going so far as that, it may be distinctly stated, I think, that there are certain people who have in certain directions no free will whatever. That is to say, if they attempt to do things for which they are not naturally adapted they *must* fail. It is not a question simply of whether they do or do not choose to try to succeed ; they cannot succeed, and if that can be determined before they waste time in trying, a great advantage will be gained. It is impossible within the limits of a short address to go deeply into a question like this, and I have only suggested various lines of thought that have occurred to me, and which, I may say, have been of considerable practical value to me ; and if I have succeeded in turning the attention of others in the same directions, I shall be satisfied.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, December 9th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. Papers to be read :—(1) "On Colour Vision," by W. B. Croft ; (2) "On Japanese Magic Mirrors," by Prof. S. P. Thompson ; (3) "Reflection from Diffusing Surfaces," by Dr. Sumpner.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read :—"Electric Light Cables," by E. S. Franklin.

MONDAY, December 12th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture. I., 4, "The Generation of Light from Coal Gas," by Prof. Vivian B. Lewes.

TUESDAY, December 13th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed :—(1) "The Manufacture of Small Arms," by John Rigby, M.A. ; (2) Paper to be read, time permitting :—"Gas Power for Electric Lighting," by J. Emerson Dowson, M.Inst.C.E.

CHEMICAL SOCIETY.

8 p.m. Extra Meeting on the anniversary of the death of Jean Servais Stas.

WEDNESDAY, December 14th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read :—"The Utilisation of Niagara." By Prof. George Forbes, F.R.S.

THURSDAY, December 15th.

CHEMICAL SOCIETY.

8 p.m. Ballot for the Election of Fellows. Papers to be read.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. Paper to be read :—"Continuous Current Dynamos," by J. Brentnall Duckett.

FRIDAY, December 16th.

OLD STUDENTS' ASSOCIATION.

8 p.m. Smoking Concert at Broad-street Station Restaurant.

*** Particulars of meetings to be held or Papers to be read before Scentific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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ELECTRICAL STANDARDS.

With the presentation of a supplementary Report to the President of the Board of Trade, the labours of the Committee on Electrical Standards may be assumed to have ended. The real work had been finished some time ago; it consisted, firstly, in the careful discussion of both principles and details, and secondly in the construction and calibration of the concrete standards. The delay in further proceedings has been due to international civilities. The opportunity for giving and receiving a reciprocal acknowledgment, offered by the proposal of the German Government to establish legal standards, was not to be missed. The discussion was re-opened at Edinburgh, and but slight modifications in the original Report were found necessary to secure agreement. The only change in the numerics is that of 1·434 instead of 1·433 as the voltage of a Clark's cell at 15°C. A very complete set of instructions for making and setting up this cell has been appended to the Report, which will be found elsewhere in our present issue. The instructions for using the silver voltameter are much more brief, but this matters less; not, indeed, because the operation is less difficult to carry out with four-figure accuracy, but because no one need ever perform it for measuring current or for calibrating instruments.

An intelligent man visited the British Museum the other day and asked to see "the original Sanskrit." The library authorities were rather puzzled, and, after some questions, found that the inquirer had been interested in an article on philology, and was endeavouring to carry out the instructions given in a foot-note—"See the original Sanskrit in the British Museum." Anyone impelled by curiosity, or animated by scientific inquiry, if he be also armed with the

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requisite authority, may inspect one of the original Yards, and may gaze on that mass of platinum which was, until recently, the original Pound, but which, having been tried in the balance and found wanting, leaves us at present with no Imperial Standard of Mass. Similarly, the standard ohm may be seen, and standard Clark cells may be inspected; but the standard ampere, unlike any other unit, is represented only by a balance and coils of wire on a marble cylinder.

The work of the Standards Committee has, on the whole, been accomplished with just that degree of scientific accuracy which is most likely to command respect. The ohm might have been defined as a velocity; Clause 13 might have contained allusions to polarisation and magnetic fields. On the other hand, the "bot" was rejected and the ambiguity of the alternating ampere was allowed to pass. A subsequent attempt was made to bestow a name on the supply unit, but failed, owing to lack of a real demand. The dilemma let loose upon the Committee by Mr. H. E. Harrison still lurks among the mysteries of alternating currents, nor is it likely to give any trouble until the practice of redressing alternating into continuous currents becomes more common. Proposed by Mr. Ferranti, Sir David Salomons, and others, and actually carried out in practice by M. Leblanc, such rectification may be sometimes convenient, but presents the anomaly that 1·11 alternating ampere, as defined by the advisers to the Board of Trade, is required to produce one of the straightforward variety. We have admitted that this may be sometimes convenient, but why not turn continous currents into alternating by a dynamotor? The advantage of this would be an efficiency of 110 per cent., quite enough to float a company on, in these bad times.

OBITUARY.

WERNER VON SIEMENS.

It is with deep regret that we have to record the death in Berlin on Tuesday, of Dr. Werner von Siemens, founder of the famous firm of Siemens and Halske, and Chairman of Messrs. Siemens Bros. and Co., of London, Dr. Siemens died in the evening at half-past six, after a few days' illness. On Tuesday next he would have celebrated his 76th birthday. He was some time ago attacked with influenza, which brought on inflammation of the lungs, and the doctors declared that, considering his great age and his weakened condition, his recovery was not probable. In Dr. Werner von Siemens the scientific world loses one of its most widely known representatives. It is a curious coincidence that Dr. Siemens fell ill on the very day on which his Reminiscences were published.

Born at Lenthe, in Hanover, in 1816, and educated at the Lübeck Gymnasium, Dr. Siemens joined the Prussian Artillery in 1834, where his eminent talents soon attracted notice. Whilst in the army he applied himself with great zeal to the study of practical chemistry and physical sciences, and became the inventor of the process of electro-gilding, the differential governor, and the electric automatic recording telegraph, for all of which patents were granted him in Prussia.

In the autumn of 1840 his studies were interrupted by a somewhat curious incident. He acted as second in a duel, and was sentenced to five years' confinement in a fortress. He was sent to the citadel of Magdeburg. But even there he continued his experiments by setting up a small laboratory in his cell. A Magdeburg jeweller bought his rights in connection with electro-plating for 40 louis d'or. This gave him the means of further experiments, when, unexpectedly, after one month's imprisonment, he was pardoned. His request to be allowed to remain a little while longer in his cell in order to complete his experimental work was regarded by the authorities as an impertinence, and he was summarily expelled from prison at midnight.

As member of a Commission of the Prussian General Staff for the introduction of the electric telegraph system in place of the optical telegraphs, he proposed, in 1847, the application of subterranean conductors, insulated by gutta-percha, and successfully carried out experimental lines coated with gutta-percha by means of a press invented by him for that purpose, which is still used in the manufacture of cables. With the help of these insulated wires he succeeded in laying, together with Prof. Himly, the first submarine mines with electric ignition in the spring of 1848, for the protection of the harbour of Kiel from the Danish fleet. In the same year he carried out the first great telegraph line in Germany between Berlin and Frankfort-on-the-Main, and in the following year the subterranean line between Berlin and Cologne.

Dr. Siemens left Government service in 1850, and devoted himself afterwards entirely to scientific studies and private enterprises. Dr. Siemens' personal achievements are to be found in the field of science as well as in that of the technical arts. His scientific merits induced the University of Berlin to confer on him the dignity of Doctor of Philosophy, *honoris causâ*, in 1860; they opened likewise for him the doors of the Academy of Sciences in Berlin in 1874, and subsequently of many other academies and societies. In 1892 he was elected an Hon. Member of the Institution of Civil Engineers, and he was Hon. Secretary of the Institution of Electrical Engineers for Germany. Amongst his many and various claims to renown, and to the gratitude of mankind, must be mentioned the invention and practical application of the mercury unit (Siemens' unit); the gutta-percha press already referred to; the development of methods for testing underground and submarine cables, and determining the position of faults; polarised relays; the Siemens armature, the dynamo, the principle of which he published at a meeting of the Berlin Academy of Sciences, on January 17, 1867; the electric railway, and numerous other inventions, such as the pneumatic despatch tube system.

Dr. Siemens was a member of the Prussian Order "Pour le Mérite," and the late Emperor Frederick III. of Germany conferred upon him the patent of nobility. In 1886 Dr. Siemens laid science under a deep obligation by presenting 500,000 marks to the German nation for the foundation of a national scientific and technical institution.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the annual general meeting of the Institution of Electrical Engineers, held last night, the following members of Council were elected for the year 1893:—

President.

W. H. Preece, F.R.S.

Vice-Presidents.

Alexander Siemens.	Sir David Salomons, Bart., M.A.
R. E. Crompton, M.Inst.C.E.	Sir Henry Mance, C.I.E., M.Inst.C.E.

Members of Council remaining in Office.

Major G. W. Addison, R.E.	Prof. A. B. W. Kennedy, F.R.S., M.Inst.C.E.
Prof. J. A. Fleming, M.A., D.Sc.	W. M. Mordey.
Prof. Geo. Forbes, F.R.SS. (L. & E.)	Prof. John Perry, D.Sc., F.R.S.
Edward Hopkinson, M.A., D.Sc.	James Swinburne.
Colonel R. Raynsford Jackson.	

New Members of Council.

Frank Bailey.	Gisbert Kapp, M.Inst.C.E.
Walter T. Goolden, M.A.	

Associate Members of Council.

W. A. Chamen.	Arthur Wright.
C. P. Sparks.	

Honorary Treasurer.

Sir David Salomons, Bart., M.A. (*Vice-President*).

It was announced in the course of the reading of the annual report that the Institution Premium had been awarded to Mr. Nikola Tesla for his Paper, "Experiments with Alternate Currents of High Potential and High Frequency"; the Paris Electrical Exhibition Premium being awarded to Mr. Anthony Reckenzaun for his Paper, "Load Diagrams and the Cost of Electric Traction"; and the Fahie Premium to Messrs. Heaviside and Jackson for their Paper, "Electrical Distribution by the Newcastle-upon-Tyne Electric Supply Company."

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SPARKING AT COMMUTATORS.

BY F. M. WEYMOUTH.

Few inventions probably, in connection with the industries of modern times, have produced so many unexpected results as the dynamo. Of these, moreover, the causes have often for a long time eluded research, and have remained incomprehensible, leading to much perplexity and a great amount of working in the dark. While the most puzzling effect is doubtlessly the sparking that takes place at the brushes and the commutator.

It is far however, from being a matter of mere scientific interest to find out what may be the precise cause or causes of this peculiar phenomenon. For, as seen from a practical, not to say a mercantile standpoint, these scintillations, so brilliant to the eye, are none the less a manifestation of so much wasted energy, destruction of material, and loss in capital or dividends. A double object, therefore, each of weight, will attend any investigation into such a subject; and it is hence, with this purpose in view, that we may now proceed.

At the outset of our task various preliminary questions occur, which will have presented themselves in times past, and doubtlessly still present themselves to the inquiring mind in detail. Thus, what are the exact reasons that brushes will spark in one position on a commutator and not another; and why worse in one position than another? Why do some dynamos always spark, but not others? Or, again, why do dynamos sometimes spark, and yet at other times give no trouble in this direction whatever? While a yet further problem of some present day interest relates to the comparative absence of sparking in connection with the use of carbon brushes.

For the better solution of these and many other similar queries, it will thus be well if, in the first instance, we endeavour to attain some clear understanding on the subject of electric sparking generally, apart from that in connection with commutators in particular. We should, perhaps, need to be excused if in so doing we run over ground which is already more or less covered in various text-books. But our apology must be that to omit this elementary matter would be to leave out some most important links in the general chain of our argument; while it is evident that, without a proper comprehension of the fundamental laws and facts, no really good and satisfactory understanding of more complex portions of the subject ultimately to be arrived at, will be possible.

A first necessary condition for any sparks is that there be a difference of potential or electric pressure between two bodies for a spark to pass from one to the other; and such a spark will then flash from the body of higher potential to the lower.

It will now, however, afford assistance in the elucidation of our subject as a whole if we submit electric sparks to a subdivision into five distinct orders. These are as follows:—

(1.) Statical disruptive sparks.
(2.) Induction disruptive sparks.
(3.) Self-induction disruptive sparks.
(4.) Continuous flame, or voltaic arc.
(5.) Continuous disruptive discharge.

The above classification, it may thus be observed, is based on differences partly in the effects, and partly in the causes. We may briefly review these orders separately, before more fully studying them in a greater or less measure conjointly.

The first is distinguished by the fact that it occurs with statical electricity: that is, the electricity which is produced by friction between various substances, such as glass and silk or fur, and resides on the surface of the charged bodies. Two bodies thus charged respectively with positive and negative electricity, or one of them not charged at all, being brought near together, a disruptive spark will flash between them without their being in contact.

A spark of the second class takes place in connection with current electricity, such as is generated by a chemical battery or a dynamo. It is of high voltage and disruptive, and like the first, requires no previous contact of the objects between which it passes.

The third, or self-induction spark, is also the result of current electricity, and a high electromotive force between the terminals. It is likewise disruptive, but only follows after previous contact.

The fourth in our classification, or voltaic arc, is a further phenomenon in connection with current electricity. It is preceded by a spark of the third order; but is then dependent on the electrodes not being parted by too great a gap in proportion to the strength of the current and its potential, principally the latter. This latter condition being observed, it has the peculiarity that it continues over a gap too great for the normal potential to send a spark across, in the well-known manner exemplified by the ordinary arc lamp, and contrariwise to the complete cessation of their being, and the infinitesimally small fraction of time occupied by a spark of either the first three orders.

The continuous discharge forming our fifth order is a simple effect in current electricity, where there is a normal very high potential difference between the electrodes. It is disruptive, and requires no previous contact.

We may now, however, subject the above to a more complete analysis, taking the various orders into consideration, not only separately, but as intimated, also in conjunction with one another. Thus, statical electricity, besides residing on the surface for instance of jars or brass knobs and so forth, is of extremely high potential, it may be of hundreds or thousands of volts; while the current, if it may be said to have any in passing from one object to another, may only be a minute fraction of an ampere. A peculiarity, moreover, of sparks of this class, even when of great length, and so of great potential, is that they have but little effect on the electrodes they play between, such as the brass knobs of a frictional electrical machine, which only become slightly tarnished. But they are far however from being necessarily harmless: for these sparks have this further peculiarity, that they are destructive to any dielectric substance that may be between the electrodes, in the sense that they can *pierce* or *break* and *rupture* any such object. Thus a spark may be made to pierce not only the *air*, but with a sufficiently high potential difference between the electrodes, also glass, paraffined wood, ebonite, or other such materials. Hence the term "disruptive," as applied to this kind of spark. It is in this direction, indeed, that the destructive effect of lighting is probably to be found. For while a cloud may be a body heavily charged with statical electricity, say positive, the true negative will be the damp interior of the earth. Objects projecting above the ground, such as trees and tall chimneys and so forth, are for the most part dielectric, though perhaps not entirely so, especially in so far as they contain moisture; but in so far as they are dielectric, the large disruptive spark known as a "flash of lightning" has a destructive effect on them in its endeavour to pass by their means to its true negative in the body of the earth; while a good conductor, such as a copper rod extending from the summit of the erection down well into the earth, will not encounter the disruptive qualities of the discharge, and so will escape damage.

Passing the second and third of our orders for the time being in this more particular review, we may now glance at our fourth order—the arc. As a clear conception of the production and continued generation of this form of electrical flame will tend to a good understanding of our subject as a whole, we may consider it with more or less thoroughness. In the first instance it has to be borne in mind that the carbons in an arc lamp form, part of what is termed a "circuit." That is, the electric current, starting from some generator, is conveyed by a conductor, say, a copper wire, to one carbon; it thence passes to the other carbon, and back by another conducting wire to the negative terminal of the generator. In this case moreover, at least with "continuous" currents, the electricity passes through the *interior* of the conductor, in contradistinction to the manner of the statical electricity, which lies on the surface. With the latter, a "circuit" as above described, is not necessary; for there it is a pure case of two bodies charged at different potentials, of which when they are brought sufficiently near, or are connected, the one higher charged will discharge into the lower one, so that both become of equal potential. This may be likened to the case of two tanks of water at different levels; when connected by a pipe the water in the higher

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one will flow into the lower till both are of the same level. But there is nothing of the nature of a circuit; and when the water in both is of the same level, the action ceases. Current electricity, on the other hand, may be compared to the case of hydraulic distribution of power, wherewith the water is pumped by engines into a series of pipes which convey it to various points where its energy may be utilised, as for working lifts and hoists, and thence bring it back to the suction of the pumps once more. It *may* be brought back to the pumps, that is. For after having been used, it can be run to waste, or returned to the earth instead, and fresh water be pumped into the pipes. The *earth* may then be said to be the return half of the water circuit. For as the used up water is returned *to* the earth, so is the fresh water drawn originally *from* the earth. It is thus also with electric currents, though it practice only with weak currents, such as are used for telegraphing purposes. The return half of the circuit may be the earth instead of another wire or "lead."

Reverting however to the arc, we find the explanation of this phenomenon, which we take from Prof. Silvanus Thompson's "Elementary Lessons in Electricity and Magnetism" (though we use our own words), to be as follows:—On the carbons being duly connected up in a circuit as described, they are first allowed to be in contact at their points. A current, which experience shows should not be less than 5 amperes as a minimum, or at a less pressure than 40 or

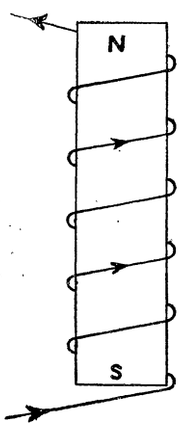

Fig. 1.—Elementary Coil.

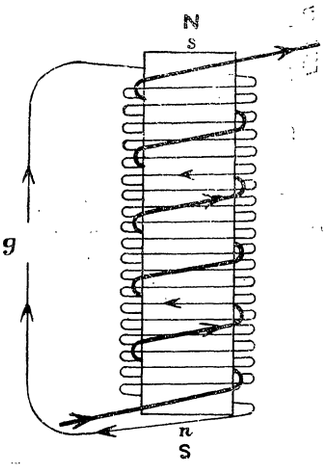

Fig. 2.—Induction Coil at "Make."

50 volts, is started through the circuit. The carbons are then drawn slightly assunder. At the first instant a self-induction spark of the third order of our classification, to be dwelt on later, flies from the positive carbon to the negative. This is accompanied by great heat due to the current, which volatilises into gas some particles of the positive carbon. If now the carbons be drawn not too far apart, this gas will form a conductor for the current from one electrode to the other. The precursory self-induction spark being spent, and the current now flowing continuously through this gas, intense heat is developed owing to the high resistance of the latter. This causes the points of the carbons to become white hot, whence arises the light. They are thereby also slowly consumed; and it is to be noted that the *positive* carbon, or that *from* which the current flows, burns down at twice the rate of the negative. The current flowing continuously through the gas from one carbon to the other, in appearance like a blue ambient flame, thus forms what is known as the voltaic arc.

A marked difference will thus here be noted between the arc and the disruptive spark already enlarged on. For contrary to the case of the spark, the *electrodes* are here distinctly subject to destruction. A body between the electrodes—that is, within the arc, will also be destroyed however, though not by any form of disruption as with the spark. But the intense heat of the arc will burn, melt, or volatilise, almost if not quite every known substance. We shall however return to this point.

Now, as explained, the arc is immediately preceded by, and has for one of its own pre-existent causes, a spark of the third order. To this latter, and the second order, we may now give our attention. Induction and self-induction sparks, like those of the first order, are disruptive. But they differ from the first, not only in being effects of current electricity as intimated, but further in that they have their origin in *magnetism*. This we may now proceed to make more clear.

It is well known that if a coil of wire be made as shown in Fig. 1 herewith, and a current of electricity be sent through it, a magnetic field will be formed within the coils. If the direction of the current be as indicated by the arrowheads, then according to Ampère's well-known law, the polarity of the field thus formed will be as also shown by the letters **N** and **S** If the current be reversed, the poles will also be reversed. On an iron bar moreover being enclosed within the coil as depicted, the magnetic effects will be still greater, owing to the iron having a much greater magnetic permeability than air.

In Fig. 2 are shown two coils, one within the other, having a common centre line, and also enclosing an iron core. Now, especially when an iron bar is enclosed as represented, a further effect may here be realised. This is, that if a *sudden* current be sent through one of these coils, say the interior one, it will *induce* a sudden current running in the *opposite* direction in the other coil. Further, on suddenly breaking the primary current in the interior, a sudden current will again be induced in the outer or secondary coil, but this time in the *same* direction as the primary current, as shown in Fig. 3.

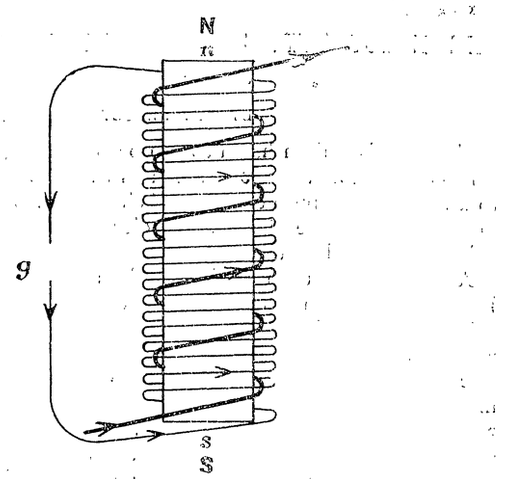

Fig. 3.—Induction Coil at "Break."

In Fig. 2 the induced secondary current tends to produce a polarity opposed to the polarity of the primary coil, as shown by the small and large letters; while in the case of Fig. 3, the secondary polarity augments the primary. But the point immediately to be arrived at is that this *secondary* current is purely a *magnetic* effect, that is, a result obtained through the intervention of magnetic induction. On this we may yet further enlarge.

(To be continued.)

A HIGH FREQUENCY DYNAMO.

No sooner did Messrs. Siemens Bros. propose to show 50,000 volt experiments at the Crystal Palace Exhibition last year than Messrs. Swinburne and Co. offered a 100,000 volt set. The two shows did not materially differ, the arcs and disruptive discharges were very much of the same character in the two cases. Similar competition has been going on in the construction of little dynamos of high frequency. Tesla brought over his 13,000 $\sim$ dynamo; three weeks ago we described Ewing's 14,000 $\sim$ dynamo, giving 5 amperes at 100 volts, and Messrs. Pyke and Harris, in conjunction with Sir David Salomons, have constructed a 16,600 $\sim$ machine giving one ampere at 100 volts. This is about 28 per cent. higher frequency than that of Tesla. The principle of this machine closely resembles that of Prof. Ewing, but the poles are cut on the opposed plane

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faces of two fly-wheels instead of radially. The diameter of these wheels is one foot, and the poles run about ten to the inch. The zigzag winding on the magnets is of some depth, as in Prof. Ewing's machine, but the armature winding is only of one layer. In order to get a high speed, the plan proposed by Edmunds and Sellon in 1879, Kelway in 1882, and others, to revolve the armature and the fields in different directions has been adopted. This method, while quite impracticable in ordinary dynamo work, becomes possible in this machine, since it contains a direct current motor.

A radial electro-magnet fixed to one half revolves in front of a Gramme ring wound in ten sections. The two parts are mounted on overhung bearings, and the friction of each being approximately the same, they run at about 1,500 revolutions per minute, in opposite directions, giving a relative speed of 3,000 revolutions. The machine is, in fact, a dynamotor, and where a definite frequency is not demanded, such an arrangement may be found convenient. The experimental results can hardly be expected to differ much from those of Tesla, nor does it seem worth while to double or even to quadruple these high frequencies by the device suggested by Mr. Trouton. We understand that it is intended to modify this machine, and we therefore wait further development before presenting details to our readers. An advantage presented by this arrangement is that it is easy to run it for experimental purposes from any 100-volt circuit.

THE ELECTROLYTIC PREPARATION OF METALLIC CHROMIUM.*

BY EM. PLACET.

Metallic chromium has hitherto been nothing but a laboratory curiosity, and in most instances the name has been given to a more or less pure carburet of chromium. I have succeeded in obtaining the metal by a new electrolytic process, which I will succinctly describe.

An aqueous solution of chrome-alum is prepared, to which is added an alkaline sulphate and a little sulphuric or other acid. This solution is then electrolysed. At the negative pole a beautifully brilliant deposit is formed on the surface of the electrode, and this deposit consists of pure chromium. The metal is very hard, and is of a beautiful bluey-white colour. It resists atmospheric action perfectly, and is only attacked by concentrated sulphuric acid, nitric acid, and a concentrated solution of potash. When the electrolytic deposit takes place under certain conditions, it is even possible to obtain arrangements of chromium crystals, which recall the branches of fir trees. This metal, which can now be prepared on a thoroughly commercial scale, furnishes numerous alloys, which are being investigated.

I may add that this new process has led me to investigate "chromage," if such a word be permissible, or the electrolytic deposit of chromium upon the surfaces of different metals and alloys. My experiments have succeeded perfectly. With baths similar to the one described above I have obtained an adherent deposit of chromium of a thickness variable at will and resembling oxidised silver, upon brass, bronze, copper and iron.

I am glad to be able to place before the Académie a specimen of metallic chromium weighing more than a kilogramme; also samples of chromium alloys and brass ornaments electroplated with chromium.

Electric Traction in Belgium.—The Belgian State Railway authorities have, says *Industries*, decided to carry out some experiments with electric traction. The experiments will be carried out in the neighbourhood of Liège, at a point where all conditions of railway operation, such as inclines, curves, &c., are available. In the first trial two waggons loaded with pig iron will be employed, the necessary electric current being supplied by accumulators. Experiments will afterwards be carried on the Petite-Espinette local railway, electric conductors being employed in this case.

* From the *Comptes Rendus*, Vol. CXV., No. 22 (November 28th).

EXPERIMENTAL RESEARCHES ON ALTERNATE-CURRENT TRANSFORMERS.†

BY J. A. FLEMING, M.A., D.SC., F.R.S.

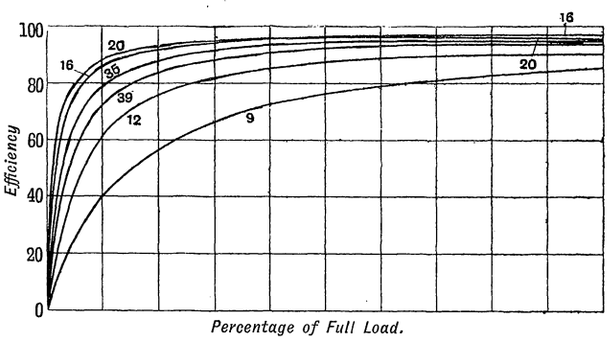
(*Concluded from page 125.*)

Thomson-Houston 4,500-*Watt Transformer.* (Tables XXIII. and XXIV. Figs. 34*, 35, 36*, and 37*.)

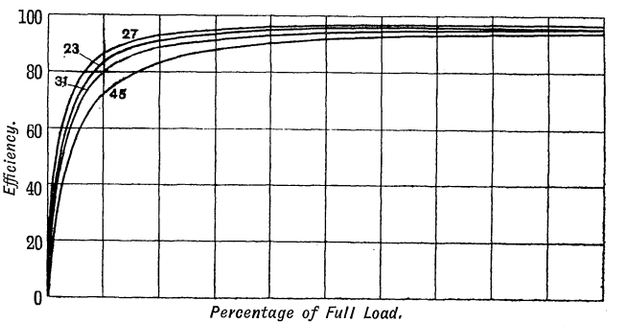
There is nothing which here specially calls for remark. The transformer is a very good example of a high efficiency closed iron circuit transformer of small size. At one-tenth of full load the efficiency is 79·1 per cent. The open-circuit loss is only 1·6 per cent. of the total full secondary output.

Kapp 4,000-*Watt Transformer.* (Tables XXV. and XXVI. Figs. 38*, 39, 40*, and 41*.)

This is a very interesting transformer, having an exceedingly good regulation for such a small size. Its total secondary drop is under 2 per cent. of its secondary voltage at no load, and its open-circuit loss is 2·8 per cent. of full output. It is curious in the rather slow rise of its power-factor as the secondary load is increased. More about this will be said presently. The good regulation of the transformer and small "leakage drop" are no doubt due to the effective "sandwiching" of the primary and secondary coils.



The following are the Transformers of which Efficiency Curves are given. The number against each curve refers to the Figure mentioned in the paper. **9.** 5-H.P. Ferranti (1885 pattern). **12.** Ferranti rewound. **16.** 65,000-Watt Westinghouse. **20.** 15-H.P. Ferranti (1892 pattern). **35.** 4,500-Watt Thomson-Houston. **39.** 4,000-Watt Kapp.



23. 15-H.P. Ferranti rewound (1892 pattern). **27.** 20-H.P. Ferranti (1892 pattern). **31.** 6,000-Watt Mordey. **45.** 3,000-Watt Swinburne ("Hedgehog.")

Swinburne 3,000-*Watt* "*Hedgehog*" *Transformer.* (Tables XXVII., XXVIII., and XXIX. Figs. 42, 43, 44, and 45.)

Lastly, but by no means least, there are several remarks to make about the "Hedgehog" transformer of Mr. Swinburne. As a problem in transformer testing this open-circuit transformer of his is a hard nut to crack. From first to last we have made many hundreds of observations on it. The Tables XXVII., XXVIII., and XXIX. give the results of the two best sets of observations with the dynamometer wattmeter on this transformer. The mean of a number of observations with the dynamometer wattmeter on the power taken up at no load by this transformer gave a value very close to 114 watts. We have already seen that the mean of the three-voltmeter and three-ammeter methods indicated probable values of the power loss close to this number. The dynamometer observations gave values of 114, 108, 108, 114, 114, 121, 121, in seven series of observations at slightly different frequencies. Hence

† Abstract of a Paper read before the Institution of Electrical Engineers on November 24, 1892.

* This figure is omitted because the curves of the transformer closely resemble those which we have given as specimen curves. The actual limits of the other curves may be easily found by referring to our abstract of the tables.

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the mean of all means of over 62 observations by three different methods gives the value of 112 watts for the power absorbed at no load in this 3,000-watt "Hedgehog" transformer.

The core of this transformer is composed of soft iron wires 18in. in length, and each 0·9225 of an inch in diameter. The total volume of iron wire is about 856 cubic centimetres, and weighs 5,982 grammes. The induction in the centre of the core is about 10,000 C.G.S. units. It is clear that with such subdivision of the iron true eddy-current loss in the iron must be small, and my estimate of it is that it does not amount to more than 10 or 15 watts at the frequency used. Also, the true hysteresis loss cannot probably be much greater than 20 to 30 watts. In general one watt per 30 cubic centimetres of core is about the value of the true total core loss in most usual small-sized transformers. How comes it to pass, then, that all the measurements above described point to a loss of about 112 watts at no load? The answer to this question is, I take it, that there may be considerable eddy-current loss in the copper of the secondary circuit. In this transformer the secondary circuit is first wound on the core, and then the primary circuit over it. If we consider for a moment, we shall see that the lines of induction passing up the core return back through the space outside the core, and in so doing they must cut through the copper of the circuits. Hence, at each reversal of induction, unless the copper circuits are exceedingly well stranded, there are eddy-currents set up in the copper mass; and this takes place equally well at full and at no secondary load. The only way to prevent this waste is to make the secondary circuit of stranded wire, each strand slightly insulated and very small. It is perfectly clear that this loss must take place to some extent, and that it is a special defect of the open magnetic circuit transformer. We may, from one point of view, regard the function of the iron core of a transformer to be the preservation of the lines of induction in the proper place, and making them thread through the aperture of the secondary circuit without intersecting or cutting through the mass of the copper in that circuit.

I proposed to Mr. Swinburne to obtain convincing proof of the correctness or incorrectness of this view by winding an exactly similar transformer with a dummy secondary circuit of string or rope. If such a transformer with only primary circuit were tested, I believe it would show a far smaller power-absorption than the actual transformer does. His firm have not yet been able to try this experiment, but it would be most interesting and satisfactory to have it tried. In any case, it seems to me clear that in the "Hedgehog" tested by us there is probably a large eddy-current loss in the copper, and that this accounts for the abnormally large loss on open circuit, which cannot well be accounted for in the iron core alone, unless phenomenally bad iron has been employed. I venture to suggest, therefore, that Mr. Swinburne should direct his attention to getting rid of this copper eddy loss, because, as it stands, this 3,000-watt "Hedgehog" must be kept down in efficiency from this cause. If we compare the efficiency curve of this transformer with that of a closed magnetic circuit transformer of nearest size, we see that the open magnetic circuit so far gives no advantage in efficiency at the low loads. This "Hedgehog" has an efficiency of about 73 per cent. at one-tenth load, and 94 or 95 per cent. at full load. A transformer with a closed magnetic circuit and of not much greater output can be built to do just as well, or better, than this, as can be seen by an inspection of the efficiency curves of the Kapp or Thomson-Houston transformers. If, however, the eddy-current loss in the copper can be entirely destroyed, and the large magnetising current provided by non-wasteful condensers, the open-circuit transformers may perhaps be made more efficient at low loads than closed-circuit transformers of equal output. To attempt to predetermine the efficiency of this type of transformer as now made by calculations carried out on the assumption that the only internal loss is the eddy and hysteresis loss in the iron, leads to considerable overstatement of the efficiency.

If subsequent experiments should confirm this view that at present there is considerable avoidable loss in the copper circuits of

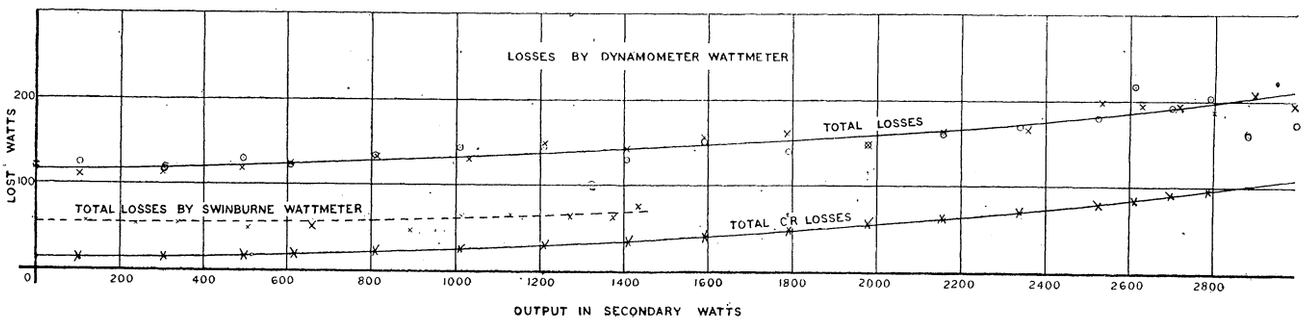

FIG. 42 —3,000-Watt Swinburne (Hedgehog) Transformer.

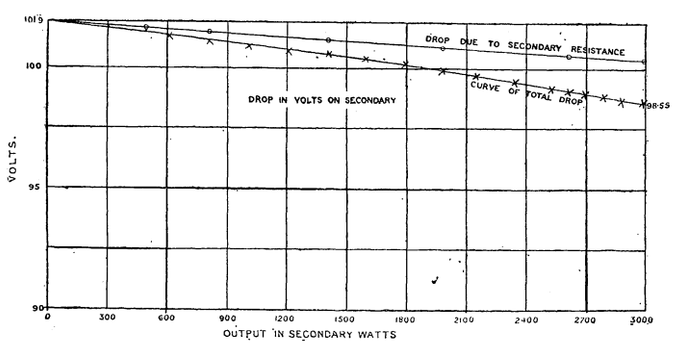

FIG. 43.—3,000-Watt Swinburne (Hedgehog) Transformer.

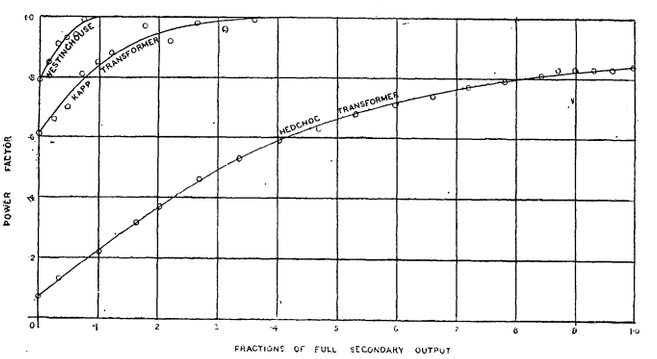

FIG. 46.—Relation of Power Factor to Secondary Output.

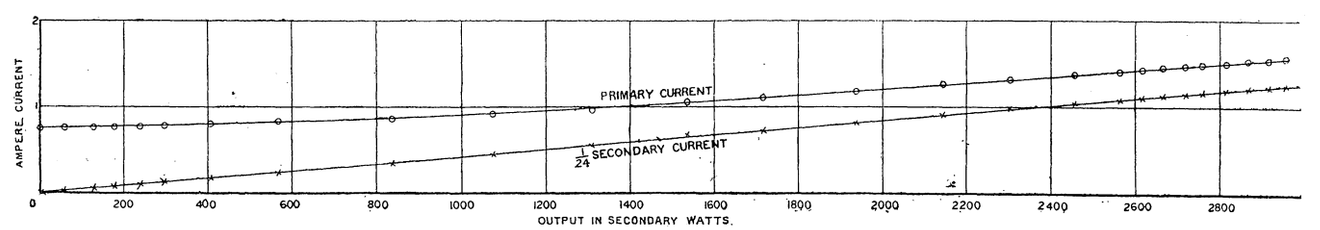

FIG. 44.—3,000-Watt Swinburne (Hedgehog) Transformer.

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the "Hedgehog," it is clear we are not yet at the end of our inquiries; and until it has been freed from this defect it does not show inherent superiority over its closed-circuit rival. When it has arrived at the ideal condition, and enjoys the constant presence of a condenser imparting to it its necessary magnetising current, which in the 3,000-watt "Hedgehog" is nearly 50 per cent. of the full-load primary current, we shall be in a position to give it a final verdict, and say if the result could not be just as well obtained by adding the necessary small amount of iron to complete the magnetic circuit.

V.—*General Remarks on the Above Experiments.*

14. On examining all those diagrams in which are delineated the curves of total loss of power in the transformer and the curve of total copper resistance loss ($C^2 R$), we see that in every case the upper curve runs *sensibly parallel* to the lower curve; in some cases most exactly parallel. In the curves for closed magnetic circuit transformers of good design the difference between the total $C^2 R$ loss and the total loss of all kinds is the iron core loss in the transformer. Hence we see that all the experiments lead to the conclusion that *the iron core losses are constant at all loads.* In no case have we found any substantial evidence that the iron core losses are evanescent at full secondary load. This last view has been held by Mr. Mordey and others. Seeing that our methods, when applied to the 6,000-watt Mordey transformer, give practically the same results at no load as Mr. Mordey obtains, it is an interesting matter to inquire how it comes to pass that the calorimetric method employed by him seemed to indicate that the whole loss in the transformer at full load was accounted for by the frictional losses in the copper. At present the writer can offer no explanation of this discrepancy. The above-described observations were all made and plotted out before the appearance of the Paper of Prof. Ayrton and Dr. Sumpner, and shown to many people, but it is very satisfactory to find that their undoubtedly excellent method has conducted them to precisely the same conclusion. Hence we seem to have very good reason to believe that the total internal loss curve of a transformer can be drawn from observations of the $C^2 R$ losses and the total core loss at no load

When we come to consider it, it is very difficult to see on what valid supposition we could conclude that hysteresis loss should be less at full than at no load. The only difference in the magnetic conditions are that in one case the iron is magnetised by a small current acting in one direction, and in the other by the difference between two currents flowing in opposite directions, but governed by the condition that the total ampere-turns remain the same. In a special experiment, I have taken the hysteresis diagram for a soft iron wire employing a magnetising force of 1,000 ampere-turns, in one case produced by 2·5 amperes and 400 turns, and in the other case by 20 amperes and 50 turns. The hysteresis areas for one complete cycle were found to be practically the same—the latter, if anything, the larger of the two. Prof. Ewing's direct evidence on this point will be remembered.

15. These measurements have brought out, in addition, another very interesting fact. In the foregoing tables for each transformer will be seen a column of figures headed "Power-Factor." We have already defined this term as the ratio of the "true watts" to the "apparent watts," or product of the effective amperes and effective volts. This ratio is given for each measurement of the power. We see at once that for closed magnetic circuit transformers of good type, such as the Mordey, Westinghouse, Ferranti, &c., the power-factor at no secondary load begins at a value of about 0·8 or thereabouts. For such types of transformers, however, a very little loading up of the secondary circuit—not more than one-tenth of full load—brings the power-factor up to unity. In Fig. 46 are given three curves showing the progress of increase of the power-factor as the load on the secondary circuit is progressively increased. The upper curve represents the growth of power-factor (P.F.) for the 6,500-watt Westinghouse transformer. Beginning at 0·8, it rises up to unity at about one-tenth of full load. Hence at and after this very little load the apparent watts are the same as the true watts, and the real power taken up in the transformer is quite accurately given by the product of the primary terminal pressure and the primary current, effective, or $\sqrt{\text{mean}^2}$, values being understood. For an open magnetic circuit transformer like the "Hedgehog" the case is quite different. The P.F. begins at a value of 0·08 or 0·06, and it never rises up above 0·8. Hence at no stage of the load is the real power taken up by the transformer anywhere nearly equal to the "apparent watts." A transformer like the 4,000-watt Kapp appears to occupy an intermediate position, and although it has a medium power-factor to start with, its P.F. rises up to unity at about half load. The importance of this fact in alternate-current station working is very great. It shows us, if we have a station wholly supplied with transformers of the type of Mordey, Westinghouse, Thomson-Houston, Ferranti, &c., that the apparent watts supplied to the transformers is the real watts at any hour when all the transformers are more than one-tenth loaded. If, however, the station is engineered with "Hedgehogs," or with that museum of transformers of all sorts and makes which some central station engineers are fond of gathering together—under the idea, perhaps, that they can "hedge" for economy and make up for the vices of one kind by the virtues of another—then in hardly any state of the load will it be safe to assume the identity of the true and apparent measures of outgoing power. We must, of course, here assume that concentric primary cables are not in use, otherwise an error of another kind may be introduced. If we take the case of a station provided wholly with closed magnetic circuit transformers, and consider it as having an average kind of load diagram, say for the whole year—then if the measure of the "apparent units" sent out from the station is taken, I do not think that in general we shall be far out in our estimate of the true units sent out if we deduct from the apparent units about 12 to 15 per cent. and call the remainder the measure of the true units of energy sent out in the whole time.

16. On looking at the curves in which are delineated the values of the primary and secondary currents for each transformer, we note that in these the value of the primary current and 1-24th part of the secondary current is plotted in terms of the secondary output. These curves are very nearly straight lines. In the case of the closed magnetic circuit transformers of large power-factor the difference between these current-values is constant.

Since the winding of these transformers are in the ratio of 24 to 1, it is obvious that the ordinates of the current-curves may be taken to represent the primary and secondary ampere-turns. If we look at the tables and examine the difference between the values of the primary current and 1-24th part of the secondary current, we shall find this difference is sensibly equal to the primary current at "no load," or to the "magnetising current," so called. This is only another way of stating the fact that the resultant ampere-turns are constants at all loads and equal to the ampere-turns at no load. The above is true only for the high power-factor transformers. For the open magnetic circuit transformer it is not the case. In this last the difference between the primary and secondary ampere-turns diminishes as the load increases. This is probably because there is a continual change of the relative phase of the primary and secondary currents in the open magnetic circuit transformer as the load is increased; whereas in the closed circuit, after the first beginning of load, the primary and secondary currents come nearly into opposition with each other as regards phase, and preserve that difference at all greater loads.

There are also, as mentioned, for each transformer a set of curves showing the total secondary drop in volts between no load and any load. Consider the case at full secondary load. The P.D. between the secondary terminals is then less than that between them when the transformer is unloaded; primary terminal P.D. being kept always constant. The difference between these secondary P.D.'s is the "total secondary drop." Part of this drop is due to the volts lost by resistance in the secondary circuit, part by resistance in the primary, and the outstanding portion is the "leakage drop," or lost volts due to magnetic leakage. In all of the "drop" curves a line is drawn in to indicate the "drop" due to secondary resistance, and in some a dotted line is added also to indicate the drop due to the primary resistance. The relation of these parts to the whole drop in volts may be examined as follows for a closed magnetic circuit transformer:—

Let v_1 be the instantaneous value of the potential difference of the primary terminals, and v_2 the same for the secondary terminals, of the transformer. Let i_1 and i_2 be the instantaneous values of the currents, and let R and S be the primary and secondary circuit resistance, and N_1 and N_2 the primary and secondary turns. Then let b_1 be the induction density in the centre of the primary coil, and b_2 that in the secondary, and b the density of the leakage; or, if A is the constant cross-section of the magnetic circuit, let $A\,b_1$ be the lines threading through the primary coil, $A\,b_2$ those through the secondary coil, and $A\,b$ the leakage of lines. Then,

$$A\,b_1 = A\,b_2 + A\,b \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

By fundamental equations,

$$\left.\begin{aligned} v_1 &= R\,i_1 + A\,N_1 \frac{d\,b_1}{d\,t} \\ \text{and} \quad o &= S\,i_2 + v_2 + A\,N_2 \frac{d\,b_2}{d\,t} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Hence, writing a for N_1/N_2, we have, by elimination of b_1 and b_2 between (1) and (2),

$$\frac{v_1}{a} + v_2 + S\,i_2 - R\frac{i_1}{a} = A\,N_2 \frac{d\,b}{d\,t} \quad . \quad . \quad . \quad . \quad (3)$$

Let $v^1 = V_1 \sin p\,t$: then $v_2 = -V_2 \sin p\,t$, because the primary and secondary potentials are in opposite phases. Also, we can write $i_1 = I_1 \sin p\,t$, and $i_2 = -I_2 \sin p\,t$, at all stages of the secondary load very nearly, because the primary and secondary currents are in opposite phases, and the primary current is in synchronism with the primary P.D. at all stages of the load above one-tenth. Also, we can write $b = -B \sin p\,t$, because the "leakage" is deter-

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mined by, and is in close synchronism with, the secondary current. Hence we arrive, by substitution in (3), at the equation.

$$\left(\frac{V_1}{a} - V_2 - S\left(I_2 - \frac{R}{a} I_1\right)\right) \sin p t = -A N_2 p B \cos p t . \quad (4)$$

The quantity $A N_2 p B \cos p t$ is the instantaneous value of the volts lost by leakage. Hence, taking the $\sqrt{\text{mean}^2}$ value of both sides,* and putting dashes over the letters to indicate that they now stand for the values of the currents and potentials as read on alternate-current ammeters and voltmeters, we get,

$$\left(\frac{1}{a} V_1' - V_2'\right) - \left(S I_2' + \frac{1}{a} R I_1'\right) = A N_2 p B.$$

Since $1/a\ V_1'$ is the value of the secondary P.D. at no load, and V_2' is that at, say, full load, the first term in the bracket is the "total drop." The second term in the bracket is the sum of the copper drop due to the secondary circuit and that due to the primary circuit, and the term on the right-hand side of the equation is the drop due to leakage. Hence, if we have a closed magnetic circuit transformer with windings, say, in the ratio of 24 to 1, we have the following rule for obtaining the true magnetic leakage drop, or volts lost by leakage at full load:—Add together the product of secondary resistance and secondary current and 1-24th part of the same product for the primary circuit. Subtract this sum from the total observed drop, and the remainder is the secondary volts lost by magnetic leakage.

Examining in this way all our transformers, we see that in same, such as the Westinghouse, half the observed drop is due to magnetic leakage; whilst in some, such as the Kapp transformer, magnetic leakage is very small. This is no doubt due to the way in which the primary and secondary coils are interplaced in the Kapp transformer.

From what has been said above, it is clear that we can, from certain figures of observation on a transformer, predetermine all these curves when that transformer is of the closed magnetic circuit type. For if we are given—

(*a*) The primary P.D. of terminals;

(*b*) The primary current at no load, commonly called the "magnetising current;"

(*c*) The primary and secondary resistances;

(*d*) The P.D. of secondary terminals, and the secondary current corresponding to various secondary loads up to full load;—

we can determine the efficiency curve and everything else.

For the product of (*a*) and (*b*) gives us the apparent watts at no load, and if we take 0·8 of this we get the core loss at all loads. Then from the ratio of the primary to secondary volts at no load, and the observed secondary currents and magnetising current, we can calculate the primary currents, and from the currents and resistances get the total $C^2 R$ loss at certain secondary loads. Hence we can draw a total $C^2 R$ loss curve and a total loss curve parallel to it, and from this last determine the efficiency at every stage of the load.

VI.—*Experiments with Mr. Swinburne's Wattmeters.*

17. As mentioned, Mr. Swinburne sent with his transformer a brass-cased wattmeter stated to be adapted for measuring alternating-current power. In most of the tables giving the power absorbed by various transformers will be found a column headed "Total Power taken up in Transformer by Swinburne Wattmeter," and in the "total loss" curves these numbers are plotted as a dotted line, marked "Losses by Swinburne Wattmeter." In various cases we made measurements with the Swinburne wattmeter, as far as it would read, and our own dynamometer wattmeter, either simultaneously or immediately after one another. The Swinburne wattmeter was carefully calibrated on the same non-inductive resistance as the dynamometer wattmeter, and its constant determined. An examination of the values of the power taken up by various transformers at various loads shows that the power values given by the first sent Swinburne wattmeter are in nearly all cases lower, and often much lower, than those given by the dynamometer wattmeter. In the case of the Westinghouse transformer the two instruments gave practically the same value for the loss at no load; and for that transformer, and for the 15-H.P. Ferranti transformer, the differences in the two readings are not great at any load. It seemed that the Swinburne wattmeter gave readings, within reasonable limits of experimental errors, quite as likely to be right as not. The case is quite different, however, when it is applied to measure the power-absorption in a transfer of small or moderate power-factor. In the case of the Thomson-Houston transformer the Swinburne wattmeter gave power values only about two-thirds as great as those given by the dynamometer; in the case of the Kapp transformer rather less. Most remarkable of all, in the case of Mr. Swinburne's own transformer, his wattmeter gave power values on the average only about half of those obtained by the dynamometer wattmeter. Again and again we repeated these experiments, calibrating the wattmeters in various ways, and using every precaution. The mean of all our observations with the Swinburne wattmeter gave 74 watts as the power taken up in the 3,000-watt "Hedgehog" at no load, and the most frequent value obtained was 55 watts. We have seen that the mean of all other methods gave 114, and the most trustworthy observations by the dynamometer gave 121 watts. Here, then, was a riddle to be explained. It was only susceptible of two solutions. Either the dynamometer, three-voltmeter, and three-ammeter results for the "Hedgehog" were greatly in excess of the true value of the power absorbed, or else Mr. Swinburne had achieved the marvellous feat of inventing a wattmeter which, whilst reading approximately correctly the power taken up in transformers of good closed magnetic circuit type, measured too little by nearly 50 per cent. when applied in the same way to test his own.

18. It was felt to be necessary to examine this matter with the greatest care. Experiments were therefore made with three small "Hedgehogs" which had been made for lecture purposes. These transformed from 100 to 33 volts. These three little transformers were arranged with their primary circuits (100 volts) in parallel, and with their secondary circuits open. The power taken up in the three together at 100 volts was measured by the three-voltmeter method, the dynamometer wattmeter, and with the Swinburne wattmeter. These experiments were carried out as follows:—In series with the transformers was placed a couple of incandescence lamps as a non-inductive resistance, and three Kelvin multicellular electrostatic voltmeters were employed in a three-voltmeter method to measure the power absorbed in the transformers. The resistance of the lamps was obtained by a measurement of the current passing through the lamps, using either a Kelvin ampere balance or a dynamometer placed behind the voltmeters. With these arrangements, and using a very steady pressure, and such ratios of the potential differences as would give the best results, we obtained 11 measurements of the power absorbed at no load by these three little "Hedgehogs." These results are tabulated in Table XXXI. Then, next, both the Swinburne wattmeter and the dynamometer wattmeter were carefully standardised on an incandescence lamp working at 100 volts; measuring first the true power taken up in the lamp by volts and current, and then using this value to obtain the constant of the wattmeters. The standardised wattmeters were then set to measure the power taken up in the three small transformers. The results are given in Table XXXII.

Table XXXI.—*Experiments on Power absorbed by Three small "Hedgehog" Transformers at No Load, taken by Three-Voltmeter Method at 100 volts.*

Current through transformers, in amperes.	Readings of electrostatic voltmeters (Kelvin).			Resistance in series with transformers, in ohms.	Power in watts absorbed by the three transformers.
	V_1.	V_2.	V_3.		
2·02	100	93·6	143·0	46·3	18·2
2·02	100	93·9	143·5	46·5	19·1
2·02	100	94·0	143·0	46·5	17·1
2·02	100	93·9	143·4	46·5	18·9
2·02	100	93·9	143 0	46·5	17·6
2·02	100	94·3	144·0	46·7	19·4
2·07	100	95·2	144·7	45·9	20·4
2·06	100	95·4	144·6	46·2	19·5
2·096	100	95·5	145·0	46·1	20·7
2·092	100	96·7	145·8	46·2	20·5
				Mean power in watts, 19·26	

Table XXXII.—*Experiments on the Power absorbed by Three Small "Hedgehog" Transformers at No Load, taken by Dynamometer and Swinburne Wattmeter at 100 Volts.*

(Wattmeters both standardised on an incandescence lamp taking 42 watts.)

Volts on terminals of transformers.	Scale Readings of		Power absorbed in watts by the three transformers.	
	Dynanometer wattmeter.	Swinburne wattmeter.	By dynamometer wattmeter	By Swinburne wattmeter.
100	15·0	28·5	19·1	12·6
100	15·1	28·5	19·2	12·6
100	15·1	28·8	19·2	12·7
			Mean	Mean
			19·16	12·61

* This symbol, $\sqrt{\text{mean}^2}$, is a convenient abbreviation for the long phrase, "taking the square root of the mean of the squares of all the instantaneous values of the periodic quantity at equal short intervals of time throughout the period." It is the *effective* or *virtual* value.

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Collected Results for the Mean Value of Power absorbed by the Three Small "Hedgehogs" arranged in Parallel.

By three-voltmeter method	19·26 watts.
By dynamometer wattmeter	19·16 „
By Swinburne wattmeter	12·61 „

We see that the mean value of the power taken up as measured by the three-voltmeter method agrees quite well with the value obtained by the dynamometer wattmeter, but that the value obtained by the Swinburne wattmeter is nearly 34 per cent. lower than the other two. These experiments, which were very carefully made, convinced me that the cause of the discrepancy must be looked for in the Swinburne wattmeter.

Mr. Swinburne sent for use with his transformer a condenser suitable for putting upon the primary circuit in parallel with the primary circuit of the "Hedgehog." We therefore applied the two wattmeters to measure the power taken up (1) in the condenser alone, (2) in the transformer alone, and (3) in the condenser and transformer on open secondary circuit when the condenser was joined in parallel with the primary of the transformer. The primary pressure was 2,400 volts in all cases. When the condenser was across the circuit alone, the current flowing into it was 0·458 ampere, as measured by a Kelvin balance. Since the frequency was 83, this shows the capacity of the condenser was about 0·36 of a microfarad. The magnetising current, or open-circuit current, of the 3,000-watt "Hedgehog" was 0·761 ampere; and when "Hedgehog" and condenser were joined in parallel the current flowing into them jointly was 0·283 ampere. The Swinburne wattmeter and dynamometer wattmeter being both standardised, 12 measurements were taken with each instrument—four of the power absorbed in the condenser, four of that absorbed in the transformer with open secondary, and four of the condenser and transformer joined in parallel. The results are given in Table XXXIII.

Table XXXIII.—*Experiments on the Power absorbed in Condenser and "Hedgehog" Transformer separately and together, taken by Two Wattmeters at a primary pressure of 2,400 volts.*

(*a.*) *Power absorbed in Condenser alone.*

By Swinburne wattmeter.		By dynamometer wattmeter.
44·8 watts	.....	18·0 watts.
44·0 „	.....	21·0 „
50·0 „	.....	30·0 „
47·0 „	.....	27·0 „
Mean ... 46·4 „	..... Mean...	24·0 „

(*b.*) *Power absorbed by "Hedgehog" at No Load.*

By Swinburne Wattmeter.		By Dynamometer Wattmeter.
41·5 watts	.....	120·0 watts.
44·0 „	.....	120·0 „
36·0 „	.....	108·0 „
33·0 „	.....	112·0 „
Mean... 39·0 „	..... Mean ...	115·0 „

(*c.*) *Power absorbed by Condenser and same Transformer in Parallel.*

By Swinburne Wattmeter.		By Dynamometer Wattmeter.
96·3 watts	.....	144·0 watts.
95·0 „	....	144·0 „
100·0 „	....	150·0 „
95·0 „	.....	140·0 „
Mean ... 96·5 „	..... Mean ...	144·0 „

It is clear, therefore, that whilst relatively to the dynamometer wattmeter Mr. Swinburne's first wattmeter reads too low on his transformer, it reads too much on his condenser, and he has been overrating the power taken up in the condenser to about the same extent as he has been underrating that taken up in the transformer.

On thinking over these results, it became evident that they could be accounted for on the supposition that the current through the shunt circuit of the Swinburne wattmeter was *advanced* in phase as compared with that of the primary impressed potential difference between the ends of that circuit. The correctness of the wattmeter as a power-measuring instrument depends upon the current in the shunt circuit being exactly in step, or consonance, with the periodic potential difference at the ends of that circuit. When the wattmeter is applid to the open-circuit transformer, the current through the transformer, which is also the current in the series coil of the wattmeter, lags behind the P.D. at the primary terminals of the transformer. Hence, if the current through the wattmeter shunt circuit (which should represent that P.D. in phase and magnitude) is advanced in phase, the two currents (series and shunt) in the wattmeter will have a greater difference of phase impressed upon them, and hence the mean product will be diminished. Again, if the wattmeter is applied to a condenser, the current through the condenser is normally in advance in phase of the P.D. at its terminals. Hence, by the same reasoning, any cause tending to advance the phase of the current through the shunt circuit of the wattmeter will bring the shunt and series currents more into step and increase the mean product. Therefore the wattmeter reading will be too little on a transformer and too great on a condenser.

It is obvious that this advancement of phase of the current in the shunt circuit of the wattmeter could be produced by *capacity* in that circuit. The resistance of the shunt circuit of the Swinburne wattmeter is about 100,300 ohms; of that, the moveable coil has 300 ohms resistance, and the 100,000 ohms is the resistance of the doubly wound fine wire in two brass boxes, which are joined in series with the bobbin. Experiments were then made to see if we could, by artificially increasing the capacity of either of these parts of the shunt circuit, exaggerate the defect, and, if so, whether the readings of the wattmeter on the "Hedgehog" were more altered than readings on a non-inductive resistance.

Experiment 1.—A small Leyden jar of 1 pint size, about 0·001 or 0·0005 of a microfarad in capacity, had its inside and outside coatings connected to the ends of the external resistance (in brass boxes) of the shunt circuit. So arranged, the Swinburne wattmeter was applied to measure the power taken up in the 3,000-watt "Hedgehog" on open circuit and in our non-inductive resistance. With the jar removed, the deflection of the wattmeter was five divisions, corresponding to about 80 watts taken up in the transformer. With the jar added, the deflection fell to 0·3, or 5 watts. No such change was produced by adding the jar when the power being measured was being taken up in the non-inductive resistance. It is evident, therefore, that capacity added to the shunt circuit still further reduces the wattmeter readings.

Experiment 2.—In order to find out, if possible, whether the prejudicial capacity existed in the external resistance in the brass boxes or in the internal resistance in the moveable bobbin of the shunt circuit, the brass boxes were removed and their place taken by a resistance of 34,000 ohms, made up of the filaments of high-resistance incandescence lamps. It seemed clear that a row of lamps could have no sensible capacity. The readings of the wattmeter were then compared when the shunt circuit external resistance consisted of 34,000 ohms made up of lamp filaments, and 100,000 ohms made up of doubly coiled wire in brass boxes, being taken both on the 3,000-watt "Hedgehog" and on a 15-H.P. Ferranti transformer. No greater difference was found in the power measurements in the two cases than might be due to errors of reading. For the "Hedgehog" the power reading with the external resistance of lamps was 79 watts, and 81 watts in the case of the wire resistance. For the other transformer values of 125 and 130 watts were found. Hence it appeared to be more probable that the capacity giving rise to this diminished power reading might be due to the small electrostatic capacity of the tightly coiled wire bobbin of very many turns which forms the suspended circuit of the wattmeter, and that this capacity advances the phase of the current in the shunt circuit, so that instead of being exactly in step with the P.D. on the terminals of the transformer it is slightly in advance of it.

Subsequently to the date of the experiments above recorded, Mr. Swinburne sent a second wattmeter of similar character, but differing from the first sent in that it had an ebonite outer case and no metal frame near the moveable coil. This second wattmeter was carefully compared with the first one and with our own dynamometer wattmeter. The three wattmeters were standardised, and their constants determined by noting the instrumental readings when the instruments were set to read the known power taken up in the standard inductionless platinoid resistance arranged to absorb 600 watts at a P.D. of 2,400 between its terminals. The so-calibrated wattmeters were then set to read the power taken up in the 3,000-watt "Hedgehog" on open circuit, the Swinburne condenser, the old Ferranti 1,850-watt transformer, the Kapp and Thomson-Houston transformers. The results are given in the table below.

Table XXXIV.—*Comparison of Wattmeter Readings on various Circuits.*

Reading of dynamometer wattmeter, in watts.	Readings of Swinburne wattmeters in watts.			Object tested.
	Second pattern.	First pattern.		
		Case on.	Case off.	
600	600	600	600	Standard resistance
114	106	57	68	3,000-watt "Hedgehog"
15	20	46	—	Condenser
114	99	83	—	Thomson-Houston transformer
156	154	112	—	Kapp transformer
303	282	—	—	Ferranti transformer

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It is clear from the above observations that the second wattmeter with ebonite case agrees much more nearly with the dynamometer wattmeter than does the first having a brass case. The differences between the second wattmeter and the dynamometer are quite within the limits of errors of observation, seeing that the instrumental reading for 15 watts is only about 0·5 of a scale division on all instruments. It is evident, therefore, that the second wattmeter sent by Mr. Swinburne is a very different instrument from the first one. The writer is unable to say whether it differs in any way from the first one, except in having an ebonite instead of metal case, and in having no metal supports near the shunt coil, but it is obvious that the displacement of phase of the shunt current no longer takes place. According to the view above stated, this displacement is the consequence of a capacity effect. It is difficulty to see how eddy-currents set up in any metal near the moveable coil could create the observed defects in accuracy; because, although these might weaken the resultant field in which the moveable bobbin hangs and so make the wattmeter readings too low, we have to account also for the fact that the first wattmeter reads too much on a condenser. It is evident, however, that the second wattmeter Mr. Swinburne sent me is a fairly accurate instrument, whereas the first one is quite unreliable on circuits of small power-factor.

Before we christen a wattmeter a "non-inductive wattmeter," it should be carefully tested on inductive circuits of small power-factor and large capacity or inductance.

VII.—*General Remarks on the use of Dynamometer Wattmeters to Measure Alternating-Current Power.*

The foregoing experiments impressed upon us the necessity for caution in concluding that any wattmeter of the dynamometer pattern, and however made, would give correct readings of the alternating-current power taken up in an inductive circuit. If we consider a simple harmonic current, I, in, and potential difference, V, at the ends of such an inductive circuit, then the mean value of power, W, taken up in the circuit is $\frac{1}{2}$ I V cos ϕ, where I and V are the maximum values during the period, and ϕ is the phase difference of I and V. If ϕ varies, then the rate at which the measurements of the power W is varied is expressed by $d\,W/d\,\phi = -\frac{1}{2}$ I V sin ϕ, and the ratio of d W/W is therefore equal to - tan $\phi\, d\,\phi$. Hence a small change in ϕ produces a greater effect on the value of the error in measuring the resulting power in proportion as ϕ increases from 0° to 90°.

In the case of an open-circuit transformer there is a very considerable difference of phase between the primary current at no secondary load and the difference of potential between the primary terminals.

Accordingly, if a wattmeter of the dynamometer type is applied to measure the power being taken up in such a transformer at no load, there is a correspondingly great difference between the phases of the currents in the shunt and series coils of the wattmeter. If, then, either by reason of capacity or inductance in the shunt circuit, the phase of the shunt current is displaced by a small amount, the percentage change so introduced into the mean product of the currents—*i.e.*, into the wattmeter reading—is much larger than if the instrument was being used on a transformer of large power-factor.

Hence, in the employment of such a wattmeter it is desirable that the moveable part of the shunt circuit should have very few turns, and that all metal framework near it be avoided. Generally speaking, it will then be difficult to bestow upon the shunt coil sufficient magnetic moment unless the current in it is comparatively large. This means that considerable power will be dissipated in the wattmeter itself. It is better, however, to employ a wattmeter which uses up a few horse-power and obtain accurate results with it, than reduce its shunt circuit to a small value and introduce sources of error. It is as necessary to avoid capacity as to annul self-induction in the shunt circuit. As to the external non-inductive resistance in series with the shunt coil, we have, as seen, always preferred to employ a series of incandescence lamps. There is no difficulty in doing this when the means exist for keeping the P.D. between the primary mains constant. Large circuits of incandescence lamps in series are, however, rather unwieldy and expensive. I have been experimenting lately with other methods to obtain the necessary non-inductive resistance for the external shunt circuit of the wattmeter cheaply and in a compact form. The conclusion arrived at, however, is that, with proper precautions, a suitable dynamometer wattmeter is a very useful instrument to employ for measuring in a practical workshop-like way, the power being taken up in inductive circuits, and that it is much more easy to manage than any of the many other complex methods which look so well on paper and are so difficult to carry out satisfactorily in real life. In any case, a practically non-inductive metal wire resistance is necessary wherewith to standardise the wattmeter *in situ* and before use; and if the moveable coil has very few turns, and no metal near it, and the external shunt circuit is of proper kind, excellent results in measuring alternating-current power may be obtained with it

VIII.—*Experiments on the Magnetic Behaviour of Transformers at the Moment of Connecting them to a Circuit.*

More than fourteen months ago I carried out a series of experiments and observations on the behaviour of transformers at the moment of switching them on to a "live" circuit, and which are, I venture to think, of some practical importance. They arose out of facts which came to my notice regarding instances of sudden failure of transformers at the instant of closing the primary switch. Transformers have been known to be pierced or to break down on switching on after having worked well for a long time. To investigate the behaviour of transformers at the moment of closing the primary switch and connecting them to a high-pressure "live" circuit, the following experiments were tried:—

Experiment 1.—The secondary circuit of a 4-inch spark induction coil (kindly lent by Mr. Apps) was closed by a vacuum tube of a very sensitive kind. It had long overlapping platinum electrodes. The ordinary primary coil with iron core was removed, and its place filled by a bobbin of 12,000 turns of insulated copper wire wound on a wooden core. This primary coil could be slid into or out of the secondary coil. The primary coil was placed in series with the primary circuit of a 40 H.P. transformer, the "magnetising current" of which was 0·137 ampere. When the transformer had its secondary circuit open, this magnetising current in the primary flowing through the primary coil of the induction bobbin just sufficed to keep up a glow, visible in the dark, in the vacuum tube. The primary coil of the induction bobbin was then withdrawn from the secondary until the glow in the tube just disappeared. Under these circumstances the vacuum tube was an exceedingly delicate detector of any sudden increase in the primary current. If the primary circuit of the transformer was then suddenly and frequently opened and closed by a switch, it was found that at intervals, on some occasions of closing the primary switch, the vacuum tube flashed up brilliantly, thus showing that a rush of current far exceeding the normal magnetising current took place into the transformer on some occasions when the primary switch was closed.

Experiment 2.—Another way of detecting this rush of current is to insert in the primary circuit of the transformer an incandescent lamp, which is brought to proper incandescence by the normal magnetising current of the transformer. Thus, in one of our experiments, a 10-candle incandescent lamp, taking 0·33 ampere, was placed in the primary circuit of a 5-H.P. transformer, the magnetising current of which was 0·35 ampere. When the secondary circuit of the transformer was left open and the primary switch suddenly closed, on most occasions the lamp came quietly to normal incandescence; but on some occasions, on closing the primary switch, the lamp flashed up brilliantly, so much so as to blacken the glass, and in some cases even to break the filament. This experiment showed in a striking manner the sudden rush of current into the transformer on closing the primary switch.

Experiment 3.—In another experiment, a Kelvin centiampere balance was inserted in the primary circuit of a 40-H.P. transformer, of which the normal magnetising current was 0·17 ampere. The balance was adjusted so as to be in equilibrium when this current was passing, and the primary current was then switched on frequently. On some occasions the balance was thrown up violently, even when the weight was moved into positions corresponding to 5 or 10 amperes. In one case, the weight being at the position corresponding to 10 amperes on the balance, the balance was thrown up violently at the third switch-on. On other occasions, the weight being at the position corresponding to 10 amperes, the balance was thrown up at the 5th, 11th, and 13th time of switching on, whilst on the other occasions it was not moved. In one instance the beam of the balance was thrown up so violently that the weight, having a mass of about 66 grammes, was completely thrown off the scale pan; thus indicating that on that occasion an immense rush of current passed in the transformer at the moment of closing the primary switch, but which current sank again almost instantly to the steady value of 0·137 of an ampere.

Experiment 4.—The safest and by far the most convenient method of showing this rush of current was found to be the employment of a simple form of dynamometer placed in the primary circuit. Two flat coils were constructed of No. 20 covered copper wire, each coil having 23 turns coiled up as a sailor coils a rope, the external diameter of the coil being 5½ inches. These flat coils were suspended by silk ribbons on a vertical plane, facing one another. The coils had straws cemented to them, which hung down like the leaves of a gold-leaf electroscope. By means of flexible connections, the primary current of the transformer could be passing through both coils in series in such a direction that the coils tended to repel one another when the current was passing. The weight of the coils was such that when the normal magnetising current of the transformer was passing the repulsion was hardly visible. On switching on and off the primary current a great many times, on certain occasions the coils were flowing widely apart, so that the straws, which were about 8 inches long, diverged from one another like the leaves of a gold-leaf electroscope when an excited glass rod

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is brought near them ; the divergence being such as to cause the tips of the straws to separate about 6 inches. This arrangement could be conveniently inserted in the primary circuit of any transformer, and adjusted so as to show the sudden rush of current on some occasions when the primary circuit was closed.

Experiment 5.—On those occasions when the sudden rush into the transformer took place, a violent thump, or knock, was heard in the transformer. The suggestion was made by Mr. Partridge to employ a wooden rod pressed against the transformer in order to listen to the internal sounds. Accordingly, a transformer stethoscope was constructed, consisting of a rod of deal with a piece of ebonite on one end and a circular disc of pine on the other. By pressing the ebonite against the iron core of the transformer and putting the ear against the wooden disc, it was found possible to study these internal noises in the transformer. On listening to the character of the sound made on switching on a transformer, it was found that on some occasions there was hardly any noise ; on others, a slight knock, or thump, or loud tick ; and on others, a still more violent noise ; and the violent noise always occurred when the other appliances showed a sudden rush of current taking place into the transformer. It is clear, therefore, from these experiments that something peculiar happens on some occasions on closing the primary switch of a transformer having an open secondary circuit, at the moment when the primary current is connected to the "live" circuit. On considering the matter carefully, it became evident that the conditions under which the transformer is disconnected from the circuit must determine what happens when that transformer is reconnected to the circuit. If the current is flowing into the primary circuit of a transformer, and the switch is opened, as long as the arc continues at the switch, so long does the alternating current produce in the iron core an alternating magnetism ; but, at some instant, the arc breaks suddenly, and the primary current is then interrupted. The transformer, therefore, is left magnetised in some particular phase—either strongly magnetised one way or the other, or, perhaps, not magnetised at all, depending on the phase of the current when the current finally ceases. It is clear that on switching on the current again the switch must be clos d in some particular phase of the pressure, and that, therefore, the incoming current finds the iron of the transformer already in a magnetic condition. It may be that the magnetism of the iron is in such a direction that the current is able to produce instantly the necessary counter electro-motive force to keep down the current to its normal mean value ; but it may be that the magnetism of the core is in such a direction that the first change which takes place in the magnetic condition of the core is one which, so far from introducing a back electromotive force into the primary circuit, actually assists the current. In other words, the self-induction of the tranformer is non-existent for the first moment, and until the current has got the core into proper magnetic condition, in proper relative step with itself, there is not sufficient impedance in the primary coil to prevent the impressed electromotive force making just whatever current it can, so far as the true, or "ohmic," resistance of the primary circuit will allow. Under these conditions, therefore, it is evident that there must be a great rush of current into the transformer, until the impedance is built up by the magnetism of the core falling into proper relative step with the current.

Experiment 6.—It was considered advisable to find out whether this sudden rush of current into the transformer was accompanied by an increased potential difference between the primary terminals of the transformer ; accordingly, the induction coil and vacuum tube employed in experiment 1 were arranged so that the primary circuit of the induction coil was in series with a non-inductive resistance placed across the primary mains, in parallel with the primary circuit of the transformer. It was expected that if a rise of pressure took place on switching on the transformer, the vacuum tube would indicate it by flashing up ; but the experiment failed to indicate any rise of pressure, even when the primary coil of the induction coil was adjusted as carefully as possible to show any increase in pressure between the primary mains.

Experiment 7.—The following method was then tried :—Two brass balls, about 1 cm. in diameter, carried by horizontal screws, having 24 threads to the inch, passed through fixed nuts on an insulating stand. One of these screws had a large divided ebonite head, or arm, to serve both as a handle and an index. This discharger was placed in series with a primary fuse across the primary mains, in parallel with the transformer. The balls were then screwed up until just in physical contact, and afterwards separated by such a distance that the alternating pressure employed between the primary mains—namely, 2,400 volts—just could spark across the distance. This sparking distance was found to be about three-quarters of a millimetre. Having determined this sparking distance, the balls were further separated by such a small amount as just to prevent the normal pressure from sparking across. This arrangement being kept in parallel with the primary circuit of the transformer, the primary current was then switched on and off a good many times, and on some occasions the spark jumped across the spark balls at their increased distance, thus showing an increase of pressure. The greatest distance between the balls across which the spark was found capable of jumping was 0·84 of a millimetre. Other experiments were made to determine what alternating pressure would jump across this increased distance. It was found to be something not exceeding 4,000 volts.

The above experiments were varied in many ways, but they all went to prove that at the instant of switching the transformer with an open secondary circuit on to the primary mains, a sudden rush of current may take place into the transformer, and a sudden rise of pressure at the terminals of the transformer.

Experiment 8.—It was deemed advisable to ascertain whether the rush of current into the transformer was a continuous rush—that is to say, a rush all in one direction, lasting over a certain fraction of a second—or whether it was an alternating rush—that is to say, a great increase of current, but at the same time maintaining the normal alternations. In order to settle this point, the flat coils before described in Experiment 4 were arranged so that the primary current of the transformer flowed through one coil, whilst the other coil was traversed by a continuous current produced by a secondary battery. If the rush of current into the transformer is a current always in the same direction, lasting a sensible fraction of a second, it was thought probable that a repulsion would take place between the two coils, one traversed by the steady current, and the other traversed by a current into the transformer ; but no such repulsion was found under any circumstances.

It seems probable, therefore, that this rush of current is an alternating rush, and that it is simply due to the fact that until the magnetisation of the core has settled down into the proper condition, the impressed alternating electromotive force produces whatever current it can through the primary coil, being only limited in so doing by the true resistance of the primary coil.

Experiment 9.—It was considered important to ascertain how this rush into the transformer could be prevented. It is obvious that it can be entirely destroyed by inserting a sufficient non-inductive resistance into the primary circuit, which is gradually removed in place of suddenly closing the switch.

A better method, however, was suggested by Mr. Reginald Brougham—that is, to wind on the transformer a small tertiary circuit. This tertiary circuit is made to take current from another small transformer, which is kept in permanent connection with the primary main, and by means of which the core of the transformer to be connected is magnetised in the proper manner and in the proper direction for producing instantly the necessary opposing electromotive force in the primary circuit when the primary switch of that transformer is closed. When this is done, there is never any "bang," or sudden current-rush, on closing the primary switch of the transformer under test. As a matter of fact, it has been found that when a bank of transformers is being fed from one primary circuit, and feeding their secondary currents into one secondary circuit, then, provided that one of the transformers of the lot is kept connected both to the primary and secondary sides, it is amply sufficient to proceed in the following manner in connecting in other transformers, in order to obtain perfect immunity from any harmful rush of current :—The transformer to be connected to the circuit is connected first on the secondary side, and although this process does produce a rush of secondary current back into the transformer, yet, nevertheless, the rises of pressure that take place never seem to be very serious. The transformer core being thus magnetised in proper relative step with the primary pressure, the primary circuit can be closed, and under no conditions then will there be any sudden rush of current into the transformer.

Experiment 10.—Many experiments were tried to find out what was the minimum resistance necessary to prevent this rush in the various sizes of transformers. It is obvious that a switch which closes the primary circuit, first by inducing resistance, and then gradually removing it, will sufficiently prevent any obnoxious rush of current into the transformer, because the impressed electromotive force is held back, as it were, by the additional resistance from producing excessive current until the magnetism of the core has had time to fall into proper step.

Experiment 11.—Many effects due to similar causes can be produced in open magnetic circuit transformers. In switching off an open-circuit transformer, such as the "Hedgehog," when the secondary of the transformer is on open circuit, a very strong arcing is sometimes observed at the switch ; and the shorter the magnetic circuit of the transformer, the worse does this effect become. On one occasion I had brought to my notice an experimental transformer of an open-circuit type, the iron core of which was remarkably short in comparison with its width. This transformer had a remarkable property—that, after having been connected to the primary circuit, it could not be disconnected as long as the secondary circuit of the transformer was open, without making an immense arc at the switch.

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The rough explanation of this fact appears to be as follows :—In the open magnetic circuit transformer, especially if the iron part of the magnetic circuit is very short, the average value of the rate of change of induction or of the back electromotive force decreases much more rapidly as the mean value of the current decreases than is the case in closed magnetic circuit transformers. Hence, when in the case of the first-named transformer the primary switch is opened, the immediate reduction of the primary-current strength removes the greater part of the back electromotive force, or opposing counter electromotive force of induction, and greatly increases, therefore, the resultant electromotive force in that circuit. An arc, therefore, continues to follow the switch points as they open, for a considerable distance. In the case of the closed magnetic circuit transformer this is not the case. The initial reduction of the current-strength as the primary switch opens is not accompanied by so great a reduction in the mean rate of change of the induction, and, therefore, of the back electromotive force. The resultant electromotive force in the circuit does not, therefore, rise much, and the switch points are soon beyond the distance at which an arc can be maintained.

Such an arcing can be subdued in the case of a very short iron magnetic circuit transformer by closing the secondary circuit. The mutual induction of the circuit then assists in creating a greater back electromotive force in the primary circuit, and so keeps the resultant electromotive force small as the switch points open.

There are several effects of this kind observable in the process of connecting or disconnecting large condensers to or from high-pressure alternating circuits. There is, in fact, always a risk of breaking down large condensers at the moment of putting them on or off alternating-current circuits, and this appears to be connected with a peculiar behaviour of an alternating-current arc between metallic surfaces, in virtue of which it acts like a resistance of large self-induction.

Conclusion.

There are very many derivative matters which, if space permitted, might be discussed as consequences of facts observed in the course of the above-described researches. It is evident, for instance, that the last word has by no means been said on the subject of design of transformers. I have every hope that before long transformer manufacturers may be able to produce transformers of 25 H.P. and upwards, having close upon 90 per cent. efficiency at one-tenth of full load. When that is done, it will be interesting to repeat some of those calculations which have already been made as to the relative cost of delivering a certain number of thousand units on an average load diagram, say for distances of 1,000, 2,000, 3,000 yards, &c., by low-pressure feeders and by high-pressure plus transformer feeders. Calculations of this kind can be made with some degree of confidence now that it seems clear that the iron losses in transformers are constant at all loads, and that there is a definite relation between this loss and the open-circuit or magnetising current. We can hardly regard the great controversy of open *versus* closed magnetic circuits as entirely and definitely settled, but there is no reason to believe that the majority of those who have designed transformers with closed magnetic circuits have been supremely unwise in their faith or in their works.

In the matter of transformer testing, the experience gained in obtaining the facts brought before you has established in the writer's mind at least the feeling that a properly constructed dynamometer wattmeter is perhaps the best workshop instrument to use for this purpose, but that its personal character must be strictly examined before trusting too implicitly to the results obtained by it.

In conclusion, it will only be right to make mention of those who have assisted me in the somewhat arduous work of taking the observations here recorded. The principal share of this has been borne by my assistant, Mr. Shields, who has worked with great perseverance and care for many months in taking the actual observations, and this in many cases required some painstaking work. He was assisted at intervals by Messrs. J. and D. Morris, students in University College, London, especially in those observations in which the careful simultaneous reading of several instruments was required. The observations on the sudden rush of current into transformers were made for me by Mr. Wordingham.

The facts and measurements thus obtained have in all cases been sifted and repeated with the greatest possible care, with the desire to arrive at conclusions which should be worthy of confidence, and useful to those engaged in transformer manufacture and design.

The discussion on Dr. Fleming's Paper was opened on December 1st, by Mr. J. Swinburne, who attributed the errors of the wattmeter to eddy currents in the brass case of the instrument. He denied that the losses in the Hedgehog transformer were due to eddy currents in the copper, but admitted that such currents were set up in the core which was violently compressed during winding. An abstract of the discussion will appear in our next issue.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 25, 1892.

The Chicago and St. Louis Electric Railway.—Considerable comment has been excited during the past week by the rumour that the General Electric Company would take a financial interest in this line. Early in the week one of the financial news agencies of the city made the statement that the recent issue of $6,000,000 in 5 per cent. Debenture Bonds by the General Electric Company was for the purpose of raising funds for this enterprise. The General Electric officials have been very reticent about giving information as to the purpose for which the bond issue was made, and, of course, there was more or less guessing regarding it. It seems that Dr. Wellington Adams, in an interview at St. Louis, had said that during his recent trip east he had made a deal that put all worry about finances out of the way; and when this issue of General Electric Bonds was made it was surmised that it was for this purpose. General Electric officials are out to-day with a practical denial of the rumour, saying that they have no intention of backing the project financially, but that in case the equipment of the line should be entrusted to them, they would have no hesitation in undertaking it. It is highly probable that should this concern take hold of the equipment of the projected line which—as your readers will remember—is to be constructed between the two cities in a bee-line over a distance of 250 miles, the work would undoubtedly be pushed forward and completed in time for the World's Fair traffic. The project is certainly becoming a matter of more general interest, and one which railroads, as well as electrical engineers, are now discussing from a business as well as an engineering point of view. The construction of the line has already been inaugurated and will be carried forward rapidly. A section at about the centre of the line, 10 miles in length, is already graded, and the right of way has been secured over a large part of the entire line, including a section 29 miles long at the Chicago end of the road. This section takes in the entrance through the suburban and business part of the city of Chicago, and is probably the part which would be the most difficult to secure.

The Edison Lamp Patent Suit.—The injunction recently obtained by the Edison people in their big lamp patent suit, it will be remembered, was against the United States Electric Lighting Company. This Company, it now appears, has turned over its entire business to the Sawyer-Man Company, and an injunction is now sought by the Company controlling the Edison patent to prevent the Sawyer-Man manufacture of lamps. Under ordinary circumstances it might appear that the decision would merely be a repetition of the former one, but this time a number of different questions will arise. The Sawyer-Man Company is, as is well known, at the present time a branch of the Westinghouse Company, while the Company controlling the Edison patent is the General Electric Company, so that the fight is now between the General Electric and Westinghouse Companies. The Westinghouse Company admits that the lamps now turned out by the Sawyer-Man Company are an infringement on the patent just sustained by the United States Court of Appeals, and expresses its willingness to go out of the lamp business so far as this particular kind of lamp is concerned, but asks for time to do it in. The principal question, however, to be decided, is one raised by the Westinghouse Company to the effect that the General Electric Company being a "most vicious trust," established in violation of the laws of the State of New York, has no standing in court. By agreement of the counsel in the case a preliminary injunction was granted in the lower court, which, however, was stayed until the matter can be brought up before the United States Court of Appeals, which is the same court that recently passed a decision on the Edison lamp patent. The question to be decided, it is evident, is a very important one, and the decision of the Court of Appeals will be awaited with interest. It is expected that the matter will be pushed forward as rapidly as possible, and that the decision will be reached before the end of the year.

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CORRESPONDENCE.

FIRE AT THE LONDON STEREOSCOPIC COMPANY'S PREMISES, REGENT-STREET.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to a letter you publish in your last issue signed "J. D. F. Andrews." The statement he makes therein, that I examined and passed the electrical installation at the London Stereoscopic Company's premises, contains not a single word of truth. I knew nothing whatever about the installation, nor were any of the insurances effected in the Phœnix Fire Office.

With regard to Scott's Oyster Rooms, I never saw the installation, nor was I even aware that the electric light was on the premises. Neither was the Phœnix Fire Office aware that there was any electrical installation, the work having been placed up some years ago, when the premises were insured in another fire office. As to whether there is the slightest justification in laying the charge of the fire to electricity, I leave those concerned to say, if they think it worth their while. I must request you to publish this letter, as the false and misleading manner in which Mr. J. D. F. Andrews has made use of my name makes me depart from my rule of passing unheeded erroneous or unjust statements in print with regard to myself or my work.—Yours, &c., MUSGRAVE HEAPHY.

London, Dec. 6, 1892.

[We sincerely regret the annoyance which the inadvertent publication of Mr. Andrews' statements has caused Mr. Heaphy and the Phœnix Fire Office. The fire at Scott's Oyster Rooms was recorded in *The Electrician* of May 27, 1892, when we stated that the work had not been inspected by the Phœnix Office. The Phœnix Fire Office has never become liable for any risk undertaken by them under their Electric Lighting Regulations, which were framed so long ago as February, 1882.—ED. *E.*]

VARLEY TESTIMONIAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We shall be glad if you will allow us the opportunity of calling the attention of your readers who are interested in the above to the fact that, although we have received encouraging responses and subscriptions from some of those we expected to aid us, yet the response has, as a whole, up to the present been disappointing, more especially on the side of the manufacturing community. We are sure that it will be found in most cases that this is due to our circular letter of appeal having been overlooked, owing to its being sent out during the season when a good many members of the electrical profession were away on their holidays.

The object of this letter is to remind them and all others who have benefited by the undoubted impulse which Varley's inventions gave to electrical engineering, to send in, without further delay, their subscriptions according to their means to Mr. A. Stroh, 98, Haverstock-hill, N.W., endorsing subscriptions to Varley Testimonial Fund.—Yours, &c.,

A. STROH, Hon. Treasurer.
R. E. CROMPTON, Hon. Sec.

December 5, 1892.

GILBERTIANA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been drawn to the paragraph in your American Notes on p. 135, in which there is a statement that a translation of Gilbert's "De Magnete" is about to be brought out in the States, and which further refers to the Gilbert Club, of which I have the honour to be one of the secretaries.

I think your American correspondent must be under some mistake in attributing the proposed translation to Mr. Mottelay, who is an honourable gentleman. He visited me at my laboratory rather more than a year ago, when we talked of Gilbert and of the Gilbert Club, and its long-cherished work. He then begged me to enter his name in one of the then few remaining places in the list of the members, that in due time he might receive the copy of the English translation of "De Magnete." He is not the man to lend his name in an underhand way to an attempt to depreciate the careful work that has been going on for three years by the Editing Committee of the Club.

As to this alleged American translation, it is quite enough for most persons to know that its publishers are to be Messrs. J. Wiley and Sons, of New York, who have earned for themselves evil notoriety by their pirated editions of Ruskin's works. The Gilbert Club may well ignore anything emanating from so tainted a source.

As to the last part of your correspondent's paragraph, which relates to the affairs of the Gilbert Club, I will only say that down to the present time the club has not asked for a single subscription from any of its members, nor will it do so until its translation of "De Magnete" is ready for distribution. All the preliminary expenses of its foundation have been met without yet calling on the treasurer. It is true that a very few of the members spontaneously remitted their guinea apiece; and these subscriptions remain intact, awaiting the day of publication. The delay which has arisen since the first rough translation was completed two years ago has been due solely to the labour of revision. But the Gilbert Tercentenary does not occur till 1900, and the work will be published within a few months from the present date.—Yours, &c.,

SILVANUS P. THOMPSON.

Morland, Chislett-road, West Hampstead, N.W.

EARTHING THE MIDDLE WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is to be hoped that the correspondence now going on in your paper on this subject will receive the attention it deserves. There are some very important aspects of the question which have not so far been touched upon by your correspondents. The rapid development of supply from central stations has introduced new elements which have not yet, it seems to me, received full consideration. There is a deep-rooted prejudice against earthing any portion of the circuit, and this prejudice is not without reason.

The reasons which have held against earthing on isolated installations apply with thousandfold force against earthing any portion of a general supply. They need not be recapitulated in detail here. They are based on bitter and dearly-bought experience, and are not to be lightly disposed of. They apply with almost equal strength to all systems of public lighting hitherto adopted, and they become stronger as the different parts of the work become, as they surely will, more and more dissociated. The time when the station, the underground conductors, and the house wiring were all done in whole or in part by one contractor is rapidly drawing to a close, and the skilled electrician will very soon be ousted from the detail work of wiring and fitting, which will certainly fall more and more into the hands of tradesmen, who will have to be entrusted with this department. Even now it is notorious that an "electrical engineer" is not necessarily even a skilled tradesman. It is therefore necessary to reconsider the whole question, keeping this important and inevitable new development in view.

The Fire Office rules have hitherto been of immense value in helping to secure fairly safe conditions—thanks to the attention of Mr. Musgrave Heaphy and other gentlemen who have followed in his footsteps, but it still remains for electrical engineers to provide a set of conditions under which the fire inspector may be expected to look after the interests of his company, and the tradesman to carry out his work, without expecting impossibilities of them in their respective spheres.

The experience of the past few years on American low-tension stations, where the almost universal practice is to earth the middle wire, is not at all encouraging. A very casual examination of the conditions will convince any experienced electrician that they are eminently unsatisfactory. Our experience on this side is likely to be quite as unsatisfactory.

Although it is not the general practice here to earth the middle or any other wire of set purpose, all the elements of danger exist in equal degree, so long as accidental earths may, as they certainly may, arise at any part of the circuit.

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Electrical engineers are gaily proceeding with the laying of bare copper conductors in conduits where occasional, or even constant, leakage by earth connections is absolutely certain to take place. And the risk of such earth connections is by no means confined to low-tension circuits or to bare conductors. Every time such a fault occurs there are provided many thousands of conveniences for fire-making. On one side of every branch, every switch, safety-fuse, fitting and wire becomes a possible source of sparking to earth, and of fire. It is not a matter of surprise that the fire offices are alarmed at the prospect of such a state of affairs becoming normal and permanent by the wilful earthing of one of the conductors.

It would seem that the logical and right course is to admit at once the danger of earthing accidentally or on purpose, and to provide against it. This danger is really far more serious, as has been proved by the practical experience of many, than the danger of overheating of wires by putting too many lamps on.

Fortunately the cure is at hand with the disease. My friend Mr. Andrews has, as he says, nursed concentric wiring, and he deserves the thanks of the profession for his attention to the infant. There are now many others devoting their attention to its fuller development. Mr. Heaphy, on behalf of the Phœnix Fire Office, has so far recognised its existence as to embody in his rules provisions for carrying out work on this system. All danger of fire from electric light circuits disappears totally and for ever by the adoption of a continuous earthed metallic envelope forming the return conductor and completely enclosing, mechanically protecting and securing the "live" conductor at every point inside buildings from the supply mains or dynamo terminals to the lamp terminals; No part of the live conductor, whether switch, fuse, or other portion of the circuit, being exposed to possible contact with earth, the conductors being protected from overheating by fuses in the live conductor only. The outer conductor or envelope must of course be of equal or greater equivalent section than that of the live conductor.

The methods of discovering faults in underground conductors are many and easily applied, but it is impracticable even under the most favourable circumstances to remove the fault immediately it is discovered. With one wire earthed, the American method of discovering faults is also a method for removing them, and in conjunction with a concentric system of house wiring it is perfectly safe and certain. It is thoroughly practical and simple in application. Every leak causes a short-circuit; on a large station a short-circuit causes no interruption to the running of the plant, it simply causes a fall in E.M.F. More power is applied if necessary, and the fault is simply burned out. It is now considered unnecessary on a large station to use fuses in the distributing mains, because they are so much smaller than the feeders that the main itself acts as a fuse.

The connection of houses already "double-wired" to an earthed system is a serious difficulty, and therefore the system of "double-wiring" should cease to be applied as soon as possible. All bad work should be condemned by the supply companies or the Insurance inspectors, without fear or favour. A thoroughly sound job in double-wiring may safely be connected to an earthed system, earth being made only at the connection to the outside mains for convenience in testing, and all switches and fuses on the live circuit protected from possible earth contact. A daily test can then be quite simply made by connecting a single lamp of voltage depending on the size of the installation or a voltmeter, as a bridge between the earth connection and the circuit. The lamp will give a rough test of the goodness of the insulation, the voltmeter will give an exact test of its condition.

The safety of an installation depends more on the mechanical substantiality of the work than on guarantees of an imposing specification of hundreds of megohms per mile insulation resistance of the conductors. A rough surface on a sliding switch contract is more likely to cause fire than surface leakage from the body of the conductors. All such faults are rendered harmless by a complete concentric system.—Yours, &c.,

HENRY A. MAVOR.

THE PRICE OF ELECTRIC SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to Dr. Hopkinson's proposed method of charging for electricity in Manchester, I believe I may claim to have been the first to suggest a scale of charges depending on the maximum current demanded by a consumer. The schedule of prices for the Electric Lighting Licence granted to the Liverpool Electric Supply Company in 1888 contained a sliding scale of charges per quarter, which may be shortly expressed as follows:—1st. For any number of units up to 100 times the number of units per hour of maximum demanded supply, 1s. per unit. 2nd. For any further quantity up to 100 times the maximum demanded supply per hour, 8d. per unit. 3rd. For any further quantity, 4d. per unit.

For example, a consumer demanding a maximum supply of three units per hour, and having used 1,100 units in a quarter, would be charged the following rates:—300 hundred units at 1s., 300 units at 8d., and the balance of 500 units at 4d.

It was found, however, that the consumers had some difficulty in understanding the scale, being accustomed to the sweet simplicity of the uniform rate charged by the local Gas Company, and that dissatisfaction was always expressed by consumers who used their lamps only a small number of hours, and, therefore, never reached the lower rates.

All sliding charges based on the maximum demanded supply have the serious disadvantage of limiting the number of lamps fitted up by a consumer to the smallest number he can possibly do with, thus preventing the adoption of the light in positions where the lamps are only occasionally required. A sliding scale is also an obstacle to the introduction of the light in buildings not often used, and especially churches, which are valuable customers to a supply company on account of only requiring a supply on Sundays, when the central station load is at a minimum.

Four years' trial of the above method of charging in Liverpool proved that its disadvantages were greater than its advantages, and consequently in the Liverpool Electric Lighting Order of 1892 the sliding scale was repealed, and a uniform rate of charge substituted. The present price charged in Liverpool is 7½d. per unit, or about double the price of gas, and with a rapidly increasing demand for electric light, and the more efficient and cheaper incandescent lamps that may be expected when the present oppressive monopoly in lamps comes to an end next year, the day is not far distant when the electric light will, in addition to its many advantages, be light for light as cheap as gas. A uniform rate has been found to answer well in the case of the greater number of Gas and Water Companies, and is equally suitable for Electric Supply Companies when the circumstances permit of a reasonably low price being charged.—Yours, &c., A. BROMLEY HOLMES.

Liverpool, December 5, 1892.

EFFECTIVE VOLTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From your editorial comment on "Effective Volts" there seems to have been a certain ambiguity as to which definition of Dr. Thompson's was "precisely equivalent" to Dr. Fleming's. A little consideration will show that it was Dr. Thompson's definition of "effective," and not virtual (as mentioned by you), which was precisely equivalent to Dr. Fleming's definition of effective, *as referred to in his book*, and that Dr. Thompson's definition of virtual was identical with Dr. Fleming's effective, as defined in his present Paper. The main point I wish to contend is, that though granting that effective and virtual are identical in the special cases mentioned in the Paper, still they are only *special* cases, for effective as defined in the book is by no means necessarily the same as virtual; *e.g.*, if the current or effective E.M.F. were measured experimentally at every instant in the cycle as in Ryan's contact breaker experiments, the ordinates at any instant would represent effective E.M.F., but only that particular ordinate which had the value $1/\sqrt{2}$ of the maximum effective ordinate would be the virtual E.M.F. The intro-

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duction of the word maximum in Dr. Thompson's definition of virtual was, of course, a slip on my part.

Trusting you will insert this in your next issue.—Yours, &c.,

Woolwich, December 2nd. ROLAND S. PORTHEIM.

THE DISSIPATION OF ENERGY IN HERTZ RESONATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I understand by a letter received yesterday from Dr. Bjerknes that two misprints crept into the account of his experiments in the *Comptes Rendus*. These are naturally repeated in your report (November 18th, p. 69), and perhaps you will kindly insert the following corrections:—

The period of oscillation should be $1{\cdot}4 \times 10^{-8}$ (not 14×10^{-8}). Four words are omitted from the last sentence, which should run: "That metals are more transparent to Hertzian undulations than to luminous undulations."—Yours, &c.,

County Offices, Stafford, Dec. 1, 1892. D. E. JONES.

PROF. AYRTON'S MAGNESIUM CELL AND HIS EXPERIMENTS ON THE MIGRATION OF GOLD THROUGH MERCURY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In closing the discussion of Mr. Swinburne's Paper on "Commercial Electrolysis" at the Institution of Electrical Engineers, the President, Prof. Ayrton, alluded to a subject of much general interest and one on which I should have liked to make a few remarks, had it not been contrary to the rules of the society. On reading the account of this discussion in your issue of November 25th I was reminded of the matter, and with your permission I will here recur to it.

In the first place, I must express my great satisfaction that Prof. Ayrton now admits that his former experiments, which led him to believe that an electric current could be generated by the action of one metal upon another, *e.g.*, the combination of magnesium with mercury, and which was directly opposed to my own results, were not trustworthy from want of the necessary precaution in carrying them out, and that the cell was truly a "sell," as the Professor himself jokingly remarked. I had previously demonstrated that the currents observed during the amalgamation of zinc, lead, tin, and cadmium, were due to changes of temperature, produced by the combination of these metals with mercury and their dissolution therein, and were therefore of thermo-electric origin, a result which was subsequently confirmed by other observers; consequently, it was difficult to understand why magnesium should behave in so entirely different a manner to other metals.

If I understood Prof. Ayrton rightly at the meeting, he stated that his results were due to the circumstance that the mercury was not quite cooled down when brought into contact with the magnesium, but surely this cannot possibly explain the high E.M.F., viz., 1·56 volts, which he obtained. According to Matthiessen the thermo-electric force between magnesium and platinum—which formed the other electrode of Prof. Ayrton's cell—is only about one-tenth of that of a thermo-electric couple consisting of copper and German silver, and for the latter I obtained 0·00014 volt for a temperature difference between the junctions of one degree centigrade. In order, therefore, to explain the observed E.M.F. exclusively by thermo-electric action, it would necessitate an enormously high temperature of the mercury such as is entirely out of the question. I believe the real cause of the high E.M.F. observed must be sought in quite another direction and is probably due to the introduction of a film of moisture or acid into the mercury along with the magnesium or platinum. It would be interesting to hear from Prof. Ayrton if he considers this possible or what other explanation he could suggest.

With reference to the experiment, also mentioned by Prof. Ayrton and which seemed to show the migration of gold through mercury by the action of the current, I venture to predict a fate similar to that of the magnesium cell when repeated with proper precautions. My own experiments with sodium dissolved in mercury and with various other liquid alloys did not show any signs of the transference of metals by the current, and the same result was subsequently obtained by several members of the Electrolysis Committee of the British Association. In my Paper, published in Poggendorff's Annalen in 1875 (supplement, Vol. VII., p. 280-312), I mentioned several instances in which a migration of metal had apparently taken place by the action of the current, but on closer examination I found it to be due to accidental causes. If a metal such as gold is placed on the surface of mercury contained in a straight vertical glass tube, its downward diffusion depends chiefly on the almost imperceptible circulation of the mercury in consequence of slight differences of temperature at various levels; any cause, therefore, which tends to increase this circulation, for instance, the accidental touching of the lower part of the tube with the warm hand, would, in all probability, accelerate the conveyance of small portions of the dissolved metal towards the bottom of the tube. This cause of disturbance could be overcome by the use of W-shaped tubes such as I employed for my experiments. An illustration of my apparatus was shown by Prof. Roberts-Austen in his Cantor lectures on alloys in the Society of Arts a few years ago, and is reproduced in his book on Metallurgy, p. 66.

As an apology for this somewhat lengthy letter I must plead the great interest attached to all experiments bearing directly upon our fundamental conceptions of the *genesis* of the electric current and the *modus operandi* of electrolysis.

—Yours, &c., EUG. OBACH.

Woolwich, Dec. 3rd, 1892.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As you have been so kind as to forward me a proof of Dr. Obach's letter of the 3rd inst., I am able to reply to it in this week's issue of *The Electrician*.

Dr. Obach says that he does not understand how an E.M.F. of 1·56 volt can be produced by a temperature effect in our metallic cell of magnesium-mercury-platinum, and he therefore suggests that a film of moisture, or of acid, may have been introduced into the mercury on the magnesium wire; but, so far from that, I think that it is possible that it was the very drying or the distilling of the mercury which led to the effect which Prof. Perry and I observed; for if a reference be made to our Paper, No. III., on "The Contact Theory of Voltaic Action," *Phil. Trans.* Roy. Soc., Part. I., 1880, and to my remarks made on the discussion of Dr. Lodge's Paper, "The Seat of the Electromotive Forces in a Voltaic Cell," it will be seen that apparent P.Ds. of as much as 3 volts are obtained between hot mercury and cold metals for a difference of temperature of only 20°C if the P.D. be measured inductively after the manner of Volta, Kohlrausch, Lord Kelvin, &c. And, as there stated, "The real explanation of the high potential difference and the abnormality of the results was that probably the main portion of the potential difference measured inductively was produced by an *invisible* film of oxide on the surface of the warm mercury, which possibly existed in spite of the fact that every effort was made to remove this oxide by distilling the mercury between every two sets of experiments," *Jour.* Soc. Tel. Eng. and Electricians, No. 57, Vol. XIV., 1885. The mercury I may mention was distilled at 350°C. in an iron still, for we had no vacuum mercury-still in Japan 15 years ago.

Our measurements with the magnesium-mercury-platinum cell were made with a quadrant electrometer, resistance, therefore, in the cell would not have affected the E.M.F. measurements, and, consequently, I have thought it possible that the E.M.F. of 1·56-volt may have been caused by the mercury and the magnesium wire being separated by a thin film of something which may have acted like an oxide, and by there existing a difference of temperature on account of the mercury not having been left long enough to cool down to the temperature of the room.

This possible explanation of the action of the metallic cell was not seen in 1877, since our experiments on hot and cold

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mercury and on hot mercury and cold metals were not made until later.

In connection with this subject I may mention that a striking experiment can be made with a pair of platinum-copper junctions, one kept cool and the other placed in a flame. For if the wires at the hot junction be not very tightly twisted together, and the temperature be raised until the oxide plays on the copper wire, occasionally the junction between copper and platinum will be made through the oxide. Then instantly the spot of light of the electrometer rushes off the scale, indicating an E.M.F. of several volts.

As regards the electric transference of gold, Dr. Obach considers it impossible for a current passed through a vertical tube of mercury with gold at the top to have any effect in increasing the gold in the lower portion of the mercury; and he thinks that gold can only be carried down by thermal circuits. But surely if the electric current passing through the water into the mercury quickens the surface of the mercury, and so hastens the absorption of gold by mercury, it must gradually bring about the result of increasing the amount of gold in the mercury for some distance below the surface, even if there be no electrical transference in the true sense of the word.—Yours, &c., W. E. Ayrton.

December 6, 1892.

DYNAMO DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your edition of October 21st I read with some amusement the abstract of an article entitled "Some Anomalies in Dynamo Design," and venture to trespass on your valuable space to comment on the same. The views expressed in this article would seem to be rather out of date. The construction of dynamo-electric machinery has got down to such a basis that a "trained engineer," or something very like it, is required to design machinery that will meet the demands of modern practice. Some years ago, when the speed was of no importance, when no one cared whether the temperature increased 10deg. or 100deg., or whether the regulation was within 1 per cent. or 20 per cent., in fact when about the only requirement was that the dynamo should give an electric current of about a certain amount, the "intelligent cow" did very well no doubt, but *nous avons changé tout cela*.

The best dynamos of to-day show good mechanical design, as they must, and this good "engineering" is expressed not only in the *bearings*, but in the general form, in the armature core, brush holders, commutator, &c., and also in the special tools used in construction; the latter, of course, do not appear outside the shops. The article goes on to make merry over heavy bedplates, and protests against dynamos so equipped being mounted on rails. It might have occurred to the critic that as it is necessary to put the dynamo on a sliding base instead of bolting it down to a foundation a heavy base is, *therefore*, required. In street railway work the sudden strains that are constantly being thrown on the belt require a good deal of weight to keep the machine steady and the base is certainly the place for it. In addition most of the modern dynamos have beds of box or turtle-back section which gives great rigidity without great weight, though they may look ponderous to the casual observer.

With regard to the unfortunate eye-bolt it might be said that as a dynamo is a most exceedingly compact machine, it can hardly be compared with a steam engine on the question of handling. For my part I see nothing unmechanical about the eye-bolt, and unless it is cast into the pole-piece, it is a question of taste or convenience whether it is left in the machine or stored away. Finally, it might be interesting to know what is meant by engineering as spoken of in this article.

If engineering consists solely in working out mechanical parts of mechanism, then I should say that the man who designs the form and proportions of a dynamo to give a certain output at given speed with given regulation, cost and space occupied, &c., has reached something above engineering. If such is the case, it would seem to follow that he has acquired the more elementary part and can be considered a "trained engineer" without doubt. It must be admitted, however, that the small mechanical details are often neglected, and it is not uncommon to find otherwise good machines giving no end of trouble, due to badly-designed brush holders or other minor parts. This shows the necessity for a thorough engineer on construction.—Yours, &c., F. V. Henshaw.

402, Greenwich-street, New York.

MR. HAUBTMANN'S GLOW-LAMP-TESTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your journal (Vol. XXIX., pp. 573-590) you recently published Mr. Haubtmann's investigations on the efficiency and life of glow-lamps, which had originally appeared in the columns of *L'Electricien*.

Messrs. Siemens and Halske subsequently wrote a letter to *L'Electricien* correcting some points in the original article, and we shall be much obliged if you can find space in your journal for the enclosed translation of their letter.—Yours, &c., Siemens Brothers and Co. (Limited).

Alfred Sabine, Secretary.

London, S.W., December 7th, 1892.

[Translation.]

Berlin, November 8, 1892.

Mr. Ch. Haubtmann, Paris.

Although the article which you have published in *L'Electricien* for September 24 last does not show our glow-lamps to advantage, we thank you for having, in the public interest, raised so important a question, and for affording us at the same time the opportunity of publicly defending our interests.

You admit that our glow-lamps are carefully finished, but, according to the results of your experiments, their electrical qualities leave much to be desired. Yet these experiments are not free from criticism; on the contrary, we maintain that the results are due either to erroneous calculations or to faulty instruments.

We have made, and always continue to make, numerous experiments to satisfy ourselves that we keep the manufacture of our lamps at least as good as our competitors. Unfortunately we were not at liberty to publish in the technical journals the results of our observations, which are very widely divergent from your experiments.

Our French and English competitors might have found that wrong on our part, and very justly, for they would have had the right to reproach us for attempting to injure their interests by an *oratio pro domo*. You remove our scruples by calling us publicly forward yourself.

Before entering on a criticism of your figures, we desire to inform you that the French and English markets are at present closed against our lamps on account of the Edison-Swan patents, but, on the comparatively early expiration of these patents, we intend to compete with the French and English manufacturers. It is, therefore, of primary importance for us to at once remove the bad impression which your article may have produced on the public respecting our glow-lamps.

We go on now to your experiments:—

1st. "The lamps of 'La Française,' 16 c.p., 102 volts, 2·98 watts per candle-power, would require 3·6 watts per candle-power at a pressure of 110 volts."

May we be permitted to tell you that this is simply impossible; for, by increasing the normal pressure of a glow-lamp, the light increases much more than in the simple proportion of the pressure and current. Therefore, in place of an increase, there will be a decrease in the absorption of energy per candle-power if the normal pressure be exceeded.

2nd. "The Siemens lamps would require 2·81 watts per candle-power at a pressure of 102 volts; 2·70 watts per candle power at a pressure of 110 volts.

This is far from being correct. According to the statements of the Physical Technical Institute of the German Empire at Charlottenburg, the authority of which on such points you will scarcely impugn, the Siemens lamps of 16 c.p., 102 volts, 2·81 watts per candle-power, take only 2 watts per candle-power at 110 volts.

3rd. "The absorption of energy per candle-power in the Gabriel lamps of 10 c.p., 102 volts, would be 2·1 watts per candle-power at the beginning, would rise to 6 watts per candle-power after 250 hours, to fall again to 4·9 watts per candle-power after 500 hours."

This change can only be explained by the circumstance that the one lamp which remained after the 500 hours was necessarily much superior to the other lamps of the series as regards the constancy of the emission of light. But in that case, this series could not give a correct idea of the average of the Gabriel lamps, and it would have been better to have omitted it from your article.

We will not continue, though there are many other points on which we might touch. It is enough that we have protected our own interests without impinging on those of our French and English competitors, by showing that the results of your experiments can in no way be considered as decisive, and that they leave the merit of our lamps untouched.—We are, &c. Siemens and Halske.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

TENDERS INVITED.—The Urban Sanitary Authority of Portsmouth invite tenders for the supply and erection of boilers, steam engines, condensers, steam and water pipes, pumps, overhead hand-power traveller, electrical machinery, apparatus, &c. Tenders must be delivered to Mr. Hellard, town clerk, not later than 6 p.m. on January 5, 1893. Further particulars appear in our advertisement columns.

TENDERS RECEIVED.—The following tenders have been received by the London County Council for the electric lighting (contract No. 2) of Claybury Asylum :—

Bourne and Grant	£14,400	0	0
J. D. F. Andrews and Co.	12,560	0	0
Fowler, Lancaster, and Co. (Limited)	11,780	0	0
H. Binko and Co.	10,999	10	0
Electrical Supplies and Fittings Co. (Limited)	10,300	0	0
Roger Dawson	9,887	0	0
Mather and Platt (Limited)	9,118	17	9
Cox-Walkers	8,920	7	6
R. H. Barnett and Co.	8,214	0	0
F. Geere Howard	8,076	0	0
Brush Electrical Engineering Company (Limited).	7,814	0	0
Edmundsons (Limited)	7,660	0	0
Latimer Clark, Muirhead, and Co. (Limited)	7,407	0	0
E. Mann	6,491	0	0
New and Mayne	6,278	0	0
Appleton, Burbey, and Williamson	6,074	0	0

TENDERS ACCEPTED.—The Bristol Urban Sanitary Authority have placed the contract for supplying the whole of the condensing plant for their large electric light installation with Messrs. W. H. Allen and Co., who, owing to the contract having been previously placed in other hands, are called upon to complete the work within a very short period.

——— The offer of Messrs. Lowden Brothers for the execution of the work in connection with the electric lighting of the Reading Rooms and Merchants' Exchange at Dundee has been accepted by the Dundee Chamber of Commerce.

——— The Stepney Guardians have accepted the tender of Mr. Flynn to establish telephonic communication between the doctor's house and the workhouse at a cost of £15 and £2 annual maintenance.

SALES BY AUCTION. — Messrs. Wheatley Kirk, Price and Goulty have now ready the catalogue of the modern engineering and electrical fixed and loose plant, fittings, &c., which are for sale on Tuesday next, the 13th inst., at the Eastdown Works, Dermody-road, Lewisham, S.E. The catalogue includes several fly screw presses, lathes, shaping, milling, and drilling machines, electric motors and dynamos of the Gill, Elwell-Parker, Siemens, Brush-Victoria, and other makes, measuring instruments, electric light standards, gas and steam engines, accumulators, and a large quantity of miscellaneous plant and material. The sale commences at 10 for 11 prompt.

DISSOLUTION OF PARTNERSHIP.—Messrs. Cremer and Cheeld, carrying on business at Chesham, Bucks, as electrical and general engineers, have dissolved partnership, debts being paid and received by Mr. Sydney Cheeld.

REMOVAL NOTICE.—Messrs. Gwynne and Co., Hydraulic and Mechanical Engineers, have removed from Essex-street Works, Strand, W.C., to larger premises at Brooke-street Works, Holborn, E.C.

MESSRS. J. S. LEACH AND CO.—This firm send us circulars dealing with the specialities manufactured by them, including electric telephones and bells and electric lighting plant and apparatus, and also drying machines, shafts and shaft fixings, pulleys, steam pipes, air propellers, patent ventilators, fly-wheel guards, street and door lamps, watchmen's lamps, &c.

MESSRS. PYKE AND HARRIS.—This firm have several important lighting installations in hand, amongst these being one for Lord Montagu at Queen's-gate, London, W., and another at 47, Gloucester-terrace, Hyde Park.

MESSRS. RASHLEIGH PHIPPS AND CO.—This firm are carrying out the lighting of the new premises of the Star Life Assurance Company in Moorgate-street, and also the premises recently taken by Messrs. Elkington and Co., the well-known silversmiths, in Cheapside.

MR. ROGER DAWSON.—The electric light fittings used in the extensive electric light installation at the Junior Constitutional Club's new premises in Piccadilly were, we are informed, specially designed and manufactured by Mr. Roger Dawson.

APPOINTMENT.—Mr. Joseph A. Jeckell, who was recently appointed electrician to the International Okonite Company (Limited), has, we understand, been appointed manager of the Company's works at Newton Heath, Manchester.

ELECTRIC LIGHT V. GAS IN CITY OFFICES.—The Directors of the National Safe Deposit Company decided in November, 1891, to introduce the electric light in their large underground offices and vaults at Queen Victoria-street, E.C., which comprise three floors or vaults below the surface of the street. It is absolutely necessary that the corridors in which the safes and strong-rooms are situate should be well lighted, and complaints had previously reached the Company from renters and depositors that the lighting was not efficient. The Company's staff also were frequently invalided owing to the vitiated atmosphere in which they were compelled to work. An attempt was first made to improve matters by the introduction of the most approved gas arrangements, and this resulted in a considerable saving of money, but in only a slight mitigation of the ill effects of the gas; and in consequence, the electric light was, in February, 1892, substituted over the greater part of the premises, with the result that the staff and customers have greatly benefited in health, and a saving of 10 per cent. upon the reduced gas bill has been effected, after allowing interest on the original outlay for plant (about £500) and for depreciation, repairs, and renewals. The two 28-H.P. engines used are those originally supplied for the lifts and the air and water pump. The manager of the Company, Mr. J. S. Wilkes, expresses the greatest satisfaction with the results obtained, which represent an actual saving on the original gas lighting bill of about 30 per cent.

ARBITRATION.—It has been decided to form Chambers of Arbitration, similar to that recently formed in the City of London, at Edinburgh, Cardiff and Sheffield.

CALENDARS FOR 1893.—Messrs. STREET AND CO., the well-known advertisement contractors of Cornhill, E.C., send us a neatly-framed Calendar for 1893.——The ANGLO-AMERICAN TELEGRAPH COMPANY issue a useful hanging Calendar Pad for 1893, of neat design.

ASTON.—The Aston Local Board has received from its Highway Committee an intimation that it has under consideration the desirability of adopting the electric light in lieu of gas, and hope to shortly report fully on the matter. The success and popularity of the large electric installation at the new bath had induced the Committee to take this matter into consideration, and the Surveyor has received instructions to make inquiries and get together all the information in view of the early discussion of the subject.

BELFAST.—Following on a series of interesting articles on Electric Lighting which appeared in the *Belfast Evening Telegraph*, the proprietors of that journal are to be congratulated on the "discovery," through an interview by one of their representatives with a Mr. Gallaher, of a marvellous method of reducing the first cost of electric lighting; and, more important still, bringing this improved state of affairs about by the aid of the electric light's arch enemy—gas. According to Mr. Gallaher, a Mr. Harris, of America, has invented an apparatus by which 10lb. of coal produces about 700 cubic feet of gas, and the addition of two gallons of crude oil raises this amount to over 1,000 cubic feet. By doubling the quality of oil the fuel gas can be carbonated up to any desired candle-power, and can, therefore, be used for illuminating as well as for heating purposes, at a price which, with coal at 10s. per ton, and crude oil at 3s. 6d. per barrel, represents gas at 2½d. per 1,000 cubic feet. By means of this cheap fuel gas, electricity is to be supplied at such a cheap rate that all lighting methods will be revolutionised. Mr. Gallaher says that he has seen 110 incandescent lights burn for ten hours at a total cost of 9d., the generating plant being a gas engine consuming fuel gas made on the premises. Mr. Gallaher further states that the process has been introduced in Washington, Maysville, Connorsville, and other towns in the United States. Query, Is this "discovery" any advance on the Dowson process? It is, perhaps, as well to add that Mr. Gallahar, whose offices are situated in York-street, Belfast, entirely controls the patents of this apparatus for the United Kingdom.

——— On Friday last Prof. Kennedy, in his capacity of consulting engineer to the Belfast Corporation, examined the plans of the district with the object of advising the best system of electric lighting to be adopted by the City authorities. He will shortly present his report.

BOGNOR.—The Board of Trade have intimated to the Local Board that having received no further communication on the subject of the Electric Lighting Order of 1890, they propose to revoke the Order forthwith.

BRISTOL.—The *Bristol Times and Mirror* states that about a dozen firms have sent in tenders for the distributing mains for the Bristol lighting, including, at least, one local firm of contractors whose business usually lies in building operations. The estimates vary from between £14,000 and £15,000 to something over £25,000

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The Electrical Committee have referred these tenders to Mr. W. H. Preece, consulting engineer to the Corporation, and upon receipt of his report will select the tender most nearly complying with the conditions imposed. With reference to the erection of a central station a small sub-committee has been appointed to watch the building operations, which are expected to be completed in September next.

CHAGFORD.—A curious state of affairs has come to pass in this town. For some time past the citizens could select either gas or electric light for their illuminant, but the Electric Light Company having recently succeeded in obtaining their Order for lighting the town, the Directors of the Gas Company decided either to sell the gas works or close them altogether, the result being that Mr. Willey, of Exeter, has purchased these works for £150, and took possession last week. It now remains to be seen which illuminant will survive the ordeal of acute competition.

CHELSEA.—The surveyor to the Chelsea Vestry has presented his report on the subject of the electric lighting of the district, and it has been decided to print the report for distribution amongst the members of the Vestry.

CHICAGO SOUVENIR.—The Bubier Publishing Company, of Lynn, Mass., forward us an illustrated sheet calendar for 1893, giving twelve views (one for each month) of the Chicago Exhibition buildings.

COVENTRY.—The Town Council on Tuesday had under discussion the future of the local tramways. Last year the time allowed for the continuance of the old system of steam expired, and since then the trams have not been allowed to run through the centre of the city. The line has been bought by Mr. Graff Baker, who is endeavouring to get Coventry to consent to overhead electric wires. A deputation went to inspect the Roundhay tramway at Leeds at his invitation, and came back satisfied. An official depuation, however, who also visited Leeds, as well as Walsall, now recommended the Council not to consent to the adoption of the Thomson-Houston system. A proposition to this effect having been moved, a long and exciting discussion arose, and it was finally adjourned to allow of an inspection of a sample overhead wire, which Mr. Graff Baker is going to erect in Hertford-street.

DERRY.—Opposition is to be offered to the proposal of the Derry Corporation to borrow £40,000 for electric lighting purposes.

DUDLEY.—The Borough Surveyor has been instructed to obtain all particulars with regard to electric lighting with a view to its adoption by the Town Council who have a dispute with the local Gas Company.

DUNDEE.—The first of the large boilers which are being made by Messrs. Whyte and Cooper for the Electric Lighting Station underwent a critical test last week, with satisfactory results. It is expected that four out of the six Willans and Robinson's engines which are selected for the installation will be delivered this week. These engines indicate 135 H.P., the remaining two being 60 H.P.

——— With regard to the lighting of Dundee, some considerable extensions have been agreed to, and the scale of meter rents has been prepared as follows:—10-ampere meters—Ferranti, £6; Aron, £6. 15s.; Kelvin, £8. 10s. Meter to be used—Ferranti; rent at 12½ per cent. = 15s. per annum, say, 4s. a quarter. 20-ampere meter—Ferranti, £6. 15s.; Aron, £6. 15s.; Kelvin, £8. 10s. Meter to be used—Ferranti or Aron; rent at 12½ per cent. = 16s. 3d. per annum, say 4s. 6d. per quarter. 30-ampere meter—Ferranti, £7. 10s.; Aron, £6. 15s.; Kelvin, £8. 10s. Meter to be used—Ferranti or Aron; rent at 12½ per cent. = 18s. 9d. per annum, say 5s. a quarter. 40-ampere meter—Ferranti, £8. 10s.; Aron, £6. 15s.; Kelvin, £8. 10s. Meter to be used—Aron or Kelvin; rent at 12·5 per cent. = 21s. 3d. per annum, say 5s. 6d. a quarter. 50-amperes (Kelvin), 6s. a quarter. 60-amperes (Kelvin), 7s. a quarter.

ELECTRIC HEATING AND COOKING.—A series of lectures was delivered last week at Hove, Sussex, by Mr. H. J. Dowsing (of Messrs. R. E. Crompton and Co.), on the subject of "Electricity for Domestic Purposes." The lectures were received with applause, and owing to the fact that there are three electric supply stations in the district, it is anticipated that before very long a good day load will be the outcome of the interest which they have been successful in arousing.

FALMOUTH.—In view of the early adoption of the electric light for the town of Falmouth the Lighting Committee of the Urban Sanitary Authority recommend that no further gas lamps be purchased.

IRVINE.—At a meeting of the Town Council on Tuesday night it was proposed that the Town Council appoint an electrical engineer to inspect the Town Mill, and report as to whether by fitting up a turbine water-wheel motive power could be got sufficient for the lighting of the streets and harbour by electricity. The matter was referred to the Town Council in committee.

JOHANNESBURG LIGHTING.—The *Cape Argus* states that the £35,000 Debenture issue recently offered for subscription by the Johannesburg Lighting Company have been placed in London at par, and that the Company will therefore have this additional capital at its disposal, enabling the Managing Director to supply either gas or the electric light for the whole of the township and suburbs.

KINGSWOOD.—A complaint was made at the last meeting of the Kingswood Local Board of the indifferent lighting of the streets by the electric light, and it was resolved to inspect the whole of the lighting area and report. A meeting of the Ratepayers' Association was also held, at which the terms of the contract between the Local Board and Messrs. Parfitt and Son were discussed, and it was pointed out that if Messrs. Parfitt and Son gave no better light than the gas there would still be a saving to the ratepayers on the contract with that firm. It was ultimately decided to call upon the Local Authority to deal promptly in the matter.

LA PLATA.—A trial of the electric tram cars at La Plata was recently made, and proved a success. A number of railway and tramway managers will shortly meet and inspect the working of the cars.

LIVERPOOL.—Permission has been granted to the Liverpool Electric Supply Company to put down mains in Sefton Park to supply the houses on Corporation property whose tenants desire to substitute the electric light for gas.

MANILA.—An Electric Lighting Company, with a capital of $500,000 in $25 shares, has recently been established at Manila, where in the course of a few months it is expected that the city will be lighted throughout by electricity.

MONEYMORE, IRELAND.—The *Belfast Morning News* understands that a scheme is on foot for lighting Moneymore by electricity.

OMNIBUS LIGHTING.—The London General Omnibus Company are reported to be lighting the whole of their omnibuses with electric lamps, the "Favourites," all running to the North of London, having already been fitted with the light, which is in the centre of the roof, the batteries being placed under the seats.

READING.—At the last meeting of the Town Council the question of lighting the large Town Hall by electricity came under discussion. It should be stated that a sub-committee had been appointed to take prompt measures in the matter of lighting the Town Hall by electricity, owing to the fact that the timbers in the roof had been seriously affected by the gas. The sub-committee now recommended that in view of the probability of the Reading Electric Supply Company (Limited) being at an early date in a position to supply electric current for lighting the Town Hall, no further steps be taken in the matter, but that the roof be painted near the gas jets with asbestos paint, and be provided with shields. The question of opposing the Reading Electric Supply Company's obtaining a Provisional Order for lighting the town has also been discussed by the Town Council, and the Lighting Committee have, in conjunction with the representatives of the Company, arrived at a draft agreement, which the Committee will recommend the Council to accept.

REDRUTH.—This town is shortly to have an Electric Supply Company, and the promoters, before issuing the prospectus, are endeavouring to form some estimate of the support they are likely to receive from the Redruth public both as shareholders and consumers. The capital is £10,000 in 500 Five per Cent. Preference Shares, and 1,500 Ordinary Shares of £5 each. The Company have selected the low-pressure three-wire system, the central station being situated at Pednandrea.

ST. HELEN'S.—A Sub-Committee of the Gas and Lighting Committee of the Corporation has been appointed to consider the question of providing for the supply of electricity within the borough.

SAN JUAN (ARGENTINA).—This city will shortly be lighted by electricity.

STAFFORD.—At the Town Council meeting on Tuesday the report of the Electric Lighting Committee recommending the Council to take active steps for the provision of electric light for the borough was presented. It states that the Council has a capital of £100,000 bound up in their monopoly of the gasworks, and that the period for which the provisional order for electric lighting was granted to the Corporation having expired, a private company would step in unless the Corporation took immediate action. The cost of an installation of 3,000 lights would be £20,000; it would require 2,000 lamps to make the thing pay; and with the County Council, the Post Office, and private consumers who were already prepared to take the light, there was reason to believe that 1,500 lamps would be taken from the start. The effect on the consumption of gas, even if 3,000 lamps were supplied, would be but the slightest, and the monopoly of the Corporation would be preserved. The report was adopted.

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STUDLEY.—The electric light has been introduced into Messrs. W. Hall and Company's Needle Works at Studley, and provision has been made for driving the machinery in addition to lighting.

TEIGNMOUTH.—At a meeting of ratepayers held on Wednesday, the Chairman said that two schemes had been placed before the Local Board for the extension of the gasworks, the cost of one being £16,000 and the other £10,000. Two schemes of electric lighting had also been before the Board at a cost of £8,500 and £15,000 respectively. In order to make the introduction of the electric light pay itself, it would be necessary that there should be 900 lamps taken up by private consumers. After a short discussion, a deputation was appointed to confer with the Local Board on the question.

THETFORD.—At the meeting of the Board of Guardians last week, in advocating the use of the electric light in the workhouse premises, Mr. Oldman said he had used that illuminant in his residence for 18 months, and that it had proved better and much cheaper than gas. It was therefore decided to obtain an estimate.

THE SMITHFIELD CLUB SHOW.—The annual show of the Smithfield Club was held at the Agricultural Hall, London, during this week, and amongst the exhibitors were :—Messrs. Marshall, Sons and Co. (Limited), of Gainsborough ; Messrs. Robey and Co., of Lincoln ; Messrs. John Fowler and Co., Leeds (Limited) ; Messrs. Clayton and Shuttleworth, of Lincoln ; Messrs. Crossley Brothers (Limited), Openshaw, Manchester ; Messrs. Ransomes, Sims and Jefferies (Limited), of Ipswich ; Tangyes (Limited), Birmingham ; Messrs. Ruston, Proctor and Co. (Limited), Lincoln ; and other well-known agricultural and general engine and machinery builders. Messrs. Ransomes, Sims and Jefferies' exhibits include a 10-H.P. long-stroke engine, with the main frame in one casting, and all parts interchangeable for either hand. Messrs. Robey and Co.'s extensive exhibit includes a special vertical high-speed engine for electric lighting, fitted with lubricated arrangements for continuous running. Messrs. John Fowler and Co. have an 8-H.P. horizontal engine on show, which is specially constructed for economical working in electric lighting installations, and are made for both right and left-hand working ; and on Messrs. Clayton and Shuttleworth's stand is a fine specimen of the compound under-type engine, for which this firm claim many advantages. Messrs. Marshall, Sons and Co. occupy a large space in the exhibition, and have, in addition to some fine examples of their agricultural machinery, several engines on view made with special regard to the requirements of lighting and power installations. Messrs. Ruston, Proctor and Co.'s stand includes a "U"-type vertical engine, fitted with a sensitive governor and a convenient speed adjuster. A large number of these engines have been included in lighting plants all over the country. In gas engines Messrs. Crossley Brothers had several examples on show, and it is only necessary to mention that the engines exhibited possess all the latest improvements which have made this firm's engines so well known in electric lighting circles. Tangyes (Limited) have also on view some fine specimens of their gas engines, including a 12 H.P. engine of the very latest pattern. Another class of engines which is gradually coming to the front at the Smithfield Shows are the oil engines, and Messrs. Priestman and Co. have several very compact machines on view. We are unable to chronicle that any progress has been made with the electric lighting installation at the Agricultural Hall, notwithstanding that at such a Show as that held this week the advantages of the brighter and cooler illuminant would have been obvious.

WEST BROMWICH.—The Town Council on Wednesday had under consideration a recommendation of the Estates Committee that they should be authorised to obtain specifications and tenders for lighting the Town Hall, corridors, ante-rooms, municipal offices, &c., also the free library, with electricity, and to provide such a plant for this purpose that, if thought desirable, the institute could be also lighted by the same means. In the event of the recommendation being adopted the committee propose to obtain a separate tender for the institute, so that the cost of both schemes could be ascertained, and one or both be adopted. The estimated cost was £1,720. After some discussion, the Council decided to postpone the matter for twelve months.

WESTMORELAND.—Leave has been granted to Messrs. R. H. Fell and Son (Limited) to put electric light cables under certain of the main roads at a rent of 10s. per mile per annum.

WHITTINGHAM.—At the last meeting of the Lancashire Asylums Board it was proposed to grant a sum not exceeding £450 for the lighting of the grounds of the Whittingham Asylum by electricity.

WOLVERHAMPTON.—The Committee will, we understand, recommend the Wolverhampton Town Council on Monday to accept the tender of the Electric Construction Corporation (Limited) to instal the electric light within the portion of the borough decided upon by the Council. The cost of the work will be about £28,000, exclusive of the cost of buildings which will be necessary for the machinery and other plant.

WORCESTER.—At a meeting of the City Council, on Tuesday, the Watch Committee recommended the Council to obtain a loan to purchase the Powick Mills and the land adjoining for the sum of £5,000, for the purpose of a generating station for electric lightiing and to enter into a contract with the Brush Electrical Engineerng Company (Limited), for the work in connection therewith, the total expenditure amounting to £31,000. An amendment was moved that the question should be referred to the Committee for further details to be furnished ; but after considerable discussion the original recommendation was adopted.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

November 11, 1892.

20,360. R. A. GOODMAN. Halifax. Improvements in electric arc lamps.
20,371. A. G. BURRELL. Sheffield. Automatic electric railway signal.
20,415. J. T. GENT, A. W. STAVELEY, and J. H. PARSONS. London. Improvements in microphones.
20,445. C. RAAB. London. Improvements in electric meters.

November 12, 1892.

20,473. R. CARRYER. London. The combined automatic charging switch and cut-out.
20,488. F. W. WEBB and A. M. THOMPSON. Crewe. Improvements in apparatus for closing an electric circuit by the passage of a locomotive train over a line of railway, and recording apparatus connected therewith.
20,489. A. B. WOAKES. London. Improvements in apparatus for sterilising and oxidising liquids by electricity.
20,505. W. L. WISE. London. Improvements in alternating current motors. (The Maschinenfabrik Oerlikon, Switzerland.)

November 14, 1892.

20,538. J. B. NICHOLSON (of the firm of R. Waygood and Co.). London. Improvements in electrical cash or small receivers.
20,590. R. H. COURTENAY. London. Means and electrical apparatus for preventing and killing blight on vegetation.
20,598. C. THÉRYC and A. OBLASSER. London. Improvements in and relating to the manufacture of electric accumulators.
20,602. C. BRITCHER. London. Improved construction of electric bell push.
20,603. D. L. SALOMONS. London. Improvements in the fastenings of windows, doors, and other similar devices, and in electric switches connected therewith.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

18,905. ORTEGA Y ESPINOSA. Electric railway signals.
18,938. LANGHANS. Incandescent lamps.
19,071. LANGHANS. Incandescent lamps.
19,554. LIRONI. Electric switches.

1892.

43. HOUGHTON and WHITE. Electric lighting of railway trains.
207. HOUGHTON and WHITE. Electric regulator.
259. WOAKES. Utilising electric energy for heating water, &c.
359. SIEMENS BROTHERS AND CO., LIMITED, and Others. Dynamo electric machines.
360. SIEMENS BROTHERS AND CO., LIMITED. (Siemens and Halske.) Rotary phase current installations.

COMPANIES' MEETINGS & REPORTS.

Morecambe Electric Light and Power Company (Limited).

In the report of this Company just issued the Directors congratulate the shareholders on the successful establishment of the Company's installation and its profitable working. The consent of the Board of Trade to proceed with the works was only given in March 12th last, thus greatly limiting the time in which to get down the plant for season business. Notwithstanding, cables were laid in thirteen streets, and the work was so efficiently done as to preclude any appreciable leakage.

The demand for service being much in excess of the provision made (which was based on the subscribed capital), the Directors found it requisite to make additions to the generating plant forthwith ; and as the season advanced a full load was obtained. These additions are not yet covered by subscribed capital, and will continue to absorb a portion of the profits which would otherwise be available for increased dividend. Now that the soundness and profitable character of the undertaking is demonstrated, shareholders should have no hesitation in availing themselves of the opportunity of adding to their holdings at par.

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As to depreciation, a considerable portion of the plant is under guarantee for first year ; and the "Dowson" gas-making apparatus and necessary building were only completed in October. For the remainder of the plant, in view of the short term during which it has been in use, the item would be inappreciable, and is therefore waived. A sum of £16. 3s. is, however, written off formation expenses, which stand at a low figure. The gross profit of £74. 9s. 11d. is reduced by £22. 6s. 7d. for interest on borrowed capital, leaving a balance of £50. 12s., which the Directors recommend to be applied to the payment of a dividend at the rate of 5 per cent. per annum on the called-up paid share capital. Shareholders will be pleased to learn that important extensions of the service are now in progress, and further extensions are contemplated in the Spring. The retiring Director (Mr. Farrar) is eligible, and offers himself for re-election. The auditor (Mr. Duff) also offers himself for re-appointment.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322, *&c., &c.*]

EDISON-BELL PHONOGRAPH CORPORATION (LIMITED).—This Company was registered on November 30th with a capital of £60,000 in £5 shares. The objects are—to enter into and carry into effect an agreement with the Edison United Phonograph Company, of New Jersey, U.S.A. ; to apply for, obtain, or otherwise acquire any inventions, letters patent, licences or concessions for, or in relation to, phonographs and graphophones, telephones or any combinations thereof, for the recording and reproduction of speech and other sounds, and for, or relating to, any machine, instrument, or apparatus for recording or reproducing speech or other sounds by means of electricity or other means or connected with the generation, utilisation, storage, accumulation, distribution, transmission and employment of electricity, and to carry on the business of manufacturers of and dealers in and contractors for the sale, supply, letting on hire, erection and maintenance of phonographs, graphophones, telephones, phonogram cylinders, tablets, diaphragms, motors, batteries, generators, magnets, cylinder coverings, &c., or to trade as electricians, mechanical, electrical, chemical and general engineers, iron, brass and metal founders and manufacturers, dealers in and contractors for the supply of electricity or other power agency or energy. The subscribers are :—

	Shares.
William A. Smith, 6, Hanover-street, Glasgow	1
F. Faithfull Begg, Bartholomew House, E.C.	1
Charles A. Hanson, 49, Holland-park, London, W.	1
D. Johnstone Smith, 149, West George-street, Glasgow	1
S. H. Sands, West Hill House, Lenton, Nottingham	1
Edward F. Coats, 99, Gresham-street, London, E.C.	1
C. Morrison, 53, Coleman-street, London, E.C.	1

The number of Directors is not to be less than three nor more than eight, the first being F. Faithfull Begg, W. T. Coats, D. Johnstone Smith, and William A. Smith. Two additional Directors will be appointed by the Edison United Phonograph Company of New Jersey, U.S.A. Qualification: £1,000 nominal value.

LANDORE COPPER COMPANY (LIMITED).—This Company has been registered with a capital of £3,000, in £1 shares, to carry on the copper smelting and manufacturing works at Landore, near Swansea, now being carried on by Mr. Thomas Elford.

LOCKE AND CO. (LIMITED).—Mechanical, electrical and general engineers. Capital, £1,000, in £1 shares.

WALSALL ELECTRICAL COMPANY (LIMITED).—This Company was registered on December 6th, with a capital of £10,000, in £10 shares. The objects are to acquire and take over as a going concern the business of a manufacturing electrician and electrical engineer, now carried on by Frederick Brown, at Walsall, in the County of Stafford and at Birmingham, under the style or firm of "The Walsall Electrical Company," with a view thereby to enter into and carry into effect an agreement with the said Frederick Brown to manufacture, provide, sell, deal in, and let for hire engines, dynamos, machinery, wires, lamps, telephones, instruments, fittings, &c., and to carry on the business of electricians, electrical engineers and contractors, mechanical and general engineers, iron and brassfounders, suppliers of electricity, and manufacturers of and dealers in all things required for or capable of being used in connection with the generation, supply, accumulation, distribution, and employment of electricity. The first subscribers are—

	Shares.
John Hildick, junior, Mellish House, Mellish-road, Walsall	1
Henry P. Nichlin, The Elms, Rushall-road, Walsall	1
Joseph N. Fellows, 44, Bradford-street, Walsall	1
Frederick Brown, Fairy Field, Highgate, Walsall, electrical engineer	1
Samuel Beebee, East View, Sutton-road, Walsall	1
Thomas H. Fellows, 88, Corporation-street, Walsall, electrical engineer	1
William Beebee, 4, Wolverhampton-street. Darlaston	1

The number of Directors is not to be less than three nor more than five.

"DROSOPHORE" COMPANY (LIMITED).—This Company has been registered with a capital of £15,000, in £5 shares, to acquire certain rights from Messrs. Kleiner, Bockmeyer, and Co., of Moedling, near Vienna, and to manufacture and deal in apparatus and machinery for ventilating and for warming, cooling, drying, moistening, and disinfecting the atmosphere.

UNITED KINGDOM ECONOMIC GAS SYNDICATE (LIMITED).—This Company has been registered with a capital of £10,000, in £1 shares, to enter into an agreement with A. W. Wells, and to carry on the business of gas, mechanical, electrical, chemical, and general engineers, &c.

ALLCHIN, LINNELL, AND CO., LIMITED (in Liquidation).—Proofs of debts must be sent in to the Official Liquidator, Mr. C. J. Stewart, 33, Carey-street, E.C., by the 17th inst.

LIRONI AND BOWMAN (LIMITED).—An agreement, dated October 12th, between Vittorio G. Lironi and John J. Bowman, of Bow Electric Works, Arnold-road, Bow, London, E. (called the "vendors"), and this Company states that the Company agrees to purchase the goodwill, plant, machinery, stock-in-trade, &c., of the business of electrical engineers carried on by the vendors at the Bow Electric Works, and also the following patents belonging to the vendors :—Provisional patent No. 14,527 (1891), No. 19,554 (1891), and No. 19,553 (1891). The consideration was £1,200, and was fully satisfied by the allotment of 1,200 fully paid-up shares of £1 each, such shares not being transferable for seven years without the consent of six-sevenths of the shareholders. Another agreement of the same date between Thomas W. Hollington and Alfred J. Hollington (called the vendors) and this Company states that the Company agrees to purchase certain plant, machinery, engines, tools, &c., in or about the Bow Electric Works, for £1,200, £800 of which was to be paid in fully paid-up shares of £1 each, and £400 by the issue to the vendors of debentures, part of an issue not exceeding £1,200. The statutory return, made up to November 25th, has been filed. Out of a capital of £2,000, in £1 shares. all the shares have been issued as fully paid.

LITHANODE AND GENERAL ELECTRIC COMPANY (LIMITED).—The statutory return of this Company made up to November 17th has been filed. The Company is a reconstruction of the Mining and General Electric Lamp Company (Limited), and bought the patents of the said Company, and in consideration therefor allotted or agreed to allot 91,500 shares, each considered as having 16s. paid, to the shareholders of the old Company, according to their interests. At the time of making up, 17,725 shares had been taken up, each of which had been issued with 16s. considered as paid. A call of 2s. per share had been made, resulting in the payment of £998. 3s., and leaving £974. 7s. in arrears.

LONDON CARBONS MANUFACTURING COMPANY (LIMITED).—This Company is to be wound up by the Registrar of Joint Stock Companies.

LONDON ELECTRICAL TRAMWAYS COMPANY (LIMITED).—This Company is to be wound up. The Company was registered on April 22, 1891, with a capital of £150,000, in £1 shares, to acquire and carry on the system, equipment, and undertaking of the North London Tramways Company.

NORTH-EASTERN TELEPHONE COMPANY (LIMITED).—At meetings of this Company held on November 10th and 29th, resolutions were passed and confirmed that the Company be voluntarily wound up, and that Mr. T. D. Challoner, 33, Mosley-street, Newcastle-upon-Tyne, be the liquidator.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended December 4th were £907, as against £810 for the corresponding period of last year, being an increase of £97. The total receipts for half-year amount to £18,807, against £16,983 in the corresponding period of 1891, being an increase of £1,824.

COMMERCIAL CABLE COMPANY.—The Directors have declared a quarterly dividend at the rate of 7 per cent. per annum, payable on the 2nd prox. It has also been decided to redeem £120,000 of the outstanding debenture bonds on the 15th prox.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of November were £3,200, as compared with £3,263 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the month of November were £2,137, against £2,335 for the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of November amounted to £60,491 and to £60,053 in the corresponding period of last year, an increase of £438.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of November, 1892, amounted to £40,851, and to £40,686 in the corresponding period of 1891, or an increase of £165.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for November amounted to £22,000, and from January 1st to November 30th to £245,600. In the corresponding months of 1891 and 1890 the amounts were £260,200 and £256,400 respectively.

NATIONAL TELEPHONE COMPANY (LIMITED).—The Directors declare interim dividends for the half-year ended October 31, 1892, as follows :—First Preference Shares at the rate of 6 per cent. per annum, less income-tax ; Second Preference Shares at the rate of 6 per cent. per annum, less income-tax ; Third Preference Shares at the rate of 5 per cent. per annum less income-tax. On 90,950 shares (£3 paid) numbered 1 to 90,950 upon the amounts paid up from the dates of the respective calls, and on 28,284 shares (£5 paid) numbered 90,951 to 119,234 from September 27, 1892 (ordinary shares) at the rate of 5 per cent. per annum, less income-tax.

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RICHARD HORNSBY AND SONS (LIMITED).—The ordinary general meeting of this Company was held on Monday last at the Cannon-street Hotel, E.C., Mr. James Hornsby, J.P., D.L., presiding. The Chairman regretted that the Directors were unable to recommend a higher dividend, although the earnings of the Company were larger than in the previous year, but owing to the severe competition in many branches of the engineering trade, coupled with the fact that labour was so much more costly, profits had been cut down. He reported a good business with the Hornsby-Akroyd oil engine, which had been greatly improved and recently placed upon the market. A dividend of 2s. 6d. per share was agreed to.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Dec. 2, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,185.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended November 30th were £2,338, as compared with £2,336 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 30.	Price Wednesday, Dec. 7.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 7. Highest.	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	49½ 50½	50 51	4 18 0	Jan., Apr., July, Oct.	50¾	49⅞
£2,876,140	Stock	25/0	Do. Preferred	90½ 91½	91 92	5 16 4	" "	91⅞	91¼
£2,876,140	Stock	5/0	Do. Deferred	10⅜ 11¼	11 11½	..	" "	11 1/16	..
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July	..	..
130,000	£10	4/0	Brazilian Submarine xd and bonus	10⅜ 11¼	10⅜ 11¼	5 15 7	Mar., June, Oct., Dec.	11⅛	10⅞
£68,200	£100	5%	Do. 5 per Cent. Bonds	101 104	101 104	4 16 2	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	106 110	106 110	4 10 11	June and December	..	..
$7,716,000	$100	$1¾	Commercial Cable Capital Stock	178 182	178 182	3 16 11	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½ 12½	11¼ 12½	6 19 2	February and August	11⅜	..
6,000	10	10%	Do. Preference 10%	17¼ 18½	17½ 18½	5 8 1	" "	17¾	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2¼ 3¼	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅜ 11⅝	11½ 11¾	6 1 9	Jan., Apr., July, Oct.	11⅛	11⅜
400,000	10	2/6	Eastern	14¾ 15	14¾ 15	4 6 8	" "	15 1/16	14 13/16
70,000	10	6%	Do. 6 per Cent. Preference	15¾ 16¼	15¾ 16¼	3 13 10	" "	16¼	..
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109 112	109 112	3 11 5	May and November	109⅜	..
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	14⅜ 15⅛	14⅜ 15	4 13 4	Jan., Apr., July, Oct.	15⅛	14⅞
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	110	..
£78,800	100	5%	Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	104 107	104 107	4 13 6	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	104 107	104 107	4 13 6	" "	106	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	103 106	3 15 6	February & August	103¾	103½
180,227	10	1/9	Globe Telegraph and Trust	9⅜ 10	9⅜ 10	4 15 0	Jan., Apr., July, Oct.	10	9¾
180,042	10	6%	Do. 6 per Cent. Preference	14⅞ 15⅛	14⅞ 15⅛	3 19 4	" "	15 1/16	14 15/16
150,000	10	5/0	Great Northern	19 19½	19¼ 19½	4 6 1	Jan., April, and July	19½	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104 107	104 107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	43 45	43 45	5 11 1	May and November	..	..
38,348	10	4/0	London Platino-Brazilian	6 7	6 7	5 14 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	107 110	107 110	5 9 1	March & September	..	..
10,802	8	4/0	Reuter's	7⅞ 8½	7½ 8½	4 14 1	April and October	7¼	..
3,381	£100 Cert.	30/0	Submarine Cables Trust 6%	116 120	116 120	5 0 0	" "	..	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	102	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	103 107	103 107	7 9 7	June and December	..	..
88,321	10	6d.	West India and Panama	1¼ 1½	1¼ 1½	..	" "	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10 10½	5 14 3	May and November	10 1/16	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8 9	8 9	6 13 4	" "	..	..
64,242	15	3/0	Western and Brazilian	7⅛ 7¾	7 7⅛	6 0 0	" "	7⅛	..
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5½ 6	5¼ 5¾	6 10 4	" "	5¾	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1½ 2	1⅜ 2	..	" "	1⅝	1⅝
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106 109	106 109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106 109	106 109	5 10 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	—
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	—
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
224,800	14/0	1½d.	Consolidated Telephone Const. & Maintenance	5/16 5/16	5/16 5/16	7 16 5	May and November	..	..
220,000	£1	4½d.	Oriental (11s. paid)	1/16 1/16	1/16 1/16	7 18 2	Yearly	..	..
488,984	5	3/6	National	4⅞ 5⅛	4⅞ 5⅛	5 17 1	June and December	5 1/16	4⅞
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 15	14½ 15½	3 17 5	" "	14⅞	14 11/16
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13⅜ 14½	13⅜ 14½	4 4 3	" "	14 1/16	14
420,000	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112 114	112 114	3 18 11	January and July	113⅜	113½
48,000	£10	..	New Telephone, Limited (£2 paid)	4⅝ 4⅞	4⅝ 4⅞	..	..	4 9/16	4 7/16
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	—	..	—
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	—	City of London Electric Lighting (fully paid)	10¼ 10¾	10½ 10¾	..	—	10⅞	10⅝
20,000	£10	..	Do. 6 per Cent. Cumulative Stock	..	5 5½	10 18 2	..	5⅝	5¼
19,900	£5	..	Electricity Supply Co. of Spain	..	..	..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..	..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	..	..	..
8,332	£5	..	House to House Electric	2½ 3½	2½ 3½	..	—	—	—
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5½	5 5½	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	5½ 5¾	5½ 5¾	..	January and July	..	..
30,000	£5	4½% '91	Liverpool Electric Supply (£3 10s. paid)	3 1/16 3 1/8	3 1/16 3 1/8	3 15 9	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 1/16 5 1/8	5 1/16 5 3/16	4 6 9	March	..	..
111,000	5	..	London Electric Supply	13/16 7/8	13/16 7/8	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	—	6 13/16	6⅝
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40) xd	103 106	101 104	4 16 2	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	—	—	..	..
18,680	£5	2/6	St. James' and Pall Mall	7¾ 8¼	7¾ 8¼	—	—	8⅛	..
7,900	£5	7%	Do. 7% Preference	8 8½	8¼ 8¾	—	—	8 1/16	8¼
42,853	5	3%	Westminster Electric Supply (fully paid)	5¾ 6¼	5¾ 6¼	2 8 0	—	6	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1 9/32	Brush Electrical Engineering	3 3½	3 3½	..	—	3 3/16	..
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2⅛ 2⅜	5 1 1	..	..	..
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼ 5⅝	5 5½	6 7 3	January and July	..	..
12,139	5	17%	Edison and Swan United	.. ..	.. ..	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	2¾ 3¼	2¾ 3¼	..	..	..	..
45,000	10	12/0	Electric Construction	3½ 4	3¼ 3½	..	—	3⅝	3⅜
70,000	2	10/0	Elmore's Patent Copper Depositing	1¼ 1⅜	1¼ 1⅜	—	—	1⅜	1⅛
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	..	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21 22	21 22	5 13 6	February & August	21¾	..
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	4/0 4/6	4/0 4/6	..	..	..	..
78,949	5	4/2⅝	Swan United (£3. 10s. paid) xd	3 3½	3 3½	10 0 0	May and November	3 1/16	3 1/16
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July	46⅜	45½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103 106	103 106	4 14 4	January and July	..	..
—	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	½ ¾	½ ¾	..	—	..	..
—	£5	8%	Do. Preference (fully paid)	2½ 3	2½ 3	—	—	..	..
			RAILWAYS AND TRAMWAYS.						
50,000	£10	½%	City and South London Railway	3 4	3 4	1 5 0	—	3 11/16	—

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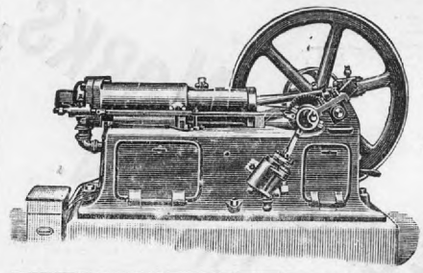
THE PRIESTMAN OIL ENGINE.



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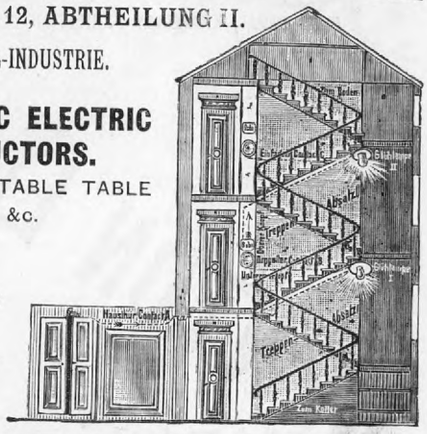

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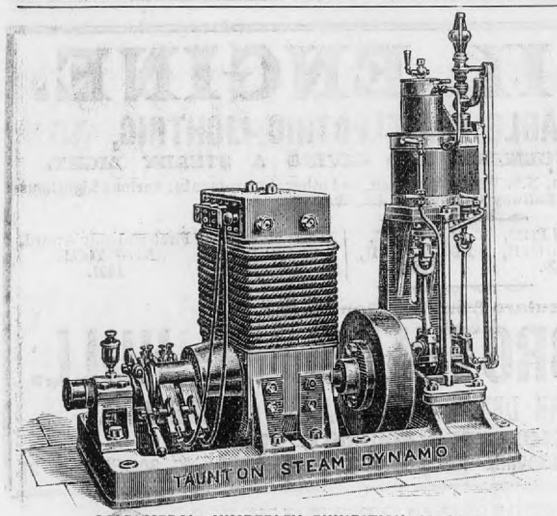

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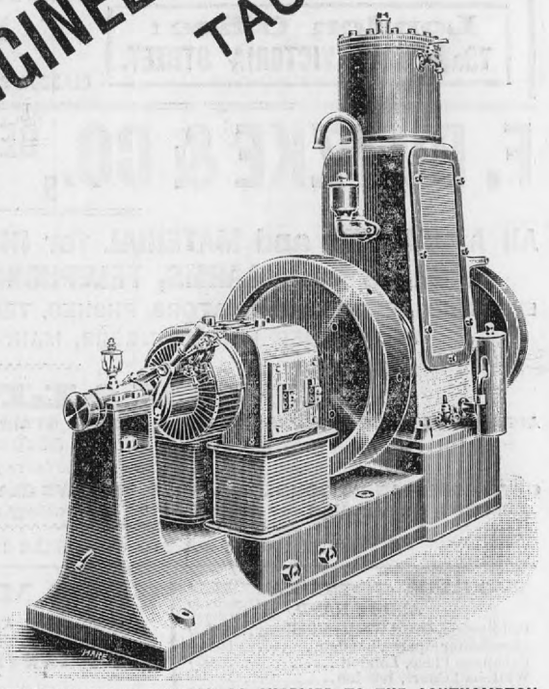

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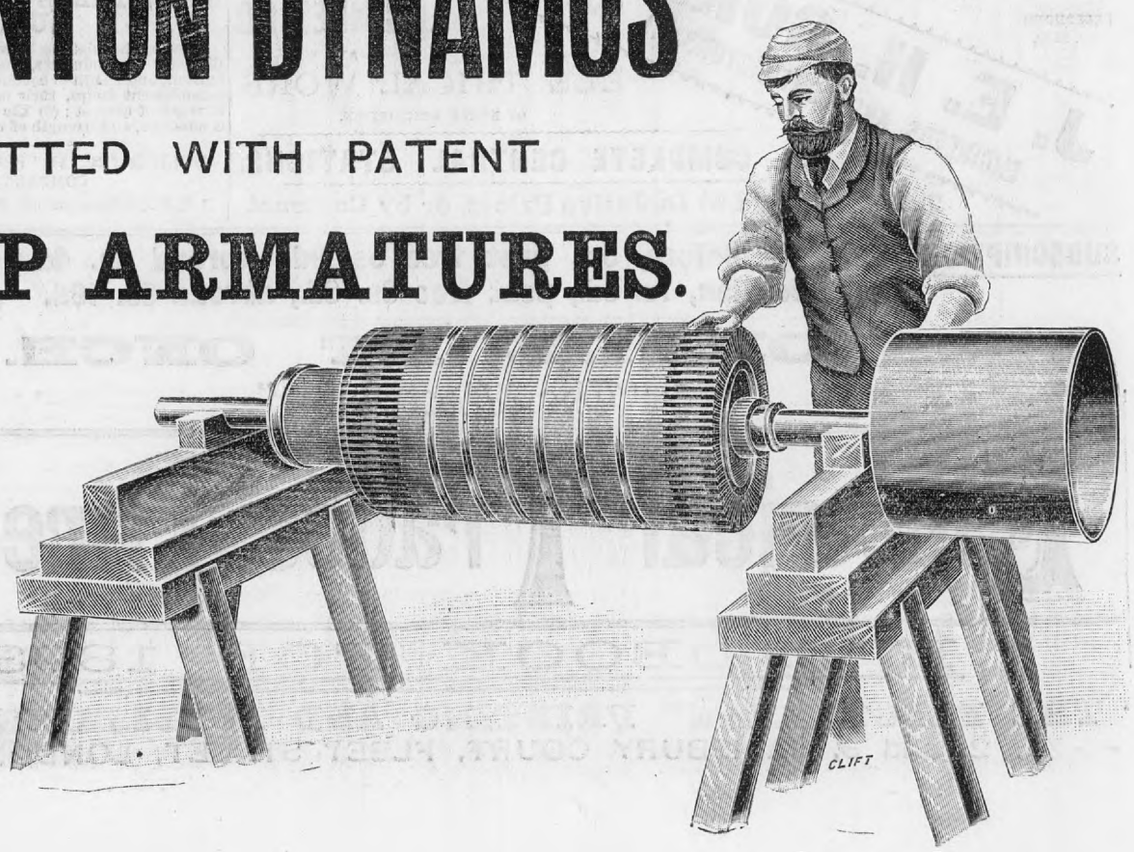

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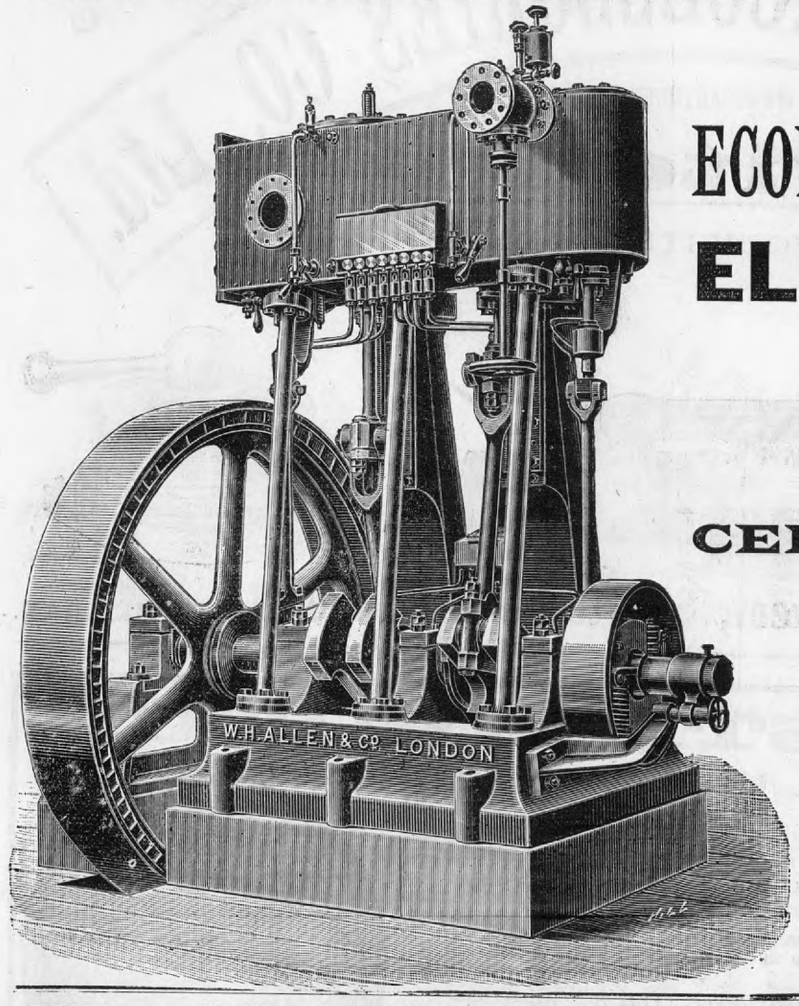

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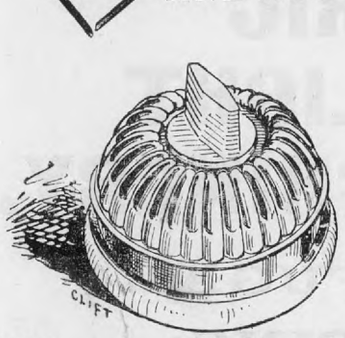

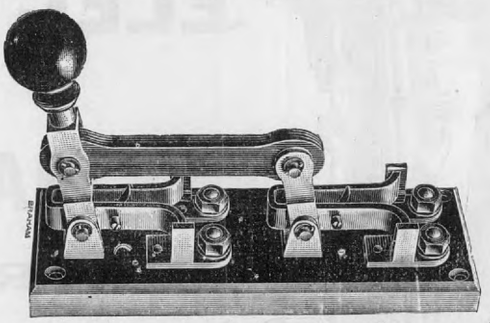

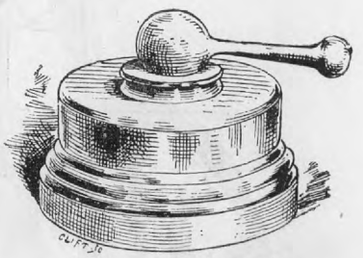

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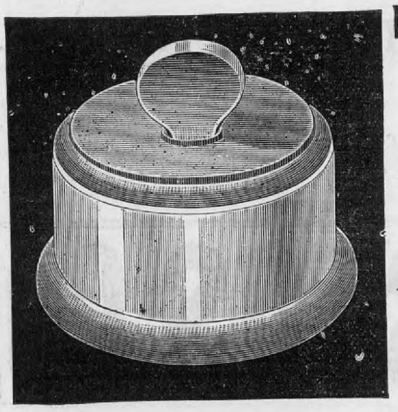
THE PAISTE SWITCH



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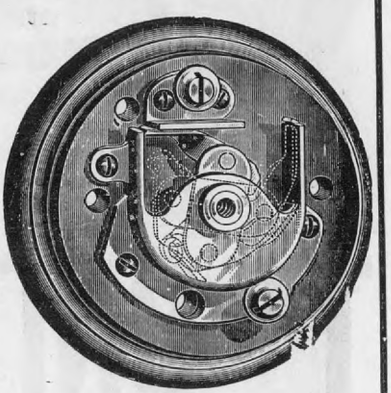

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GARROD TURNER and SON will SELL BY AUCTION, by direction of the Sheriff of Suffolk, the ELECTRIC LIGHT PLANT of the IPSWICH ELECTRICITY SUPPLY COMPANY, at 31, Carr-street, including a 14-H.P. Portable Steam Engine by Ransomes, Sims and Jefferies; two 200 light shunt Dynamos; sixty glass Accumulators; Incandescent Lamps; Ammeters, Voltmeters. Motors, and the various accessories for electric lighting. Catalogues of the Auctioneers, 1, Old Butter Market, Ipswich.

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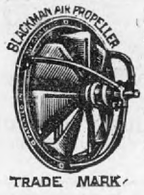

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The following Statement shows the Financial position of the Company on the **31st DECEMBER, 1891,** *including the business taken over from the Queen Insurance Company for the second half of the year only:—*

Capital Paid up	£366,702 0 0
Fire and other Reserve Funds, including Balance of Profit and Loss	2,981,078 0 0
Life and Annuity Funds	4,546,577 0 0
Total Invested Funds, 31st December, 1891	£7,894,357 0 0

INCOME FOR THE YEAR . . . £2,230,635

The following Comparative Statement shows the progress of the Company:—

1881 ...	Life Funds	£2,737,858 ...	Total Funds	£4,673,299
1886 ...	„	3,257,609 ...	„	5,672,041
1891 ...	„	4,546,577 ...	„	7,894,357

INCREASE OF FUNDS IN TEN YEARS, £3,221,058.

IMPORTANT REDUCTIONS IN LIFE RATES—see new Prospectus.

EXTRACT FROM AUDITORS' REPORT.

"We have examined all the Securities held here . . . . and have found them correct and in order, and we further certify that the present aggregate Market Value thereof is in excess of the amounts in the said Balance Sheets."

JOHN H. McLAREN, Manager.
DIGBY JOHNSON, Sub-Manager.
CHARLES ALCOCK, Secretary.
JOHN H. CROFT, Secretary in London.

THE
ELECTRIC CONSTRUCTION CORPORATION
(LIMITED).

ISSUE OF £100,000 SECOND MORTGAGE DEBENTURES
TO BEARER
(in accordance with report of Directors, dated December 8, 1892).

Bearing Interest at the rate of 6 per cent. per annum;

Redeemable by half-yearly drawings as under, and entitling the subscriber of each Debenture by way of bonus to an income bond of corresponding amount as undermentioned.

THE ELECTRIC AND GENERAL INVESTMENT COMPANY, Limited,
Of No. 1, Great Winchester-street, London,

are authorised by the Directors of the Electric Construction Corporation (Limited) to issue to the existing shareholders of the Corporation Second Mortgage Debentures of £10 each, in proportion to their respective holdings.

The Debentures are payable:—

£1	per Debenture	on 19th December, 1892.
3	„	on 16th January, 1893.
3	„	on 15th March, 1893.
3	„	on 15th May, 1893.
£10		

The first Payment of Interest will be made by Coupon attached to the Scrip Certificates, on the 1st July, 1893, and will be calculated at the rate of 6 per cent. per annum on the instalments, from the dates when they become due to the 30th June, 1893. Thereafter the interest will be payable on the 1st January and 1st July in each year by half-yearly Coupons attached to the Debentures.

The Debentures will rank next after the existing First Mortgage Debentures of £150,000 as a charge upon the whole undertaking and property of the Corporation present and future, and are secured by trust deed made between the Electric Construction Corporation (Limited), and the Electric and General Investment Company (Limited), the trustees.

The Debentures are redeemable at par by half-yearly drawings over a period of about 15 years, thus: A sum equal to £10,000—less 6 per cent. on the unredeemed and unissued (if any) Debentures of this series—to be paid over to the trustees annually, and to be applied by them in redeeming the Debentures of this series at par, in accordance with the provisions contained in the trust deed.

The Subscriber for each Debenture will receive by way of bonus an income bond for a like amount.

Such income bond will carry interest from the date of redemption of the corresponding Debenture as regards each year at a rate equal to the dividend declared on the ordinary shares for the preceding year, and such income bond will, in a winding-up, rank for payment next after the preference shares of the Corporation, and will be repayable in 50 years from date of issue or on the winding-up of the Corporation.

Drafts of the above-mentioned trust deed and of the forms of Debentures and income bond can be seen at the Offices of this Company, and at those of the Electric Construction Corporation (Limited), Worcester House, Walbrook, E.C.

Dated 9th December, 1892.

LARGE DIAMETER DYNAMOS.

Having Machinery suitable for dealing with Diameters up to 22ft., we shall be glad to undertake the production of Dynamos, &c., to above sizes.

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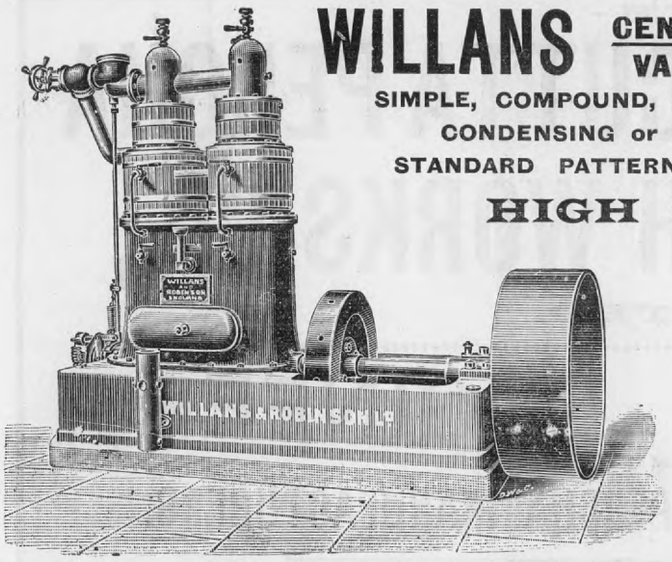

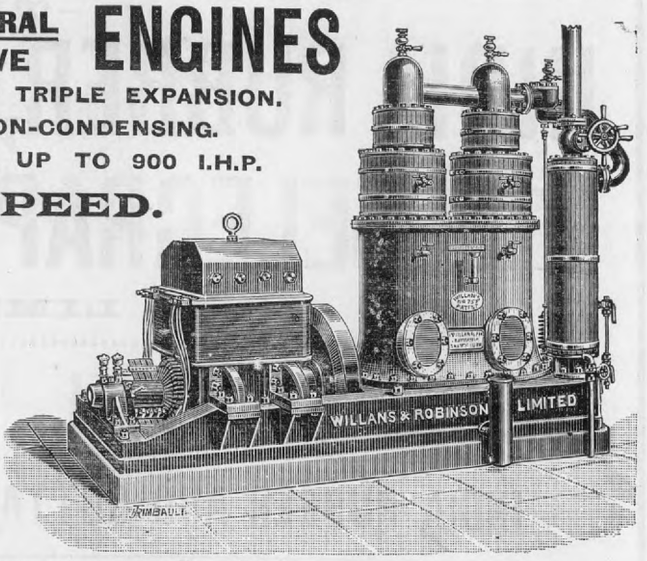

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WILLANS & ROBINSON, Ltd., THAMES DITTON, SURREY.

Crompton & Co., Ltd. — *See Important Announcement on page xxviii.*

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ENGINEERS, COLCHESTER.

London Office: 78 (late 139), QUEEN VICTORIA STREET.

MAKERS OF A GREAT VARIETY OF STEAM ENGINES & BOILERS.

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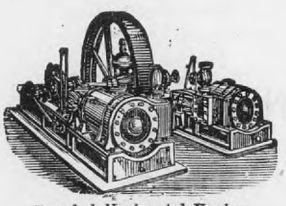
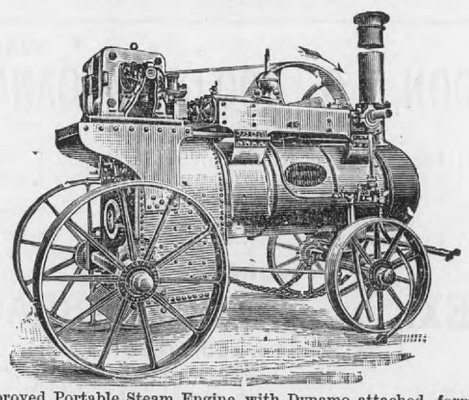


Coupled Horizontal Engine, 40 to 200 H.P. nom.



Improved Portable Steam Engine, with Dynamo attached, forming a portable electric light plant. Single cylinder, 4 to 12 h.-p.; double cylinder, 8 to 25 h.-p.; compound, 8 to 30 h.-p. nominal.

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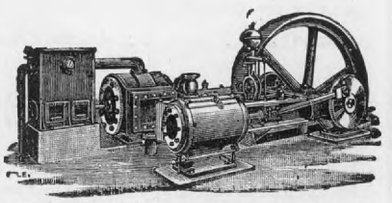

Horizontal High Pressure Coupled Compound Engine. 12 to 100 H.P. nom.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 761.—Vol. XXX. FRIDAY, DECEMBER 16, 1892. PRICE FOURPENCE. *Annual Subscription (U. K.), 19/6.*

NOTES.

The public and formal amalgamation of the National and New Telephone Companies is a satisfactory proceeding, inasmuch as the separate existence friction has been done away with. As to any blessings which may flow to the public from this union of hearts—we shall believe them when we see them. At any rate, Government purchase has now been rendered a more simple, though probably a more costly process.

The County Court decision which is reported in our Legal Intelligence this week would be of the greatest importance were it not utterly absurd, and would, as the plaintiff urged, have a disastrous effect on electrical business, were it not a complete blunder. Messrs. Laurence and Scott carry on an electrical supply business at Ipswich, and one of their customers has demanded that the expense of lamp renewals should be thrown in for the asking. Without troubling themselves to appeal and without incurring any costs, Messrs. Laurence and Scott could probably set matters right by applying to the Board of Trade, who, whether they had any *locus standi* or not in the matter, would probably give the learned Judge a little elementary information which might be useful to him. It may be, but it does not appear from the evidence, that the plaintiffs have been foolish enough to make a contract for supply of *light*, but this seems hardly possible, although the Judge thought that the agreement, such as it was, gave the defendant to understand that the plaintiffs would "keep up the electric light."

At the Society of Arts on Wednesday last Prof. G. Forbes discoursed on Niagara, but was unable to give any information about the electrical part of the work, as twenty designs for the 5,000 horse-power generators are still puzzling the commission. We hear more about the new manufacturing city that is to be built, than about the cost of the power which is to be its *raison d'être;* nor are we any wiser as to the nature of the new industries which we have been assured will be created. Prof. Forbes puts forward, tentatively we presume, £5 as the value of one horse-power day and night, for a year, and deduces the very handsome annual income of £2,450,000. Bearing carefully in mind the difference of prices in this country and in America, we may compare this figure with the estimates recently given by Mr. Swinburne and by Messrs. Cross and Bevan, the constituent items of which were given in *The Electrician* of November 25th and December 9th respectively. Mr. Swinburne put down a kilowatt-hour at 0·241d., say, 0·18d. for a horse-power-hour; Messrs. Cross and Bevan give a horse-power-hour at 0·178d. The £5 of Prof. Forbes works out to 0·137d. per horse-power-hour. The Niagara power is only 24 per cent. less than Mr. Swinburne's estimate, say 30s. per horse-power-year. Out of this 30s. will have to be paid attendance, oil, and interest and depreciation on plant, all of which are included by Messrs. Cross and Bevan and by Mr. Swinburne, and out of the balance the new manufacturing city is to be built. We wish it all success. But, as we have already remarked, it is difficult to compare prices in the two countries.

Freshness and originality are not expected in Presidential Addresses, but in the address recently delivered before the Old Students' Association by Mr. Ll. B. Atkinson both these ingredients were present in an unusual degree. The study of human character and the motives which influence mankind is as old as civilisation, but to suggest that it should form part of a course of technics was both a refreshing deviation from the beaten track and the apotheosis of the technical education mania. We are happy in the conviction that a subject has at last been suggested that no formula can compass, and nothing short of actual practical experience of the world can teach. A youth certificated in electrical engineering, chemistry, astronomy, and—"human dynamics" would be too awful to contemplate.

Mr. Mordey observed during the discussion on Dr. Fleming's recent Paper that the members of the Institution of Electrical Engineers were apt to be a little squeamish when they came to discuss profits and commercial considerations. To speak of L was scientific, but to mention £ was bad form. Mr. Mordey was perfectly right in his estimate of the character of these discussions, and such squeamishness is only part of the idiosyncrasies of the Institution, and one which we had in view when, on a recent occasion, we held that it was a distinctly scientific body. At the meetings of the Institution of Civil Engineers no such delicacy is known. The saving of a few pence in boring a rifle barrel is put forward with pride as a crowning-point in the performance of an ingenious machine, while the losses by friction are not even alluded to. Nor, when the cost of docks runs into many thousands of pounds, is there any hesitation in giving the figures; they are, indeed, necessary for the proper appreciation of the subject. During the discussion on small arms, which has not yet been

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closed, at the Institution of Civil Engineers, the price of different rifles was freely mentioned, but in a way that would simply shock dynamo-makers, for the trade or selling price was treated as of minor importance, depending simply on the relative smartness of buyer and seller. The prices quoted and compared were net cost prices.

THE attempt which has been made by M. PICOU to analyse the losses in transformer distribution would have been of greater value if he had taken some actual case or had worked out figures for an imaginary example. In his article, of which a translation will be found in another column, he gives a load curve, and adds to the useful load the losses which arise in the transformers and the mains. Amid all the theorising about transformers and the profusion of literature upon their losses, no one, so far as we are aware, has taken the trouble to calculate the C^2R losses in an ordinary alternate current supply station, or at all events to publish them. Dr. FLEMING has published hypothetical curves not unlike that of M. PICOU; but transformers as a system must be judged on actual examples from practice, and this becomes yet more imperative when one kind of transformer is to be compared with another.

WHILE some such diagram as that of M. PICOU may represent hypothetically an ordinary transformer service, it does not illustrate the losses with Hedgehogs, for the magnetising current with these transformers is, we understand, or ought to be, practically constant. The increase of power as the secondary becomes loaded is due mostly to change of phase, not, as in closed-circuit transformers, to increase of current. If we understand Mr. SWINBURNE rightly, the magnetising current gives rise to a nearly constant copper loss equal to about one-third that of the iron losses. This might be represented on the diagram by a line parallel to the iron losses. The load current, or that part of the primary current which rises with the load, entails a variable C^2R loss. But to draw these by eye on an imaginary curve is of no use at all. The objections to open-circuit transformers are chiefly directed to the heavy magnetising current, and before much weight can be attached to them some actual figures of the C^2R losses in mains must be produced. The losses in the secondary circuit, while interesting from a scientific point of view, have nothing to do with the present subject. The result is merely a drop, annoying perhaps to the consumer, but recognised and licensed by law, if not greater than 4 per cent., and it in no way affects the coal bill of the station.

THE condition of maximum efficiency given by M. PICOU only really applies when the C^2R losses include not only those occurring in the transformers, but also the average loss in the mains. Owing to the absence of data with reference to the latter losses, it is impossible to say how nearly this condition is fulfilled in modern transformers. In nearly all those tested by Dr. FLEMING the copper losses at full load are less than the core losses, so that the efficiency increases continuously up to full load. The Ferranti and Thomson-Houston transformers practically attain their maximum efficiency at about three-quarter load, and this shows that the copper losses in the transformers are, at full load, greater than those occurring in the iron. For the average load, however, the copper losses are less than those in the core, and when the losses in the mains are added, it is probable that M. PICOU's condition of maximum efficiency represents very nearly the condition of actual practice with closed circuit transformers. The instrumental details of measuring transformer losses as carefully investigated by Dr. FLEMING, and the estimation of these losses per cubic centimetre of iron and copper by Prof. EWING, are valuable in their proper place; but the real question for the engineer, as was pointed out by Mr. CROMPTON, who, by the way, meets with small thanks for his trouble, is "the enormous difficulty of ascertaining where the losses really do lie in alternating systems of distribution."

WE print this week an interesting Paper by Prof. ROWLAND on the effect of harmonics in alternating current circuits. We are, however, inclined to think that the importance of these harmonics is much over-estimated. They may sometimes represent 20 per cent. of the current, but, if so, the power they denote is only this percentage of the *losses* occurring in the mains. In alternating current circuits the loss in the primary mains represents a small fraction only of the power transmitted, and any harmonics occurring in the secondary circuits are useful, since secondary circuits are only used for lighting purposes. These harmonics are mainly caused by the presence of hysteresis in the cores of the transformers or motors worked by the current, and they represent the extra excitation necessary to make the magnetism of the iron follow strictly the variations of the potential of the mains. The power which is represented by the product of the voltage of the mains, and the effective value of these harmonics, is that which is absorbed in hysteresis, and this cannot be diminished except by the substitution of better iron. The practical conclusion to which Prof. ROWLAND comes, that the cores of transformers and the armatures of alternators should be worked at a much lower induction than 12,000 lines, is an old one now, and one which has been acted upon for some years. Indeed, there are few transformers made at the present time worked with a maximum induction of as much as 5,000 lines.

Hampstead Vestry.—The Electric Lighting Committee of this Vestry has recommended the Vestry to under take the electric lighting of the parish, under their Provisiona Order, and to borrow £25,000 for the necessary plant.

Bristol.—It has been decided to have handsome gas standards placed upon St. Augustine's Bridge, notwithstanding that the electric light mains are to be carried over the structure. The standards will, however, be suitable for electricity as well as gas.

Nottingham.—The Town Council, after a long and interesting discussion, decided on Monday last to adopt the scheme for lighting part of the town by electricity, which has been previously referred to in these columns. (See *The Electrician*, December 9th, p. 147.)

Yarmouth.—At the last meeting of the Town Council it was decided to apply to the Local Government Board for sanction to borrow £15,000 for the purposes of electric lighting. This sum will allow of from 50 to 100 arc lights for public street lighting, in addition to 14,500 private lights.

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Southport.—On Thursday last Col. Hastead, R.E., Local Government Board Inspector, held an inquiry at the Town Hall respecting an application of the Corporation to borrow £28,000 for works of electric lighting. After evidence had been given the inquiry concluded, there being no opposition.

Derry.—At a recent meeting of Derry ratepayers protests were made against the efforts of the Corporation to be entrusted with the power to borrow £40,000 for the electric lighting of the city. Eventually it was resolved to employ legal and expert assistance, and to appear before the Local Government Board to oppose the loan.

The Diffusion of Light.—A Paper of unusual interest was presented to the Physical Society by Dr. Sumpner on Friday last. Only a small portion was read, and some discussion followed. The practical bearings of this subject are of so great importance in electric lighting that we withhold the usual abstract until we are able to publish the Paper in full.

Taunton.—The statutory inquiry as to the proposed purchase of the electric light works by the Town Council was, as we announced last week, fixed to take place on Tuesday; but it having been represented to the Board of Trade that that date would be inconvenient, it was decided to postpone the inquiry until to-day (Friday), when Sir Thomas Blomefield and Major Cardew will open the proceedings at 10 a.m.

Royal Institution.—Among the lectures arranged for before Easter are the following :—Sir Robert Ball, six lectures (adapted to a juvenile auditory) on Astronomy; Prof. Victor Horsley, ten lectures on The Brain; Lord Rayleigh, six lectures on Sound and Vibrations. The Friday evening meetings will begin on January 20th, when a discourse will be given by Prof. Dewar on Liquid Atmospheric Air. Succeeding discourses will probably be given by Mr. Alexander Siemens, Mr. Edward Hopkinson, Lord Rayleigh, and others.

Wolverhampton.—The Electric Lighting Committee of the Town Council have decided to recommend the adoption of the tender of the Electric Construction Corporation for £28,772 for laying down an alternate-current system. It is proposed to appoint Mr. W. H. Preece engineer; also an architect and a deputy-engineer or clerk of the works, at a salary not exceeding £250 per annum, subject to the engagement being determined by one month's notice on either side. The details of the tenders sent in will be found in our Trade Notes column.

Windsor.—On Friday last a special meeting of the Town Council was held to consider the breaking up of the streets by the Windsor and Eton Electric Light Company. After much discussion it was moved and carried by 12 votes to 9 that the Town Clerk should be instructed to take action against the Electric Light Company for breaking up the streets without legal authority, under section 149 of the Public Health Act. An addendum was proposed and carried by 10 votes to 8 to the effect that counsel should be instructed to ask for only a moderate penalty.

"Irish" Electric Railway.—Mr. W. E. Irish, of Cleveland, Ohio, has sent us a description of what he calls "a closed electric conduit system." The conduit has, however, an open slot, through which a hanger passes and carries a trolley with two wheels. These press against two conductors hung to the top of the conduit. Each conductor is enclosed in an indiarubber tube, on the outside of which contact pieces are fastened. As the trolley passes underneath the conductors, the elastic tube is pressed upwards by the trolley wheels, and contact is made with the conductor.

Cable Interruptions and Repairs :

	Interrupted.	Repaired.
Ceara-Maranham.....	Nov. 9, 1892	Dec. 9, 1892

THE FOLLOWING CABLES ARE ACTUALLY INTERRUPTED :

	Date of Interruption.
Bolama-Bissao (communication with)	September 9, 1892
Cayenne-Vizeu	September 24, 1892
St. Thomé-Loanda*	November 24, 1892
Penang-Medan.....	December 1, 1892

* Communication with South Africa is still maintained by the East Coast route.

Bolton.—The Corporation are seeking powers to introduce electricity into the town, both for lighting and power purposes. The Corporation are the owners of an extensive gas undertaking, and it is proposed, for some time at least, to confine electricity to manufacturing establishments, tradesmen's premises, and other similar consumers. The Corporation are seeking powers to work the tramways themselves, and in the event of their doing so, electricity is being advocated in various quarters as the motive power. The motion for the Bill embodying these powers recently came before the Town Council and was carried by 21 to 11. A two-thirds majority not having been obtained, the matter will have to come before another meeting.

Obituary.—The death is announced of Mr. John R. H. Williamson at Allandale, near Sydney, on the 8th inst., at the early age of 33 years. Mr. Williamson became connected with electric lighting, and was quickly appointed Managing Director of the Manchester Edison-Swan Electric Light Company, and under his able management that Company attained a position of considerable success. Unfortunately his health broke down, and he left England three years ago for New South Wales, where he again embarked in electric lighting, undertaking several important contracts for the lighting of Sydney. Increasing ill-health, however, again necessitated his entire relinquishment of business.

The Funeral of Dr. Werner Siemens.—The German Emperor was represented at the funeral of Dr. Werner von Siemens on Sunday last by Prince Leopold. The Empress Frederick was represented by Count Seckendorff, and the German Empire by Chancellor Caprivi. The London, Vienna, and St. Petersburg Siemens factories each sent 10 officials and 10 workmen. Among the various notabilities present were Dr. von Bötticher, Minister of the Interior; Baron von Berlepsch, Minister of Commerce; and Dr. von Schelling, Minister of Justice; while representatives of the City of Berlin, and of the town of Charlottenburg, and numerous members of artistic and scientific societies, likewise attended. Mr. Edison sent a wreath.

Nîmes.—At Nîmes it appears that the electric light cables are leaking. *Sciences et Commerce* says :—"A certain number of house owners are complaining of the bad insulation of the cables of the National Electric Company. On some days, by merely touching the awning supports of many of the houses on the Rue de la Banque, one may treat oneself to a little electro-therapeutic séance, and at the same time save the penny which this amusement usually costs at the automatic machines. The Company, apprised of this state of things, which might have serious consequences one of these fine days, will surely apply itself to a better surveillance of its cables, and to the improvement of its insulators."

City and Guilds of London Institute.—The presentation of prizes and certificates in connection with the City and Guilds of London Institute for the Advancement of Technical Education took place on Monday evening last at Merchant Taylors' Hall, the Lord Mayor presiding. Those present included Dr. Anderson, F.R.S., Sir Frederick Bramwell, Sir Frederick Abel, Sir Philip Magnus, and others. The Lord Mayor opened the proceedings, and heartily welcomed the students of the Institute to the City. Dr. William Anderson presented the prizes and afterwards addressed the students, urging them not to rely too much on theoretical knowledge, but to remember that practical experience, though obtained very slowly and often at great cost, was essential to success in their professions.

Plymouth.—With reference to the tramways question the Works Committee reported at the last meeting of the Town Council that there was no intention of introducing into Plymouth the overhead trolley system of electric traction, but that they thought it desirable to apply for similar powers of working the new lines by electricity as the Corporation possessed with reference to the existing lines, so that the Corporation might be in a position to avail itself of electricity as a motive power, should experience hereafter demonstrate that it could be economically used without detriment to the public interest. The Committee also reported that the Board of Trade had sanctioned the borrowing of £8,500 for the purchase from the Tramway Company of the depôts, rolling stock, plant, and horses.

Proposed Clapham Junction and Paddington Railway.—The proposed railway from Paddington to South Kensington,

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which met with such strenuous and effective opposition last year, both from scientific men whose laboratories would be disturbed, and from many residents in the neighbourhood, has been put forward again, as we recently noticed, with an extension to Clapham Junction. This, no doubt, gives a little more reason for the construction of this line, but it seems to be admitted that it is to act chiefly as a feeder to the various institutions, museums, &c., at South Kensington, and especially to the Albert Hall. We understand that there will be a station actually within the Albert Hall itself. It is assumed that by having a deep tunnel, some 70ft. below the surface, the scientific laboratories will not be affected.

Technical Education.—One of the many rocks ahead of the technical education craze seems to be foreshadowed in a dispute which has arisen in the Dundee Technical Institute. The Institute has a plumbing class which is attended, amongst others, by two tinsmiths and a blacksmith. The presence of men not connected with the trade was objected to by the regular plumbers, and they requested the Committee of the Institute to restrict the attendance at the class to journeymen and apprentice plumbers. The Committee have not as yet agreed to concede the request, and meanwhile the plumbers threaten to boycott the class. The National Registration of Plumbers' District Council have proposed to the Committee that the class should either be conducted as an exclusive trade class, or that the teaching should be confined to the principles of the plumbing craft as defined in the Technical Instruction Act of 1887.

The Blackening of Glow Lamp Bulbs.—Writing to *L'Electricien*, with reference to the statement of Prof. Thomas that the bulbs of glow lamps exhausted by mechanical pumps blackened less than those exhausted by mercury pumps (see *The Electrician*, Vol. XXIX., p. 331), M. Bainville, works manager to the "La Française" Glow Lamp Company, says that in his opinion the mercurial vapours which may possibly be present within a lamp bulb are quite insufficient to explain the phenomenon. M. Bainville suggests that occluded oxygen is the true cause, the oxygen being present either in the residual air, in the vapour of water which adheres so strongly to the glass, or in the filament itself. This occluded oxygen in the presence of the incandescent carbon forms carbonic oxide, which, coming into contact with the relatively cold wall of the bulb, splits up, depositing the carbon and leaving the oxygen free for fresh attacks.

An Iron Ship Struck by Lightning.—Captain Woodcock, of s.s. "Capella, has given the following account of his vessel being struck by lightning on May 16th, in latitude 8 12 N., longitude 70 50 E. The "Capella" is a steel steamer, fitted with two masts, the lower portion being of iron and the topmasts of wood. The morning was squally and thundery, and about half-past seven there was a very vivid flash of lightning, accompanied by a violent explosion by the rail near the starboard fore rigging, which seemed as if something had exploded. The foretop-mast was splintered near the spirs, and some service torn off the top-gallant backstay. The shock also affected the compasses. The shock had changed the magnetism of the ship so much that it reversed the cards. Since the occurrence the compasses have never regained their original errors, and the magnets have had to be moved, and some reversed, to reduce the errors.

Telegraph Construction on the Kohat Frontier. — An excellent piece of construction, says the *Indian Engineer*, was carried out last month on the Kohat frontier by Mr. Oldbury Burne, assistant-superintendent of telegraphs, assisted by Lieutenant Greer, R.E. Orders were issued on September 7th to extend the line from Hangu to Thall, in connection with the occupation of the Kurram Valley. The stores were procured from Rawalpindi, and had to be carried 80 miles by rail to Kushalgarh, and 45 miles by road to Hangu. Notwithstanding that the working party were attacked by cholera, and that the distribution of posts and wire had to be made by coolie and donkey transport, the 41 miles of line were completed by the 1st inst., on which day an office was opened at Thall. The experience gained here and on the Haripur-Darband route has conclusively shown that the field telegraph equipment now in use is thoroughly well adapted for the purpose for which it was designed.

The Indo-European Telegraph.—The resolution of the Government of India on the working of the Indo-European Telegraph Department last year notes the increase on the capital account of eighty thousand odd rupees, mainly due to a payment on account of the extension of the Persian concession. The traffic earnings were higher by two lacs and eighteen thousand than in the previous year owing to a larger number of messages having been carried. The year's transactions show a net profit of one lac and sixty thousand compared with a loss during the previous year of eight thousand rupees. The net profit is equivalent to a return of ¼ per cent. on the capital outlay. The average length of the messages is increased owing to the reduction in the Australian tariff. There were fewer complaints of error and delay, and practically no interruption; but the number of acts of wilful damage on the Persian section are much more numerous, the increase being attributed to the year having been one of disturbance and excitement in Persia. But compensation was received as usual, and the good relations existing between the Persian authorities and the *employés* of the department were in no degree affected.

Cathedral Lighting.—The *Neue Freie Presse* of Vienna discusses the advantages and disadvantages which attend the electric lighting of St. Stephen's Cathedral, which has lately been introduced. From a practical point of view the lighting is all that could be hoped for. The twelve large hanging lamps, each 1,000 candle-power, suffice to spread a brilliant light into every part of the great church. The light also brings out the details of decoration and of the architecture, as it is never possible to see it under other conditions, because no other light is so equally distributed from the ceiling to the ground. But this may not be altogether an advantage, as an architect naturally arranges his parts with distinct reference to the distribution of light, as it is permitted to enter by the windows or dome. And as regards the building as a whole, its appearance is certainly not improved by the absence of due shade. What is here stated must apply more or less to all large Gothic buildings. The fault lies not in the strength of the light, but in its position. It can never have the same effect as that got by the sun's rays entering through side windows, and it was with reference to such lights that Gothic cathedrals were built.

Electric Lighting Legislation in Victoria.—At the monthly meeting of the Victorian Institute of Engineers, held on October 5th, the report of the Committee appointed to inquire into the Electric Lighting Bill was read by Prof. Kernot. The Committee stated that they were in favour of electrical legislation, but the Bill appeared to them defective in the following respects:—It failed to specify the ultimate authority by whom disputed points were to be settled. The fixing of a maximum price of 9d. per Board of Trade Unit was undesirable. If any limit had to be fixed to the price of electricity, it should be high enough to allow for the increased cost of production in small towns and places where motive power was specially expensive. The Municipal Councils were given dangerous power in imposing special by-laws. Too much power was given to the Postmaster-General. The Committee suggested that a Central Board, consisting of representatives of the Postal and Railway Departments, City and Municipal Councils, Metropolitan Board of Works, and Electric Supply Companies should be appointed, with power to frame regulations, settle disputed points, inspect and, if necessary, condemn imperfect and unreliable appliances, adjust disputed charges, determine the hours of supply, the location of conductors, character of insulation and supports, and perform any other duties that might be necessary to ensure a reliable supply of electricity to the public and a secure tenure to the undertakers, and at the same time protect the interests of the Postal and Railway Departments and other interested bodies; and that all municipal and departmental by-laws relating to electric supply should be subject to the approval of this Board. If such a Board were organised, and the other modifications proposed in the previous part of the report attended to, the Committee believed that the proposed legislation would be beneficial and satisfactory to all concerned.

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NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 87.)

23. The Old "Monarch" and Her Modern Namesake.—The earliest events in the history of cable laying and repairing will never cease to retain their interest. From the year 1850, when the first telegraphic submarine cable of any practical utility was laid, namely, that between Dover and Cape Grisnez in France, up to the first Atlantic Expedition of 1857, a vast amount of pioneer work in the laying and repairing of what would now be called shallow water cables was carried out. Cables were laid between Holyhead and Ireland, Scotland and Ireland, England and Belgium, and England and Holland, and during this period great progress was made in the design of machinery used in laying and repairing cables, the fitting out of ships as cable ships, their handling under heavy weather when working cable, in the manufacture of cable, and in the development of a system of electrical testing. The names of Messrs. Willoughby Smith and Latimer Clark, electricians; Messrs. Wollaston, Crampton, R. S. Newall, Reid, Edwin Clark, and F. C. Webb, engineers, and Messrs. J. and J. W. Brett, are well known as those to whose skill and indomitable perseverance was due the grand pioneering achievements of that time. It was then the custom to petition the Admiralty for the assistance of one of Her Majesty's ships during the laying of a new cable, a request freely accorded, and the names of Captain E. Burstall, R.N., and Captain J. Washington, R.N., fill an important *rôle* in the history of these early enterprises.

A peculiar intrinsic interest, attaches to the cables, past and present, connecting Great Britain and Ireland and the British Isles with the Continent; not only because their history is of such significance, in view of the incipient stages of the enterprise, but the whole system of their maintenance in the present day, coming under the control, as it now does, of the Government, must be of interest to most Englishmen, whilst the manner of coping with the special difficulties attending repairs near our coasts in shallow water of great tidal force is of no small technical interest. Of the cables touching our shores, with the exception of these to Norway, Denmark, Spain, Portugal, America, and their connections which belong to private companies, the whole network of cables between Great Britain, Ireland and adjacent islands, together with those across to France, Belgium, Germany and Holland, are kept in repair by our own Government telegraph ships, H.M.S. "Monarch" and H.M.S. "The Lady Carmichael." The two cables to the latter country belong to our own Government, while those to the three former countries are jointly owned by our own and their respective Government subject to a joint purse arrangement. The behaviour of the "Monarch" under peculiar difficulties while laying the Channel telephone cable through which London is now in direct speaking communication with Paris, attracted considerable public attention in the early part of last year, and this vessel (illustrated in Fig. 85), to which reference will be made presently, is in build and fittings admirably designed for her special work. First, however, the writer wishes to review some of the work done by the pioneer vessel of that name, justly called the first cable ship. This does not mean she was the first vessel from which a submarine cable was laid, for preceding her the steam tug "Goliath" laid the unsheathed cable to France in 1850, H.M.S. "Blazer" that in '51 over the same route (this cable being still in good working order), the steamer "Britannia" the first Irish cable from Holyhead in '52, and the second from Scotland, and the steamer "William Hutt," the first cable to Belgium in '53.

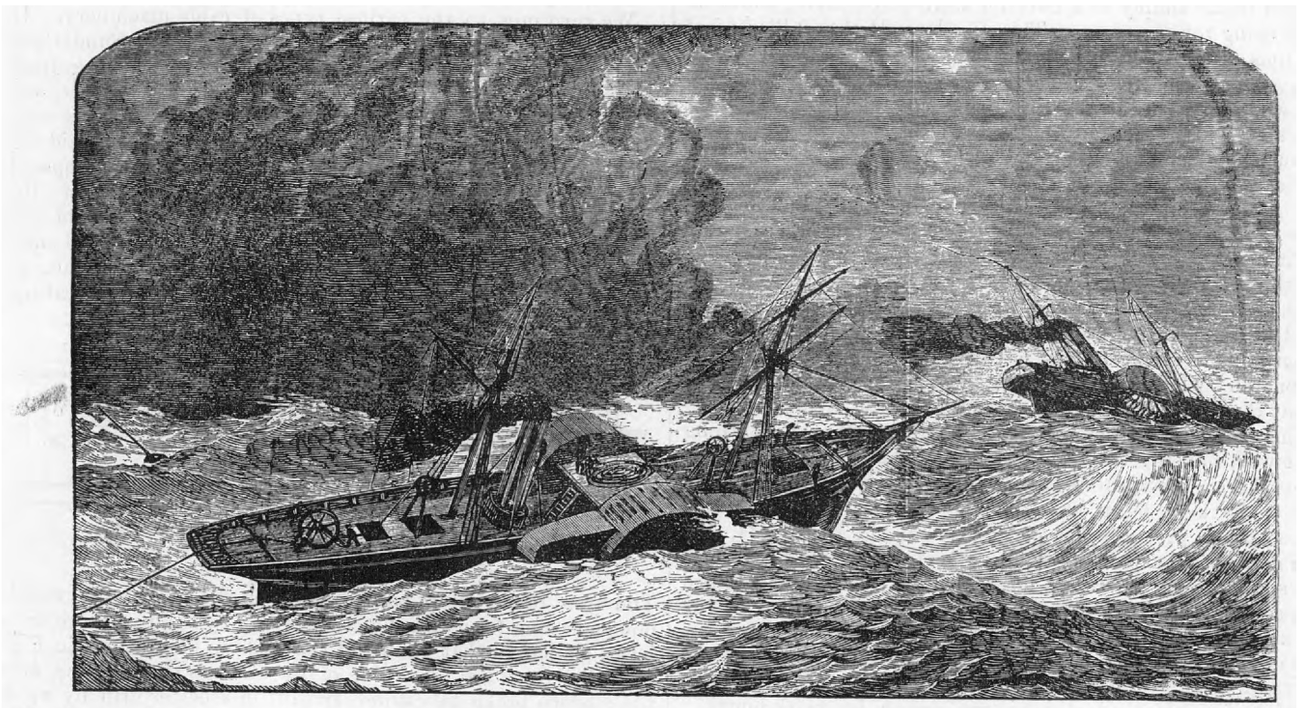

FIG. 81.—The old "Monarch" laying Cable from England to Holland, 1853. H.M.S. "Adder" in company (This illustration is reproduced from the *Illustrated London News*, of June 18, 1853, by kind permission of the Editor.)

But the "Monarch" was the first ship that grappled for a lost cable and successfully carried out a repair, and on her was fitted the first picking-up machine ever made. Besides this, her paying-out brake was the embryo of that in use at the present day, and the system of buoys, mushrooms, sheaves and steam gear was originated in her.

The illustration of this vessel (Fig. 81) (reproduced from the *Illustrated London News* of June 18, '53, by the courtesy of the editor) is from a sketch by Mr. F. C. Webb, and represents her laying one of the Hague cables from Orfordness in that year, this being her first operation. She was a wooden steamship of 500 tons, with paddle wheels, and was already 23 years old when bought by the International Telegraph Company for laying the above cables. The expedition is of interest, as showing the practice in those days. The cable (136 miles) was distributed in five coils, two in the main and three in the fore hold, coiled alternately in order to keep the ship trimmed during paying-out. Ships are now built with water ballast tanks which can be pumped up or discharged, as trimming is necessary, while loading or paying-out. The coils

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were oblong, which economised room in the holds, but were not so simple to uncoil as circular ones. In paying-out from these coils, in order to allow sufficient vertical height for the turn put in in coiling to untwist itself, the cable was led over an iron saddle or sheave erected on shear legs on deck 10ft. high immediately over the hatch. These may be seen in the illustration, one over each hold. To prevent cable running out too free the turns of the coils were stoppered down in places to the underneath turns by rope yarns. While paying-out, the stoppers were cut adrift and cable cleared away by twelve men stationed in the hold.

A perusal of the works on this and earlier expeditions from which these particulars have been gathered, viz., the Paper read on February 23, 1858, before the Institution of Civil Engineers, "On the Practical Operations Connected with Paying-out and Repairing Submarine Telegraph Cables," by Mr. F. C. Webb, and "Old Cable Stories Retold," a series of interesting articles in *The Electrician*, Vol. XIII., by the same author, conclusively shows that the greatest difficulty experienced was in steering. Towing was tried and given up, although this was a great assistance until matters were better understood. For instance, when laying the first sheathed cable (Dover to Calais, 1851), it was not deemed prudent to trust one vessel to carry it, lay it, and keep her course across channel. A vessel was, therefore, secured to act simply as a hulk for storing and laying the cable while being towed across. This vessel was H.M.S. "Blazer," of 500 tons, from which the engines and boilers were previously removed. When well on her way across, the hawser parted, and while renewing it, the ship drifted in the tideway, paying out cable nearly at right angles to the true course. Another similar experience was with the second Irish cable (from Port Patrick), which was laid without the aid of a tug. With the strong tide which runs through the North Channel, on her beam, and a light breeze aiding it, it was found only just possible to keep the "Britannia" on her course, and when about two-thirds across, the breeze increased in force and overpowered the helm, swinging her round stern to sea and tide. The cable was thereupon cut and let go.

Acting on this experience, a tug was procured to tow the "Monarch" while laying the Hague cables, and she was towed out at the start, but finding her answer the helm well and relying on her engines, the tug was cast off. Everything went well, but Mr. Webb relates that in the beam sea depicted in his sketch, when cable was all out of the forehold, the helm had to be kept hard over. During this north-easter which made things pretty lively for 22 hours out of the 34, Mr. Latimer Clark was below keeping up continuous electrical tests and speaking the shore at intervals, Mr. Spencer was lashed to his post at the brake, which in those days was worked by the pressure of a hand lever, while Mr. Webb, who assisted Mr. Edwin Clark, the Engineer to the Company, attended to the steering. The "Monarch" was pilcted by H.M.S. "Adder," which had previously laid down the course by mark-buoys, 8 miles apart. By steering for the buoys as indicated by the pilot vessel, the cable was laid with only 4 per cent. slack, a remarkably straight course considering the weather and tide. Mr. Webb about this time rendered great service in devising a table in which by inspection could be seen how a ship's head should bear, and what her speed should be for a given speed of paying out when set, and rate of tide were known, in order to lay cable in a straight line.

It is now known that a ship is much better under control in strong tideways by paying out cable from the bows. With a sea or tide running, say, at right angles to the proposed route, the cable is payed out from the bows on the weather side and the ship's head kept in a direction between those of the route and tide, the exact angle depending on the velocity of the latter. By this means cable falls clear of the ship, and with her head to the weather and stern free she is easily steered. When paying out from stern, the weight of cable hanging is almost equal to anchoring the ship, with the result that she is easily swung round in a beam tide. These remarks apply only to shallow water work in strong tides, such as prevail round our coast. Moreover, the heavy armouring necessary to resist wearing effect of tide wash increases weight hanging to ship and brake power required. In deep sea work these considerations do not apply. Cables are light, brake power small, and no tides to cross, and it is found that for lengths above ten miles paying out from stern is preferable.

On this point Sir Charles Tilston Bright, in his Paper before the Institute of Civil Engineers in November, 1865, on "The Telegraph to India, and its Extension to Australia and China," describes how he laid the Persian Gulf cables from sailing vessels towed by steam vessels. Five sailing ships had between them brought 1,234 miles of cable from England to the Gulf, each vessel being fitted with three tanks, paying-out drum, brake and stern sheave; and on arriving on the spot were towed during the laying by Government steamers. Sir Charles Bright said in this Paper that "he considered that in some cases, such as the work now described, where the cable was to be laid in a sea rarely subject to disturbance during the season for submergence, and where the depth of water was not great, sailing ships, towed by steam vessels, might be employed with safety, and it would be found that the economy in so doing, when the cable had to be conveyed a great distance to its destination, was very considerable. In this instance no difficulty of any kind was experienced. The steamer towed the cable ship with two hawsers, and the ships were in constant communication by a complete system of signalling."

We turn now to the earliest types of cable machinery. In the earliest appliances Mr. R. S. Newall, of the Sunderland firm of that name, took a prominent part in breaking fresh ground. His experience in the manufacture of wire rope, and the use of winding engines in collieries in the North, was used to great advantage. His firm having sheathed and laid the three cables to Ireland and that to Belgium, he was prepared with a very practical form of paying-out brake for the "Monarch" on the Hague expedition. This was a drum and brake in one, mounted between bearings on a horizontal shaft exactly similar to the drum and brake in the picking-up machine in Fig. 84, though, of course, without the spur gearing.

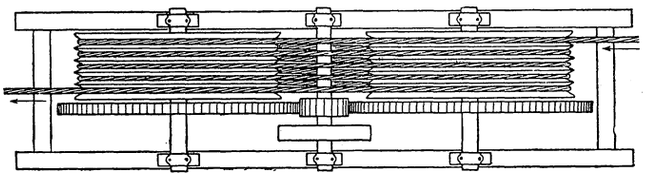

FIG. 82.—Plan of earliest Picking-up Machine (1853).

The iron brake strap bore directly on the face of the wheel, one end being fixed and the other set up by hand pressure on a lever, similar to that shown in the picking-up machine in Fig. 83. This was the best thing of its kind up to that time, and the modern brake only differs from it in a better grip by wood blocks and in means for mechanically setting it up by weights or a right and left-handed screw, making an easier adjustment by hand in place of entire manual effort. The brakesman of to-day has an easy job compared with his predecessor of 40 years ago, as the brake is now set to about the strain necessary for a given percentage of slack, and he has only to ease the wheel one way or the other as the stern rises or sinks in pitching.

The first picking-up machine (illustrated in plan in Fig. 82, from a sketch kindly supplied to the writer by Mr. F. C. Webb) was also the work of Mr. Newall, and fitted by him to the "Monarch" for recovering the cable, which, as related above, he was forced to cut and abandon when two-thirds of the distance from Scotland to Ireland had been successfully laid. The successful grappling for, and picking-up of these 16 miles was the first instance of the kind. It is evident that Mr. Newall anticipated heavy work, as he placed two drums tandem, each having five grooves in which the cable was wound backwards and forwards. From the bows it was led over the top of the after drum, taking half a turn, then on to forward drum, leaving this at the top and going round aft drum again, and so on five times. The machine was worked by a small steam engine driving the pulley by a belt. Although never used for the same purpose again, it was not a bad

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design where a large bearing surface was required, as proved by Sir Charles Bright using tandem-grooved wheels for paying-out drums in the "Agamemnon" on the second Atlantic.

After this operation the "Monarch" was again on repairs under Messrs. Edwin Clark and F. C. Webb, who jointly devised the first single-drum picking-up machine (Figs. 83 and 84). Spur gearing was arranged, as there shown, with square shafts at A and B for winch handles. These were prolonged both ends to bearings on gunwale, so that 20 men could be put on each side to turn the handles. About 25 turns of the first shaft A made one revolution of the drum. The ratchet-wheel on the drum shaft was to prevent any cable running back during pitching. Men were also put on to draw cable taut off drum, as there was then no hauling-off gear. Over the bows was fitted a 3-foot sheave between two timber baulks 12in. square. By degrees improvements were made. Manual work was superceded by steam, a 4½ H.P. engine being fitted to drive the pulley on shaft A, and then the ratchet was discarded. This design of gear made a very distinct advance, and was the germ of that now generally in use; in fact, with the addition of the hauling-off gear in '57, Mr. Webb's overhanging drum in '63, and improvements in the brake, we arrive at the principle of most modern machines.

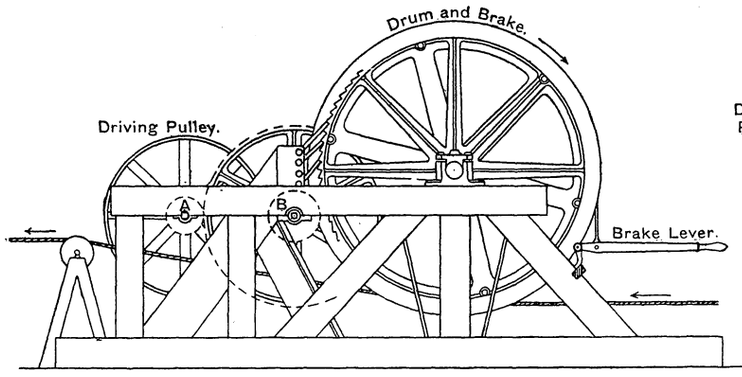

FIG. 83.—Earliest Single Drum Picking-up Gear. 1854.

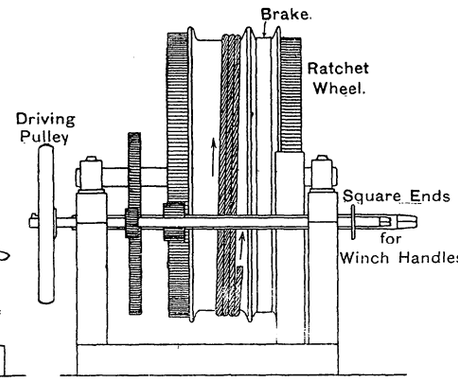

FIG. 84.—End View of Gear.

The steamer specially built in 1883 to maintain Her Majesty's telegraph cables was fittingly christened the "Monarch," keeping up the name of the now derelict steamboat, whose remarkable pioneering achievements have been briefly sketched. The illustration of this fine screw-steamer (Fig. 85) is from a photograph by Mr. W. R. Culley, electrician on board the "Lady Carmichael," to whose courtesy, and that of Mr. W. H. Preece, F.R.S., Engineer-in-Chief and Electrician to the Post Office, the writer is indebted for the accompanying details of these two vessels. The "Monarch" was built at Port Glasgow by Messrs. D. J. Dunlop and Co., her measurements being 240ft., by 33ft. beam, by 20ft. deep, indicated horse-power 1,200, and displacement at 15ft. mean draft, 2,073 tons. In view of the large compound-cored cables, weighing over 30 tons to the mile, which she has to deal with, her picking-up gear was made specially strong. It is composed of two sets of double-purchase gear, to each of which is a drum and brake, so that picking-up and paying out can be carried on at the same time. The gear is driven by a double-cylinder steam-engine, with usual reversing links and levers, and is capable of bearing a strain of 50 tons at the bows. The bow balks with two sheaves are built in to the head of the vessel, and the bows tapered gradually, so as to give a considerable overhang of the sheaves over the cutwater. This build is not apparent in the illustration, but as viewed broadside the sheaves jut out a considerable distance, and fit snugly into the taper of the bows. The primary object is to facilitate cable work from the bows, chiefly in paying out, so that the cable shall fall clear of the ship even when there is a very small angle between ship's head and route of cable. More deck space forward, where it is wanted, is also secured by this

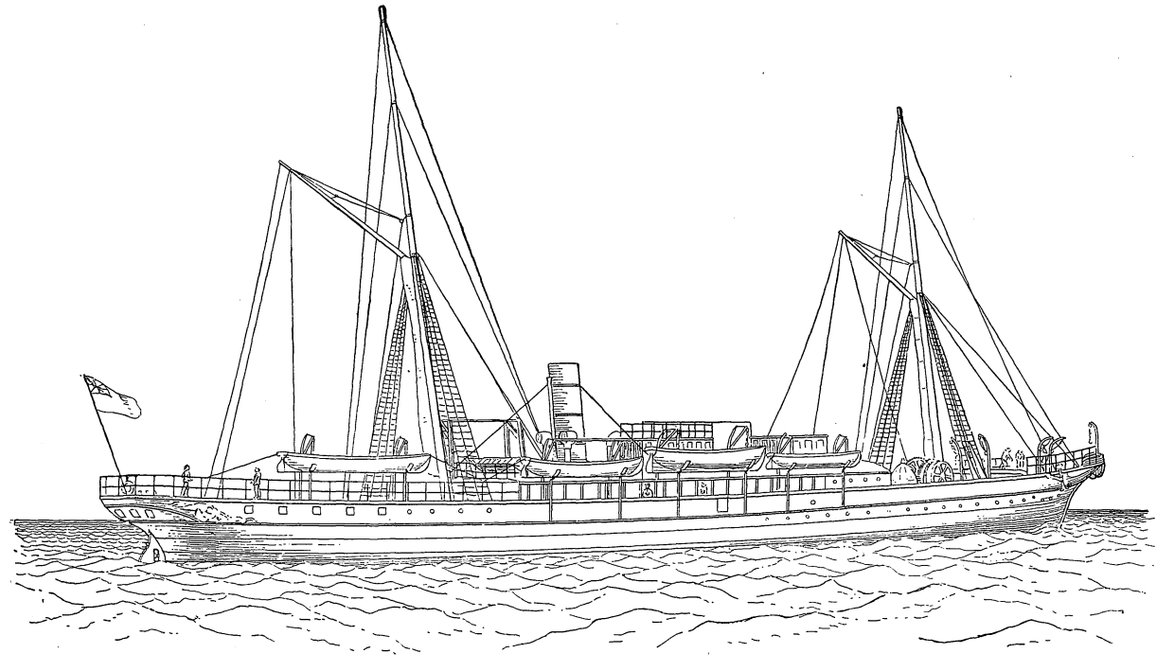

FIG. 85.—H.M. Telegraph Ship "Monarch."

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construction. The design was first applied to this ship, and its utility demonstrated, and several ships since built have adopted the principle. Evidence that repairing and laying in shallow waters of strong tidal force is exclusively bow work is manifest in walking along the after deck of this vessel. The old holding-down bolt holes for securing brackets of cable leads sheave and brake in paying out aft are seen plugged up. The gear can be rigged in a very short time if necessary, but is practically shelved. The ingenious adjustable friction table devised by Sir Charles Bright for the cable ship "Dacia" is fitted on the "Monarch" in a suitable position for cable to pass through on its way to the paying-out gear forward. It is hoped to illustrate this later.

The "Monarch" carries two life-boats and one steam launch specially for landing and repairing shore ends. A raft is made of the boats lashed together with joists and planks across, forming a sound floor on which ten tons of cable can be coiled. A curious form of dynamometer is fitted forward in which the sheave is normally horizontal, mounted on a vertical shaft about 18in. high. As the strain comes on the wheel, the shaft is pushed out of the vertical, and by means of an arm moves a piston in a cylinder containing mercury. The mercury then escapes from a small hole in the cylinder, and rises in a tube on which the strains are graduated. As a matter of fact, the apparatus is not used, but this is mostly owing to the fact that dynamometers are not needed in shallow water work.

(To be continued.)

A BALLISTIC GALVANOMETER.

The remarkable outburst of scientific research in the United States during the last year or two has resulted not only in several valuable Papers which have from time to time appeared in these columns, but has created a demand for high-class instruments. Until recently these have been supplied largely from this country, not because our workmanship is better than that of the best American workshops, but because the apparatus was to be bought ready-made. Among the

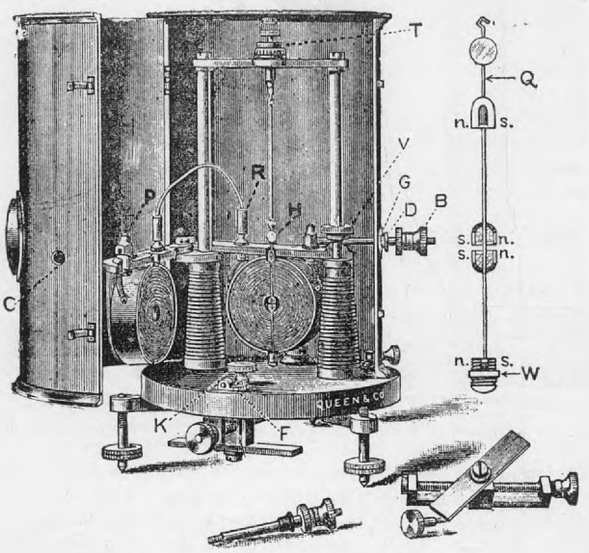

FIG. 1.—New Standard Ballistic Galvanometer.

leading Transatlantic firms Messrs. Queen and Co. are well known for careful design and accurate finish, and the latest of their productions is described in the *Electrical Engineer* of New York as "a new standard ballistic galvanometer with variable sensibility and without 'drift.'" When a measuring instrument is dignified by the title Standard, it commands special attention, though the precise difference between this and any other class of instrument is difficult to define. In all probability American instruments of precision, to use a French expression for which we have no equivalent, will assume a character of their own just as their machinery has done. This will be due partly to the different nature of the conditions of use and user, as well as to those causeless *nuances* which enable a sailor to tell the nationality of a vessel by the cut of her rig.

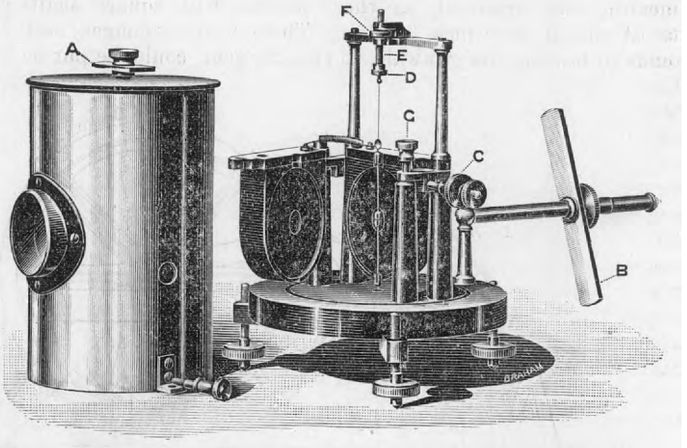

FIG. 2.—Messrs. Nalder Bros.' Ballistic Galvanometer (1891).

The galvanometer illustrated in Fig. 1 has been designed by Mr. E. F. Northrup, and it is no disparagement to say that it closely resembles in many respects an instrument made by Messrs. Nalder Bros., and described in *The Electrician*, Vol. XXVI., p. 610. We reproduce the illustration of the English galvanometer for comparison, not necessarily invidious, but none the less instructive.

FIG. 3. Nalder Ballistic Galvanometer. Details of Needle System.

The method of hingeing the coils which has been adopted by Messrs. Nalder Bros., and the mounting of the suspension bridge on two pillars, were, no doubt, worthy of exact repetition, but the corrugation of the ebonite posts is of doubtful advantage. If corrugations are used at all they should be deep and with well-rounded corners, but Messrs. Queen and Co. cut 60deg. grooves, which only double the effective surface, and their shape must accentuate the difficulties in cleaning which have led to the abandonment of this device by other makers. The coils are wound with five sizes of wire graded according to calculation, and this is said to increase the sensibility as 9 is to 4. The clearance between the coils is 1-20in., and connection is made by the plugs and wire R. The mounting of the coils is, however, very inferior to that of the English instrument. A nut V screws down upon two halves of a coned seat, as shown in Fig. 1; while it will be seen in Fig. 2 that the coil is held by a separate screw G on a separate pillar yoked to its neighbour. The terminals B are provided with ebonite washers D to keep dust out of the hole G of the case; as in Messrs. Nalder's instrument, which contains exactly the same device, these are withdrawn when the instrument is in use. Spirit-levels are not only abandoned, but attention is called to this fact in the description of the galvanometer—"the instrument being usually levelled up until by inspection of the mirror the system is seen to swing freely."

The use of bell magnets in constructing the needle system is, of course, public property, and while Messrs. Queen and Co. have acted wisely in adopting this feature, it is a pity that they have gone back to the old and erroneous idea that a large moment of inertia is desirable in ballistic galvanometers. So prevalent was this notion at one time that we should hardly have been surprised to hear that a ballistic galvanometer is so called because a ball of lead is

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sometimes attached to the needle. Bell magnets are invaluable for ballistic work, where constancy is essential; but filling them with lead, as is done by Messrs. Queen and Co., is objectionable for several reasons. A stronger supporting fibre is needed, and this entails a strong control, the very thing to be avoided. It also diminishes the sensitiveness for discharges by increasing the moment of inertia; this quantity, indeed, is said to be "extremely large." Mr. Willyoung, the writer of the description, and electrician and electrical engineer to Messrs. Queen and Co., claims this as an advantage. It is true that the inertia lengthens the period of swing, and lessens the decrement; but with bell magnets properly hung, this is usually quite small enough, and sometimes too small for convenience in working. The sensitiveness of this galvanometer is described thus: "Mean deflection 1-16 M.F. at 1·44 volt. . . . 237mm.; period, single swing, 21·6 seconds.' But in the absence of information about its resistance or the scale distance, this tells us little or nothing. If the scale distance be a metre, the sensitiveness at a given period is nothing remarkable, and, in the absence of any definite information from Messrs Nalder Bros., we believe we are right in saying that it is somewhat less than one-half of that afforded by their bell magnet instrument of about 8,000 ohms.

A feature of novelty in this galvanometer is the control. It will be seen in Fig. 1 that the outer magnets, *ns* and *ns*, are longer than the middle magnets, *sn* and *sn*. If all are magnetised in the same way, the stronger will control the system. A nut of soft iron, W, is capable of being screwed up or down on the lowest magnet, on the cylindrical surface of which a fine screw thread is cut. When it is down it is inoperative, but if it is desired to diminish the control, the needle system is removed from the instrument and the nut is screwed up. This has the effect of short-circuiting the magnetic field and thus weakening the control, making the system more astatic. The rod Q on which the system is built is of quartz. To have to unship the needles every time the control has to be altered is a serious objection, especially when of so fragile a material.

It is satisfactory to find that attempts are being made in the United States to build really high-class instruments, and no doubt more originality will be forthcoming in future examples. In the meantime we may observe that Messrs. Queen and Co.'s address is Chestnut-street, Philadelphia.

THE GROUND RETURN.*

In the course of the discussion at the recent meeting of the American Street Railway Association, at Cleveland, Mr. F. S. Pearson, chief of the steam and electrical department of the West End Street Railway Company of Boston, brought up some points in reference to the ground return, which, from his long experience in this line, should prove of interest to practical men.

In small towns and systems where there are few cars running, Mr. Pearson thinks the ordinary method of returning the current through the rails and supplementary wire is sufficient unless the distance is great. On large roads, where the traffic is heavy, more return grounds than have been used heretofore will have to be installed. It was found so in Boston, and from lack of return feeders a great deal of electrolytic action was caused in the supplementary wire, and the West End Company is now putting up a large amount of overhead copper for return grounds, since the underground will corrode and rust away. There is no advantage in using iron, as the conductivity is only one-seventh that of copper. Originally the positive current was run through the trolley wire, but it was found that the action on the supplementary wires was too great, and so the negative was put to the trolley wire. It was not thought that there would be much less effect, as it merely transfers the action to another point.

In reference to water pipes, Mr. Pearson said that he did not have in mind any particular trouble with water pipes; but naturally, if there is a large volume of current going through the earth, it will take hold of a water pipe or a gas pipe, or any other pipe, and there will be an electrolytic action set up; and in any large railway system, if the attempt is made to use the earth for return ground by putting in ground plates in driven wells, or by putting them in the rivers, and the return current is not provided with a good metallic circuit, the current must inevitably injure the water pipes and all other pipes. The current, when it leaves the car, goes into the ground, and, taking a water pipe, may go a mile on that pipe, then leave it for a better conductor, the result being that the pipe will be corroded at this latter point.

As to using old rails for a return, the difficulty is to make a good joint. If the rails could be welded or soldered, this plan might work, but the joints could hardly be made in any other way so that they would carry the large volume of current without heating or corrosion. To joint the rails by copper plates would be a poor construction, as the iron and copper would form an electrolytic element and cause corrosion, even if no current was passed through the joint. The passage of the current would also heat the joint and cause further oxidation. In the early days of electric railroading an attempt was made to use the rail for a return current and not put in supplementary wires, but it was found almost impossible to maintain a joint of any sort. When a large volume of current is sent through the joint oxidation takes place, and the joint soon becomes worthless. This condition will exist no matter how large the joint is made, and if dissimilar materials or metals are used a local electrolytic action will also take place. With steel in contact with iron the effect will be produced in a lesser degree than with copper, and it will take longer for the trouble to develop. Old steel and iron cables had been used in the crossing of rivers and for connecting the supplementary wires from one side of the track to the other, but the objection to the cable is that it cuts away very fast. For instance, in one place seven ropes or cables had been put in and soldered thoroughly at each end, and in less than four months they were entirely gone. If the soil was comparatively dry and sandy this scheme might do for a while, but where it is moist and solid it is a question whether the cables will last long enough to pay for putting them down.

As a rule in track construction to-day, the West End road uses supplementary wires as well as bond wires on the rails, the former having a low resistance as compared with the bond wires and joints. The greater current passes on the supplementary wire and does not go through the joint. If the supplementary wire is cut and all the current is made to pass through the bond wire there is trouble, but as long as a good supplementary conductor is maintained the current will not pass through the bonded wire, the joints will remain cool, and there will be no great tendency to oxidation, especially if tinned rivets are used.

* From the *Electrical World*.

BOOKS, &c., RECEIVED.

"Electrical Papers." By Oliver Heaviside. Two vols. (London: Macmillan and Co.) Demy 8vo. Price 30s. nett.

"Practical Electric Light Fitting." By F. C. Allsop, illustrated. (London: Whittaker and Co.) 280 pp., crown 8vo.

"Electric Lighting and Power Distribution." Part I. By W. Perren Maycock, illustrated. (London: Whittaker and Co.). 200 pp., price 2s. 6d.

Transactions of the American Institute of Electrical Engineers. July and August, 1892. (New York: The Institute.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, December 16th.

OLD STUDENTS' ASSOCIATION.

8 p.m. Smoking Concert at Broad-street Station Restaurant.

SATURDAY, December 17th.

CRYSTAL PALACE SCHOOL OF ELECTRICAL ENGINEERING.

1 p.m. Award of Certificates. W. H. White, F.R.S., in the chair.

TUESDAY, December 20th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed:—(1) "The Manufacture of Small Arms," by John Rigby, M.A.; (2) Paper to be read, time permitting:—"Gas Power for Electric Lighting," by J. Emerson Dowson, M.Inst.C.E.

WEDNESDAY, December 21st.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Papers to be read:—(1) "Moving Anticlones in the Southern Hemisphere," by H. C. Russell, F.R.S.; (2) "The Tracks of Ocean Wind Systems in transit over Australasia," by Capt. M. W. C. Hepworth; (3) "A New Instrument for Cloud Measurements," by Dr. Nils Ekholm; (4) "Rainfall of Nottinghamshire, 1861-90," by Henry Mellish, F.R.Met.Soc.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Papers to be read.

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DIFFERENTIAL CHARGES.

In his interesting letter on the now burning question of how best to charge for a supply of electricity, which will be found in our Correspondence columns this week, Major FLOOD PAGE raises a side issue, which has doubtless occurred to many of our readers, namely, whether an electricity supply company is, by the original Act of 1882, and apart from its Provisional Order, permitted to introduce either a system of discounts to large consumers, or a more or less complicated sliding scale. We do not propose to recur to the general question of electricity supply charges while the discussion is at its height, but as this issue is an interesting one, some comments thereon may not be out of place.

The technical press was recently very solemnly and very properly rebuked for hinting in a weak moment at the possession of some slight acquaintance with the laws of nature. We shall not, therefore, lay any claim to any special knowledge of the inner workings of that complex product of nature, the lego-parliamentary mind, but a careful perusal of Sections 19-20 of the Electric Lighting Act of 1882, especially if coupled with a glance at their expansions in Electric Lighting Orders, will, we think, set at rest any doubt as to the perfect right of a supply company to introduce any method of charging it thinks fit, provided always that the maximum is not exceeded, that the consumer consents, and that there is no "undue preference." A company may, therefore, announce with a clear conscience that it will charge places of worship, say at 50 per cent. less than the ordinary rate; but an announcement to the effect that it will only grant these favourable terms to the Church of England would be *ultra vires*, being not merely differential but preferential. In connection with Section 19 of the Act of 1882 a curious point arises in regard to the

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difference between a "private" and a "public" supply. The definitions in Section 3, Sub-sections 3 and 4, though eccentric, are clear enough, and it is perhaps unfortunate that they should have been obscured by subsequent Provisional Order accretions and expansions, though of course they cannot be over-ridden by them. A "public" supply was, by Sub-section 3, confined to street, church, theatre and public hall *lighting*, and did "not include any other purpose to which electricity may be applied." A "private" supply, according to Sub-section 4. included "any purposes whatever to which electricity may for the time being be applicable, not being public purposes, except the transmission of any telegram." Hence current supplied to a fan-motor in a theatre would be a "private" supply, but not the current supplied to the footlights, and the energy supplied for blowing the organ or for working the action would fall in a different category from that used for lighting a church. The exact nature, under this definition, of a supply for the purpose of charging a storage battery is a nice point, which we leave for the study of our readers.

Considerations of a very different character have suggested the desirability of distinguishing between electrical supply for lighting and for motive power and heating. It is hoped that these applications, which were hardly thought of by practical engineers at the passing of the Act of 1882, will enable the plant of the supply stations to earn something during the day; and the complications of day and night meters, and special two-way switches have been thought worthy of trial. Such contrivances may be of use in encouraging the use of motors and of electrical cooking at the present time, but the necessity for any distinction at all seems to indicate that the whole supply business is as yet in an undeveloped state, and though it is highly improbable that motors will ever become quite as common in this country as in America, a small approach to the conditions which obtain in that country would render useless all the ingenious devices of meters and of double prices. "It will be noted," says the *Electrical Engineer* of New York, referring to the proposed "Manchester" method of charging, "that in the above calculations Dr. HOPKINSON has not taken into consideration the question of supplying current for electric motors, which, so far as this country is concerned, is a source of revenue practically not calculated upon abroad; and as the rates for power per kilowatt hour in the United States are greater than those obtained for the same amount of current when used for lighting purposes, a considerable modification in the calculation would be introduced." The futility of arguing from American to English practice is very clearly brought out in these half-dozen lines. On this side of the Atlantic we have to stimulate our motor load by 50 per cent. reductions, and do not do very much at that. In the States, on the other hand, the electric motor can, it seems, be made to yield a higher rental per kilowatt hour than the incandescent lamp.

SPARKING AT COMMUTATORS.

BY F. M. WEYMOUTH.

(*Continued from page 161.*)

In Figs. 4 and 5 herewith is shown a simple armature coil in a field between two poles **N** and **S**, which may be revolved about an axis $x\,y$. Now in Fig. 4, where the coil is shown quite vertical, and so with its plane normal to the lines of force running from **N** to **S**, if the coil be rotated in either direction, by which motion the number of lines of force it encloses is being *diminished*, a current will run round it as shown by arrow heads. Its polarity also (similarly as in Fig. 1) will be as indicated by the small s and n. In the case of Fig. 5 however, the coil is represented by the curved arrow as rotating from a horizontal position to a vertical. It is thus *increasing* the number of horizontal lines of force that can pass through it. The result is that a current will course round it, but in the opposite direction to that in Fig. 4. Now a point to be noted is that in Fig. 4, the n and s poles of the coil are *attracted* by the respective **N** and **S** poles of the field that they oppose, and hence will offer opposition to the rotation of the coil. In Fig. 5 also, it will be seen that in conjunction with the direction of rotation, the s and n poles of the coil are being brought nearer to the **S** and **N** poles of the field, from which they are naturally repelled. Hence here also there is opposition to the revolution of the coil. The opposition to the rotation, which in these cases is the necessary cause of the current in the coil, and so of the polarity of the coil, thus illustrates Lenz's law, that *any primary cause for an induced electric current produces effects which tend to eliminate such primary cause.*

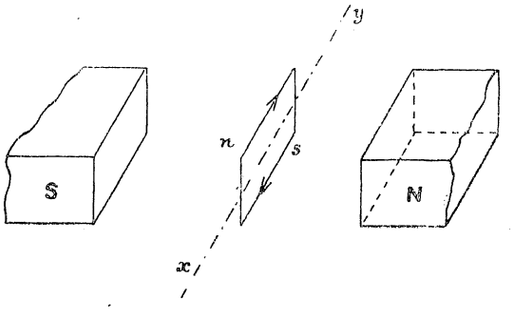

FIG. 4.—Lenz's Law Illustrated in Elementary Dynamo Coil.

We may now return to Figs. 2 and 3. It should be mentioned first that the iron core is supposed to be without magnetism when there is no current flowing round it. In Fig. 2 we find the sudden influx of the primary current causing the lines of magnetic induction within the core to rise in number from zero up to a certain maximum. This increase in the lines of *magnetism* is now the real cause of the current generated within the outer secondary circuit, running round in the opposite direction to the primary, as shown by the arrow heads; precisely as an increase is a cause of such an effect in Fig. 5. The result of this again, is that the secondary current tends to produce poles s and n, which are contrary to the primary: that is, to eliminate the very influx of magnetism by which the secondary current is itself called into existence.

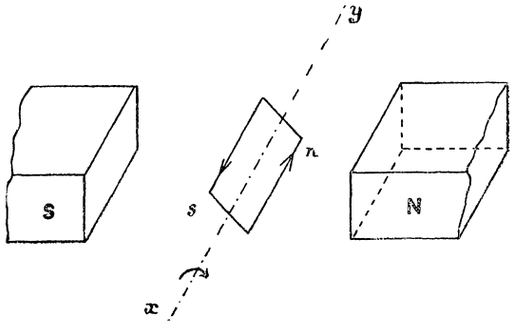

FIG. 5.—Lenz's Law Illustrated in Elementary Dynamo Coil.

Now while the primary coil may be of a few turns of stout wire, the secondary may be of a large number of turns of fine wire. The potentials of all the turns of the secondary being accumulated, forms an enormously high total electromotive force between the ends of the secondary, brought near together as at g. This distance not being disproportionate to the electromotive force, a disruptive spark will strike across in the direction of the arrow heads at the instant of the sudden increase of the magnetism of the core. The primary current continuing steady, and there being no further alteration of the magnetism of the core, there will be no continuance of current in the secondary, and nothing more will happen except that

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the full strength of the primary current and the polarity of the core become established after the cessation of the resistance thereto offered by the secondary. But if the primary circuit be now suddenly broken, there will be an immediate decrease of magnetism in the core, from maximum to zero. This will cause a current to flow round in the same direction as the primary, as shown in Fig. 3, contrary to the manner in Fig. 2. A disruptive spark will fly across at *g* again, but in the opposite direction to that in Fig. 2. The secondary here will cause a polarity identical with that of the primary. It hence tends to maintain the primary polarity, while it is to the very fact of the *decreasing* of this magnetism that it owes its own existence. We thus see in these two cases a still further exemplification of Lenz's law as above enunciated.

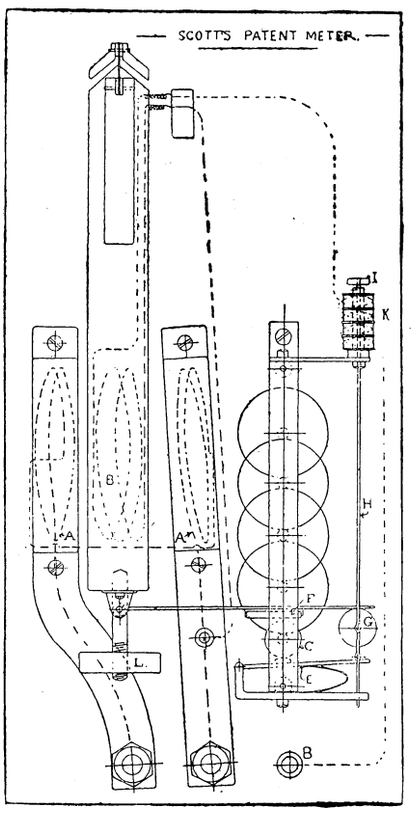
Now the sparks that take place at the gaps *g* in Figs. 2 and 3 are induction sparks pure and simple, such as belong to our second order. They are disruptive, and would do more damage to a dielectrical substance in the gap than to the terminals either side. As explained, their electromotive force would be very high, and the current extremely small. The potential difference however between the terminals will depend, as in the case of an armature winding, on the *number* and on the *rate* of the increase or decrease of magnetic lines, and on the number of turns in the secondary coil. Thus with a given rate of making or breaking the primary circuit, a compound coil, large in diameter so as to enclose many magnetic lines, and with a great number of convolutions in the secondary coil, will obviously generate a much higher electromotive force than one of smaller size, and with fewer turns in the secondary. Transformers, or converters as they are variously termed, exemplify this kind of conduction. A low tension *alternating* large current in the primary coil, consisting of a small number of turns of *thick* wire or copper bar, induces an alternating high tension small current in the secondary, having a large number of turns of *fine* wire; or *vice versâ*. The resistance caused by the fine wire, it will be noted, keeps the secondary current small, though its electromotive force may be high. In the high-tension experiments by Messrs. Siemens Bros., and Messrs. Swinburne and Co., at the recent Exhibition at the Crystal Palace, wherewith pressures of 50,000 and 130,000 volts respectively were attained, it was in this manner that such results were arrived at. Powerful disruptive sparks were emitted between electrodes; while owing to the presence of an appreciable current also, enormously long arcs, 2ft. or so in length, could be maintained. It is further to be noted here also, that owing to the normal potential being already so high, preliminary contact between the carbons was not required. The precursory spark of the arc was of our fifth order, and not our third order as is usual with the arc. For here, on the carbon points being brought within about 3in. of each other, the current would immediately leap across, after the manner of that order, with which we shall deal in due course.

As we have stated, however, the above refers to induction sparks only, which are caused in a *different circuit* to that of the primary. But sparks similar in nature, and based on the same laws, may be obtained in the primary—that is, within any circuit itself. Such sparks, with cause and effect taking place within the same circuit, are the result of what is called the *self-induction* of that circuit, and we may hence style them self-induction sparks. These, forming the sparks of our third order, may thus now engage our attention.

(*To be continued.*)

SCOTT'S ELECTRICITY METER.

The advantages of a clock-driven meter are so great, while the trouble of winding by hand and the complication and expense of automatic winding are so serious, that Messrs. Laurence, Scott and Co., of Norwich, propose to arrange one clockwork apparatus in a central position, and to control the timing of a number of meters by a special meter wire laid with the supply mains. An advantage of the system is that it enables the rates of charge for supply to be made different at different times of the day. The meter itself is fairly simple, as will be seen from the accompanying rough diagram, which shows all the working parts. Fixed series coils of strip copper A A carry the main current. A suspended shunt coil B, the resistance of which is about 1,500 ohms, carries an adjustable weight L. A terminal, B, connects this shunt to the special meter wire. These meter wires, which are arranged to take some 45 meters on each circuit, are connected at the station or at the meter station by a clock once in every 90 seconds. The effect of making circuit with the meter wire is to work the magnet K; this lowers the roller G, and allows the pad F to fall upon the wheel C, the first wheel of the meter train. The deflection of the suspended coil B measures the energy supplied, and the forward movement of the pad F, being a measure of this deflection, imparts a proportionate motion of the meter train, successive forward movements being integrated by it. The mechanism lifts



the lever F off the wheel C before the suspended shunt coil B swings back to zero. We are informed that these meters have an accurate range of 100. The central controlling clockwork is arranged to make contact with a number of separate meter circuits one after the other, and for long distances it is proposed that groups of meters may be worked by means of a relay. At any arranged time, say an hour before sunset, the clockwork can be arranged to alter from a period of 180 seconds to a period of 90 seconds. During the daytime, therefore, the meter registers half the current or any other desired fraction, and by this means a cheap daylight supply may be provided. Messrs. Laurence and Scott suggest that this will encourage the use of power, not only during the day, but will afford special facilities for power during the summer time, which might induce manufacturers who have steam power to use the electric supply during the summer months, and to run their steam-engines during the winter, utilising waste steam for warming their premises.

Royal Society.—The following Paper was down for reading yesterday before the Royal Society: "The Electromotive Properties of the Skin of the Common Eel," by Prof. E. Waymouth Reid.

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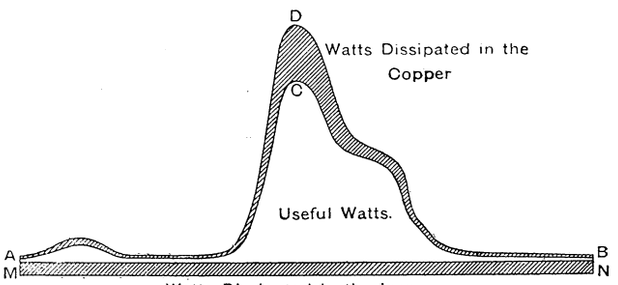
THE EFFICIENCY OF TRANSFORMERS AND TRANSFORMER DISTRIBUTION.

In a lucid communication recently made to the Société Internationale des Electriciens, M. R. V. Picou deals in a commendably succinct way with the *pros* and *cons* of transformer distribution, and, although the subject has been somewhat overdone of late, it is by no means exhausted, so that a brief summary of M. Picou's remarks may prove of some interest.

The alternate current transformer, says M. Picou, is, when considered by itself, an excellent piece of mechanism, but nevertheless its all-day efficiency when used in the usual way is comparatively low. The reason of this is, of course, well known. Of the 5 per cent. loss which occurs at full load, that due to hysteresis, which is more than one-half of this total loss, is an absolutely fixed quantity at all loads. The copper losses, on the other hand, vary as the square of the current. Hence numerous devices for securing a better average efficiency.

The following diagram was then given by M. Picou to illustrate the normal condition of things in a transformer distribution network. The curve A C B represents the paying load for an average day of 24 hours, the ordinates being watts. The area A C B A is proportional to the receipts. To this area two more may be added, giving a total area equivalent to the total output. Below A C B A draw a rectangle A B N M, the height of A M being equal to the watts wasted in hysteresis at any moment; A B N M, therefore, represents the energy wasted in hysteresis during the 24 hours. Next increase the ordinates of the curve A C B by an amount representing the total copper losses at any instant; the area contained between the curves A C B and A D B will then represent the energy wasted every day in the conductors, transformer coils and regulating resistances. The ratio of the ordinates of these two curves is evidently constant. The ratio of the area A C B A to the area M A D B N M gives the all-day efficiency of the system. A glance at this diagram shows in a very striking manner the dead weight of the iron losses at times of low load, when the copper losses are negligible.



Some engineers have had the idea of increasing the *average* efficiency by sacrificing something of the *maximum* efficiency. All economies effected in iron losses, of course, diminish the height of A M. If these economies go hand in hand with increased copper losses, the ordinates of the curve A D B are naturally raised; so that the *net* gain is represented by the difference between the sums of the two areas A B N M and A D B C in the two cases.

Two noteworthy solutions of the problem have been proposed by Swinburne and Dolivo-Dobrowolski respectively, both of whom propose to decrease the volume of iron. In the "Hedgehog" transformer the iron has been diminished by simple suppression. There can be no manner of doubt that the hysteresis loss is thereby also diminished, since air is apparently perfectly magnetically elastic. But let us look at the other side of the account. The power dissipated in such a transformer on open circuit = E C cos ϕ, and it is less than the power E C′ cos ϕ' dissipated in a closed magnetic circuit transformer. But as ϕ is much larger than ϕ', cos ϕ is much smaller, so that although we have C cos ϕ < C′ cos ϕ' the diminution of cos ϕ is such that we have C > C′. Consequently the primary current of a "Hedgehog" transformer for any given load is always greater than in the case of a corresponding closed magnetic circuit transformer, and the difference is accentuated at no load.

Now, if it were only a question of a single transformer it would be an easy matter to increase the size of the wires somewhat, and in this way to keep the copper loss constant and obtain the full benefit of the reduction of the iron loss. But when a transformer is considered as part of a system of distribution, the dynamos and conducting network have to be taken into account. Conductors traversed by larger currents waste more energy, so that we should appreciably increase the ordinates of the curve A D B, and there is nothing to prove that the final result will be economy. In fact, the net outcome of the compromise varies according to the average diurnal load, and a given transformer may result in a profit in one instance and in a loss in another.

Dolivo-Dobrowolski's solution of the problem is to reduce the volume of the iron while still maintaining the closed circuit. To push the induction density would not do, since, according to Steinmetz, hysteresis losses vary as $B^{1.6}$. To reduce the volume of the iron it is accordingly necessary to keep down the length of the magnetic circuit to just that figure which leaves sufficient room for the coils, and the gauge of the wires composing these must also be reduced; hence the copper resistance is augmented, since the number of turns has to remain the same. Hence, as in the case of the "Hedgehog," reduction of the iron loss has its counterpart in an increased copper loss, and the advantage gained by any given proportion of iron and copper depends entirely on the average output curve, and it may, indeed, become negative for a curve showing a high average.

Dolivo-Dobrowolski's solution is not, therefore, a general one, and becomes even less so on close inspection. The increased copper resistance impairs the property of self-regulation which arises from an extremely low secondary resistance. Modern practice is to arrange for a 2 per cent. fall on full load. Dolivo-Dobrowolski replies to this objection by remarking that since a central station has to have potential regulating apparatus in any case, why not extend their range to cover a 6 per cent. drop in the transformer? But this reply is not to the point. If the transformers were grouped together in sub-stations such regulation could, indeed, be effected; but the necessity for it would not then arise, since the iron losses could be kept down better by varying the size of the group to suit the load. On the other hand, with a transformer in every house the thing is impracticable. For instance, if one house has every light on, and the next one to it only a few, how is the matter to be dealt with from a central station?

In short, it is no use looking only at the transformer; we must take the *ensemble* into consideration. What are we aiming at? Evidently to obtain a high average efficiency for the system of distribution. Let us, therefore, get an expression for this efficiency and see what it teaches us. Let W be the iron losses in watts, C^2R the *total* copper losses; then the useful watts generated at a pressure E equal E C. The efficiency of the system of distribution is:—

$$\rho = \frac{EC}{EC + W + C^2R}.$$

The efficiency ρ varies with C, and if we inspect the function we see that it is susceptible of a maximum. This was, of course, to be predicted, since conductor efficiency decreases and transformer efficiency increases as the load rises. The condition of maximum efficiency is $W = C^2R$. The engineer should, therefore, arrange matters so that this equality of iron and copper losses is attained for the average current. There is no need to touch the transformers since, from a practical point of view, it is far easier to adapt the cross-section of the conductors to the circumstances of each individual case, than it is to first fix the size of the cables and then design transformers applicable only to the single case dealt with.

M. Picou concludes by giving it as his opinion that the Swinburne and Dolivo-Dobrowolski solutions of the problem are not happy ones; they show how a man may deceive himself when he confines his attention to a piece of apparatus and considers it apart from the conditions of its use. The *organism*, not the single organ, should be studied.

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NOTES ON THE EFFECT OF HARMONICS ON THE TRANSMISSION OF POWER BY ALTERNATING CURRENTS.*

BY HENRY A. ROWLAND.

In a recent number of the *Johns Hopkins University Circular* and the *Phil. Mag.* for July, 1892,† I have shown that an iron transformer introduces harmonics of the periods 3, 5, 7, &c.‡ times the fundamental period into the currents and electromotive forces both primary and secondary of a transformer, and that these increased in value as the iron was more and more magnetised.

It is my present object to call attention to the effect of these harmonics on the transmission of power and its measurement. For lighting purposes they are evidently of very little significance, as currents of all periods are equally efficient in producing heat. There is a loss, however, in the fact that they cause more loss of heat in the wires and the iron of the transformers. But for the transmission of power the case is very different. Here the motors are designed to run at speeds dependent on the period ; if there is more than one period the adjustment fails, and there is a loss. The harmonics are thus useless in the transmission of power by synchronous motors, and are of very little use in motors with revolving fields. In these cases the harmonics travel around the circuits, heating the wires and the iron without producing valuable work. They then represent an almost complete loss in the transmission of power, and as they may contain 10, 20, or even 30 or 40 per cent. of the current, according to the magnetisation of the transformer, they are probably responsible for some loss of efficiency in many cases, as will be shown further on. Indeed, I believe they are the explanation of many seeming mysteries in the working of alternating current motors. Special arrangements of condensers and coils can be made to pick out these harmonics, so that they are more important than the original period. This may occur accidentally and cause many curious results in the working of motors.

It is, then, of the first importance in the transmission of power that the curves shall be pure sine curves and dynamos.§ Transformers and motors must be designed in the future with reference to this point. It would seem, also, that most calculations on the efficiency of power transmission by alternating currents must be at fault unless they include the action of the harmonics.

As to the amount of loss from this cause it is difficult to decide in general. With synchronous motors the harmonics simply flow around the wires without producing useful current of any kind. But this may not cause great loss if the resistance is small. Indeed, considerable distortion may represent small loss of power in certain cases, and great loss in others, according to the difference of phase of the current and electromotive force in the harmonics. In the case of motors with rotary fields the harmonics produce fields revolving with velocities 3, 5, 7, &c., times the primary field. Now, it is essential for the efficiency of these motors that the armature shall revolve nearly as fast as the field, and hence the efficiency for the harmonics must be very small indeed, and this must decrease the efficiency of the apparatus as a whole. As to the heating of the wires by the harmonics, it is easy to see that the total heating due to all the currents of different periods will simply be the sum of the heatings due to each of the currents separately.

The effect of harmonics on the hysteresis is much more complicated, and can hardly be calculated without further experiment. However, the following hypothesis may give some idea of the action. Let the primary electromotive force be considered unity, and let a_3, a_5, &c., be the electromotive forces of the harmonics. If these acted separately on the hysteresis the total would be

$$1+3\,a_3^{1\cdot6}+5\,a_5^{1\cdot6}+\ldots$$

Again, if they all combined so that the maximum electromotive force was equal to the sum of them all, the hysteresis would be nearly

$$(1+a_3+a_5+\ldots)^{1\cdot6}$$

However, it is hardly probable that this last condition would be often satisfied, in which case this formula would give too great a value. When the harmonics are small this last formula can be written nearly—

$$1+1\cdot6\,(a_3+a_5+\text{etc.})$$

As an example, suppose $a_3=0\cdot3$, and $a_5=0\cdot2$, and $a_7=0\cdot1$, these two formulæ give—

$$1+3a_3^{1\cdot6}+5a_5^{1\cdot6}+\text{etc.}=1+0\cdot44+0\cdot38+0\cdot18=2\cdot00,$$
$$1+1\cdot6\,(a_3+a_5+a_7)=1\cdot96.$$

Strange to say, the two formulæ agree for this special case in making the hysteresis nearly twice that due to the primary current. The current heating is only—

$$1+a_3^2+a_5^2+\text{etc.}*$$

Or, in the example—

$$1+0\cdot09+0\cdot04+0\cdot01=1\cdot14.$$

It would seem, then, that the loss due to hysteresis may be much increased by the harmonics, while the increase of current heating may be small. I believe the statement has been made that the form of the curve does not influence the hysteresis. This is evidently incorrect, unless we take the top of the curve to reckon from, in which case the statement agrees with the second hypothesis given above, if the harmonics are of the proper phase.

To estimate the influence on the efficiency of a plant, assume the efficiency of the dynamo and synchronous motor with primary currents as each equal to 90 per cent., and of the two transformers equal to 93 per cent., and assume that all the currents have the same harmonics as given above. The total efficiency will be 70 per cent. If the harmonics are now added, and half the 30 per cent. loss be due to conduction and half to hysteresis, then the efficiency will be decreased to 60 per cent. nearly, a loss of 10 per cent. There is too much assumption about this calculation to warrant full belief, and the figures are given more as a challenge to further investigation than as facts. That there is a decrease of efficiency is certain, but the amount must be determined by further experiment and mathematical investigation. But, however small the loss, provided it occurs in the transformers or the dynamos and motors, it may be of great consequence on account of its heating effect, because the output of these is limited by the amount of the heat generated.

The practical conclusion seems to be that transformers and the armatures of dynamos to be used in the transmission of power must be designed for low magnetisations. By experiment with transformers I find immense distortion of the curves when the induction exceeds 12,000 lines per square centimetre, while the curves are comparatively smooth with only 5,000 ; hence I scarcely think it advisable to use more than 5,000 for transformers even though low frequency were used. As to dynamos and motors, the limit will depend on the variety of machine used, and will not influence the better class very much.

The fixing of the limit of magnetisation of transformers at 5,000 causes the output with given current to vary *directly as the frequency*. As the hysteresis with slow frequency will be less, we may increase the current somewhat to make up for it. As to the exact law, it depends on the relative dimensions of wire and iron. Practically, we might estimate for an ordinary transformer that the output varied as the eight-tenth power of the frequency.

The law that the output varies as the four-tenth power of frequency assumes that the magnetisation increases with decrease of frequency, and thus distorts the curves as shown above.

The immense increase of the size and cost of transformers when distortion of the curve is avoided precludes the use of very low frequencies even were it otherwise desirable.

It is to be noted that the action of the iron in producing harmonics is directly on the electromotive force, and the amount of current flowing will depend on the resistance and the self-induction of the circuit. The resistance, owing to so-called "skin" effect, will be greater for the harmonics than for the fundamental period. Self-induction depending on the air will always diminish the harmonics, while if it is due to iron it may either increase or decrease them according to their phase.

The measurement of the energy supplied by an alternating current is also much complicated by the presence of harmonics.

Let the current be

$$C=A_1\sin(b\,t+\phi)+A_3\sin(3\,b\,t+\phi_3)+A_5\sin(5\,b\,t+\phi_5)+\ldots$$

and electromotive force

$$E=B_1\sin b\,t+B_3\sin(3\,b\,t+\psi_3)+B_5\sin(5\,b\,t+\psi_5)+\ldots$$

The energy transmitted is, then, per unit of time

$$\int_0^1 CE\,d\,t=\tfrac{1}{2\pi}\int_0^{2\pi} CE\,d\,(b\,t)$$

If n is the number of complete periods in the primary term, then $b=2\,\pi\,n$ and the energy transmitted per second becomes

$$\tfrac{1}{2}\,[A_1\,B_1\cos\phi+A_3\,B_3\cos(\phi_3-\psi_3)+A_5\,B_5\cos(\phi_5-\psi_5)+\text{etc.}]$$

An ordinary wattmeter in the form of an electro-dynamometer with non-inductive coils would give the correct value of this quantity, but any attempt to multiply the mean electromotive force by the current and the cosine of the phase would lead to an incorrect result unless this was done for each harmonic separately.

* From the *Electrical World*.

† See also the *Electrical World* of July 9, 1892.

‡ The periods 2, 4, 6, &c., can evidently be introduced by magnetising the iron of the transformer in one direction by a constant current, or having it originally with a symmetrical magnetic set.

§ Dynamos and motors introduce the odd harmonics on account of the variations of the self-induction of the machine, which become very apparent when a strong current is flowing. The armature reactions may also introduce the harmonics.

* This formula assumes that the resistance is the same for the harmonics, whereas it is greater on account of the "skin" effect.

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It is to be noted that the introduction of condensers to balance self-induction will only work for one period at a time. Indeed, very many of the results hitherto obtained by observers will require modification in the presence of these harmonics. It would seem from the above that the transmission of a current for electric lighting is quite a different thing from the transmission of a suitable current for motors. It will be remembered that the transmission in the Frankfort-Lauffen experiment was one of a lighting current alone, and that some mystery seems to hang over the motor tests. Can the presence of these harmonics have anything to do with this?

EXPERIMENTAL RESEARCHES ON ALTERNATE CURRENT TRANSFORMERS.

The following is an abstract of the discussion of Dr. Fleming's Paper on "Experimental Researches on Alternate Current Transformers" which took place on December 1st and 8th at the Institution of Electrical Engineers. Speakers whose remarks are prefixed with an asterisk have returned their abstract revised :—

* Mr. J. SWINBURNE said that Dr. Fleming had found fault with the damping arrangement in his voltmeter. His firm had considered the question of putting oil or glycerine damping arrangements, but they preferred the electro-magnetic method, and the damping arrangement worked all right; but Dr. Fleming had not used enough current. These voltmeters were originally asked for, and ordered for, 1,200 volts, and he believed they were used on the 3-voltmeter method up to 3,500 volts, which was, of course, too much for a voltmeter designed for 1,200 volts. A very large factor of safety could not be used in these things, or there would not be sufficient force. He had, last year, discarded the arrangement of putting mica to prevent sparking, as anything of that sort might give trouble in calibrating with direct currents through small charges settling on the outside of the dielectric. Those instruments were really designed as electrostatic wattmeters, not as voltmeters. Turning to the wattmeter, he had now for something like five years urged that people should test power in transformers and things of that sort by means of a simple wattmeter. He had been ridiculed pretty much the whole time for it. It seemed impossible to get anyone to realise that a wattmeter would do it. If he took a wattmeter to a professor he immediately said, "That can't work. Let L be the self-induction and R the resistance and you get a reading which is a function of R and L." You say that does not matter. If you work it out and see what the value of L is you say it is so small that there can be no error. "Oh! no, that won't do at all. You bring a ridiculous little instrument that will read the power without any trouble whatever; we cannot have that; it is not scientific at all. What I really want is something like the Hampton Court Maze, made up of as many instruments and cross connections as possible." The errors that arise in that case might be pointed out, but that did not matter in the least; probably the result was entirely swamped by errors of calculation as Prof. Fleming showed, but that did not matter, and if they had something that they could call the cosine of the angle of lag it would be all right. Dr. Fleming has shown, however, that the 3-voltmeter method was not accurate in those cases; neither was the 3-ampere method. The 3-voltmeter method was first thought of by Prof. Ayrton and Dr. Sumpner, and he believed he had the honour of first publishing it while they were thinking about it, or after they had thought about it; but he pointed out at the time that he considered the thing merely a scientific curiosity, and that it could not be of practical value, because errors of observation would swamp out the power they wanted to determine. Now to go back to the 3-voltmeter and those methods; of course, the great difficulty was supposed to be the non-inductive resistance. It had been suggested that they took that wattmeter from the time it was merely a little watt-scope, and educated it up on purpose to read power low—educated it up as a sort of scientific witness with a big retainer to give evidence in favour of the Hedgehog transformer. That wattmeter was wrong, undoubtedly, and the error arose thus :—The first wattmeters were tested very carefully, very much as Dr. Fleming had done. Instead of a glass case they afterwards had a metal case of thin brass, and it did not seem at first as though it produced any effect whatever. Dr. Fleming had said the fine wire was not right—there was an inductive circuit. However, that could not hold, for the instrument read too little instead of too much, so it could not be an inductive circuit. The real cause was the Foucault current in the thin brass case of the first wattmeter sent. When the main current is lagging a quarter of a period, the Foucault current in the brass case is exactly opposite the E.M.F., and this lessens the reading. He certainly thought that a properly wound non-inductive resistance was more trustworthy than incandescent lamps. The first thing Dr. Fleming had shown was that the wattmeter was really an accurate method of testing power. That swept away at once the whole of the complications and difficulties in testing power. Anyone could make a wattmeter in which the self-induction or time constant of the fine-wire circuit was practically *nil*. The next point that he settled definitely was that with practically all transformers they could get the efficiency at full load and at various loads, if they knew the resistance of the circuits and the loss at no load; that is to say, the loss in iron remained practically constant throughout the load. The third point which Dr. Fleming did not settle was that question of the open circuit *versus* the closed circuit transformer. The real result was that the particular transformer which had been sent him was bad; but he did not mean to say that they happened to send a bad transformer, and that the rest of their transformers had losses of only 20 to 30 watts. They tested the iron first; it was no fault of the iron. Dr. Fleming first suggested, and he adhered to it still, that it was due to the eddy currents in the copper. As a matter of fact, removing the secondary circuit altogether made no difference whatever. He suggested also that it might be due to the phosphor-bronze core; they tried one without a phosphor-bronze core but it made no difference. Also that it was due to the castings at the end of the transformers; they tried one without castings, but there was no difference. It was only quite recently that they had hit upon the real cause of the abnormal results in these Hedgehogs. If a 10lb. pull was maintained on the wire while a Hedgehog was being wound it resulted in something of the order of 30 tons pressure on the core. The core was composed of small iron wires, so well insulated that if two of them were twisted together the resistance between them would be something in ohms. But it had not occurred to them that when many tons pressure was put on these wires perfect contact was made; and that was the whole of the difficulty; it was simply Foucault currents in the core. They knew now what was wrong, and were very much indebted to Dr. Fleming for showing what was wrong.

He protested against Dr. Fleming's doctrine of power factors. A great many transformers which had really closed iron circuits might have power factors upon which they they might depend; but in the case of the Thomson-Houston, or those made by Brown, Boveri and Co., there was a joint made in the circuit, and very small variations of that joint would cause very large variations in the power factor. In the beginning of the Paper Dr. Fleming pointed out a consideration which was really as essential as any other, and that was the question of price of transformers. As Dr. Fleming said, anyone can make an efficient transformer if he puts enough money into it; that was an important point, and so was weight. They could not bring that into the discussions of a Society like theirs; but it was, of course, a very important matter. Dr. Fleming did not seem to appreciate that the back E.M.F. which caused the drop in the transformer was a quarter of a period out of step with the real E.M.F., so they had to take the square root of the sum of two squares. The effect of that could be very easily seen. If they took a transformer whose inductive drop was 1 per cent. and put it on an inductive circuit, the drop was 15 per cent., that was because they then had to subtract one from the other, instead of squaring them and taking the square root of the difference.

* Prof. GEORGE FORBES alluded to a series of tests of a Westinghouse transformer at Pittsburgh in the year 1888. He had been extremely surprised at the remarkably high efficiency of those transformers, even at that date with a small output. The points which everybody had been aiming at in the design of transformers in the past had been to make the efficiency at low loads as high as possible; but when the houses which took electric light were much more closely grouped together, they would have sub-stations with much larger transformers capable of regulation either automatically or by hand. Then the efficiency of the transformer at low load would not be of so very paramount importance. If they were content to have a high efficiency at the very large loads, then they could put in a much smaller amount of copper, and a certain larger quantity of iron. That was, of course, a cause of enormous reduction in the cost of transforming. In the case of a transmission of power the cost of the transformer was very great indeed. The cost of the transformers for transmission of power from Niagara to Buffalo, according to the estimates put in up to the present time, was considerably in excess of the 5,000 h.p. dynamo which produced the current, and consequently the two transformers were nearly three times the cost of the dynamo which was generating the current. He thought it would come out something between one-half and one-third of the cost of transforming if they were not made in the way they had been made for lighting purposes, but so as to give a high efficiency only at full load.

* Mr. GISBERT KAPP : Dr. Fleming had been at great trouble to investigate the accuracy of the 3-volt meter method, and preferred the wattmeter. At Frankfort all measurements were made by wattmeter, and these instruments had been standardised in various ways, and the measurements were as accurate as possible. He had made a great many experiments with the 3-voltmeter method, using the same instrument for the three readings, by switching over into the mercury cups. He found at first that the method seemed to be very inaccurate, but that was simply due to errors of reading. He had made a test on a transformer wound with very stout secondary copper, 512 mils. × 120 mils., and then exactly the same core wound with a thin wire, and curiously enough the transformer which had the stout copper gave about 120 watts total loss, including hysteresis, and that with thin wire gave 130, so he did not believe it was in the copper. It was generally assumed that transformers at one-twentieth of their output had a very poor efficiency but it was shown by these tables it was quite possible to have transformers with 75 per cent. at one-twentieth of their full load, and as much as 85 per cent. at one-tenth of their full load. That was very important as affecting the all-day efficiency in central station working.

The PRESIDENT asked Mr. Kapp whether the transformer he referred to as being one with thick copper and thin copper was an open circuit transformer or a closed magnetic circuit transformer. Secondly, was the thick copper next the iron or the fine wire next the iron. Next, which had he magnetised?—the iron with the inner coil, or the outer coil, because that would make a total difference in the answer.

* Mr. KAPP : A closed-circuit transformer. The thick copper was next the iron, the thin copper was outside that, and was not used in the test at all. The power was supplied at 100 volts to the thick copper in one case, and then a precisely similar carcase was taken again of closed magnetic circuit, and wound with very thin copper. He thought it was 120 mils. diameter, exactly the same number of turns and exactly the same relative position as the thick copper in the real transformer; but the copper was

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not wound quite close to the iron. It was a transformer very much of the same kind as those made by Brown, Boveri and Co. to which Mr. Swinburne had referred. The copper was wound on a separate sleeve, and slipped over the core.

Mr. SIDNEY EVERSHED alluded to the very early days of the Gaulard and Gibbs transformer, when Prof. Ferraris carried out a number of experiments, showing that the losses in the core actually fell off. Those experiments received some support from Dr. Fleming himself; he gave an abstract, and a very appreciative abstract, from him in his book on alternating-current transformers. Next in the controversy was Mr. Mordey's experiment with the shilling thermometer and the Mordey transformer. Shortly after that Prof. Ayrton made experiments of a similar kind, and confirmed those results. In the meantime, in America, Prof. Ryan had practically solved the whole question. He experimented in a totally new way on a live transformer, and those who had read his results—and he was sorry to say not very many English engineers took much notice of what was done in a scientific way in America—felt that Prof. Ryan had practically settled the real question of transformers for all time. He showed what the rate was and what it ought to be, and other things. A little while after that Mr. Swinburne published his Paper at the British Association, in which he put down all the essential points in the design of transformers. Americans took up that Paper and Prof. Ryan's work, and he rejoiced to see that the transformer which came out at the top of the tree was American and not English. They deserved to be left behind in that race, and the Americans deserved to succeed. His own calculations of the losses in various transformers about three years ago came out almost exactly identical with those now tested by Dr. Fleming. He found a good closed circuit transformer might have an efficiency of about 94·5. If the magnetic circuit of that transformer were opened its efficiency would be raised to 96 per cent.—a very small rise indeed; but at one-tenth the full load a closed circuit transformer had an efficiency of 85 per cent., that was to say about as good as the best of those tested by Dr. Fleming. But that transformer, when it had its magnetic circuit opened, as he plainly showed, would have an efficiency at one-tenth of full load of 89 per cent. if there were no eddy currents or coils. He could not help thinking that that estimate of difference between open and closed circuit transformers, only 2 or 3 per cent., was more likely to be near the truth than those estimates which Mr. Swinburne gave from time to time. Mr. Vignoles and he had carried out a small experiment, only an indirect one, but it proved quite conclusively that there was no falling off in the loss, as a transformer was loaded up. It was rather curious that nobody took any notice of either Prof. Ewing's results or his own, and the tide only turned when Dr. Hopkinson published some experiments carried out on a similar plan to Prof. Ryan's and showed that first of all there was no viscous hysteresis, and secondly the losses in transformers could be calculated if the cycle the iron went through was known.

* Mr. W. B. SAYERS sent a written communication in which he observed that at the time of writing he had seen only so much of Dr. Fleming's Paper as had been printed in the technical papers for the week ended November 25th. He suggested that just as a rapidly alternating current tended to flow more through the outer portion of the metal of the conductor so conversely did a rapidly alternating magnetic flux tend to limit itself to the skin of a mass of iron through which it was passing. It would appear that calculations of the losses in transformers cores which did not take into consideration the increased density of the magnetic flux due to the crowding towards the surface of the plates might be, more or or less, erroneous, according to whether the plates were thicker or thinner, or the frequency higher or lower. Might not this crowding action be largely the cause of the divergence between actual observed losses due to magnetic hysteresis and the values calculated from Prof. Ewing's results, on the supposition that the magnetic flux was uniformly distributed in the core plates of transformers?

Mr. EVERSHED remarked that the whole of that question of eddy currents in laminæ had been gone into by Prof. J. J. Thomson and also by himself, and it was shown that the effect of the eddy current in crowding the induction to the outside was very small. In an extreme case the induction at the centre of the lamina might be 2 per cent. less than at the outside.

Sir David Salomons then exhibited an alternator, which was described in our last issue.

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Mr. MORDEY, resuming the discussion, alluded to his experiments which had shown a decrease in the iron losses at full load. He remarked that the question was not so important as it appeared to be thought, for, if he was right, and if the losses in iron did decrease with the loads, it only affected the efficiency at full loads, or at considerable loads, whereas the great and important question on which this battle of closed *versus* open circuit, this question of transformer distribution generally, had been fought, was the question of losses at no load. It was merely a question of money to get transformers so good that the losses at no load were negligible. There was a very proper feeling in that Institution against the advertising of the wares of any particular firm or manufacturer; but they must remember that this was a Paper intended for the assistance of practical manufacturers, and practical manufacturers were not in business for their health; they were in business for commercial purposes. They used a certain letter L, and if they put one horizontal cross on the £, it was "bad form." Mr. Mordey then described a number of experiments made on transformers with the view of observing the sudden rush of current on closing the circuit. He first used a 5-H.P. Ferranti transformer on the 2,400 volt mains from Trafalgar-square. On the same mains there were many transformers in use in customers' houses, so it could scarcely be a capacity effect. Then a 100-volt lamp was put in series with the primary of this transformer, the secondary being open, and the primary circuit was closed rapidly. Out of 47 contacts there were seven bad "rushes" of current, and a number in which there was a minor rush, a considerable increase over the normal magnetising current. Loading the secondary circuit made no difference. Then a 20-H.P. Ferranti transformer was put on and tried in the same way. Sixty contacts were made, there were five or six small rushes of current, and then the last contact broke the lamp by an extremely violent rush. With one of his own transformers there were only two or three trifling rushes of current. He made 400 contacts with a 5-H.P. Ferranti transformer, and got no effect at all at 100 ∿, whereas, at the London Electric Station, at 83 ∿, the effect was very marked and frequent. After other experiments, he tried making very quick contacts by tapping one wire against another, and got a very violent effect indeed at 50 periods. These experiments showed that there was a relation between frequency and time taken in switching—the lower the frequency the worse the result. He thought if, by gradually breaking the circuit, he could draw out the curve so that the following waves gradually decreased until they were very small, that he would leave the residual magnetism very slight indeed in the transformer. A number of trials fully confirmed this supposition. Slow breaking, following by slow making, never showed any effect at all. He wanted to see if the effect penetrated to the secondary, that was to say, whether a large wave of current set up a large wave of magnetism. He put a 16-c.p. lamp on the secondary and found no such effect. It all depended upon what part of the wave they made the contact at. He thought that he had better make an experiment that had probably occurred to everybody who had read the paper as a way of settling that. He took a small 1-ampere 1-c.p. lamp, and put it in with several transformers and a secondary battery to supply the current, so as to get the following wave in either direction he liked, and he found that that confirmed the explanation which Dr. Fleming had given, that when he made the contact in the same direction as the previous current, the lamp took about a second or a second and a-half to incandesce; when in the opposite direction it took four or five seconds to incandesce, showing that the current had to work out the previous magnetism and set its own going before it could assume the steady stage.

* Mr. R. E. B. CROMPTON said that he had consistently held one opinion, and that was that the system of distribution of energy by means of alternating currents had yet to be improved to a very considerable extent before it could be at all useful or at all likely to compete with the older and simpler methods which were now so successfully employed in this country. About five years ago he first started this subject. It would astonish some of those gentlemen who were so confident of the success of alternate transformer distribution if they were to turn up and read the discussion that then followed. He then gave a figure of the consumption of fuel for current sold, which had never yet been reached by any system of alternate current distribution in the world. And there were gentlemen there who could state that they had far beaten the figures he gave for direct distribution. That was to say, the real progress during the last five or six years had been in direct current distribution, and that up to very recently alternating current distribution stood almost still. The causes of the difference between the two systems, no doubt, were chiefly due to the enormous difficulty of ascertaining where the losses really did lie in alternating systems of distribution. If he looked back on the six or seven years in which they had made such enormous improvements in direct distribution, he found it entirely due to the fact that from the first they had been able to measure and locate their losses. The only guide the engineer in charge of an alternating system at present had was the readings of his consumers' meters. If he wished to find out what would be the results of an economical improvement he found it very difficult to do so, because he had first to wait such a long period until the meters could be read. It might be convenient to state that the true economic efficiency of the best existing generating and distributing plant on both systems might, when worked under the best conditions, that was to say continuously at full load, in both cases reach the figure of 37, which represented the number of tenths of a pound of coal burned under such conditions. Now, whereas the best result actually obtained with continuous current plant was 64, leaving only the difference between 37 and 64 as the room for further improvement in this class of plant; in the case of alternating machinery the difference was between 37 and 160, leaving 123-10ths, or 12½lb. of coal per unit as yet to be accounted for. He believed that it would be found that nearly two-thirds of this loss was still in the transformers, and was principally due to the low-load factor conditions under which transformers were necessarily worked. Now, although Dr. Fleming showed in his Paper that modern transformers showed greatly improved results, yet even under the improved conditions the loss still would be very considerable. It was a mistake to believe that the load factor of a central station corresponded with the load factor at the transformer sub-station. As a matter of fact the load factor at those points would occupy a position lying between that of the central station and that of a private house, that was, between 14 and 5. The efficiency of the best transformers described in the Paper would be raised from 54 per cent., if fixed at the private house, to about 80 per cent. if worked on a load factor of 7 in transformer sub-stations; and the difference between these two figures represented the measure of improvement foreshadowed by the Paper.

* Dr. SUMPNER alluded to two methods of testing transformers given on the first page of the Paper, due to Dr. Hopkinson and to himself. The difference between the two methods was, that one was only suitable for the laboratory, whilst the other was suitable for use in works. His (Dr. Sumpner's) method was economical because it only required the amount of power which was wasted in the transformer, and it was economical not only in power but also in plant, because it only required, as Mr. Mordey had publicly stated, a 3-H.P. or 4-H.P. dynamo to test 40 or 50-H.P. transformers. The best method of testing a single transformer was to use a wattmeter to measure the losses occurring in the iron, and in the copper of the transform er

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separately. He had always held the opinion that the wattmeter was both the simplest and most accurate means of measuring power supplied by alternating currents. He had gone into the theory of eddy currents in wattmeters, and taking two results which Dr. Fleming had given, he had been able to predict by calculation what the other seven or eight readings of that wattmeter were. Dr. Fleming himself was the first to point out, about six years ago, that when a piece of metal was suspended near a coil through which an alternating current of electricity was passing, the eddy currents induced in the metal were such as to act upon the suspended metal plate; and the explanation was also given by Dr. Fleming. He (Dr. Sumpner) had taken an ordinary Ganz wattmeter and used it to test the power given to condensers and choking coils, and tested whether bringing up a plate of metal near the coil altered the deflection of the wattmeter. He found that the deflection of the wattmeter was increased when it was measuring power supplied to condensers, and diminished when measuring power supplied to choking coils by as much as 70 per cent.

Mr. RAWORTH said that at Newcastle-on-Tyne, with alternating currents, they were paid for a certain number of units which were passed through the meters, and the coal which was used came to something like £20. At Liverpool, where they were at work at the same thing, they also used £20 of coal to produce these units.

Mr. ALBRIGHT observed that it must be a matter of common knowledge to anybody who knew what they did at Liverpool, that they practically did not use batteries.

The discussion was again adjourned, and will, we understand, be resumed on the first meeting of next year.

LEGAL INTELLIGENCE.

The National Telephone Company and another v. Graff-Baker.

The action brought by the National Telephone Company against Mr. Graff-Baker to restrain him from so using his electric cars at Leeds as to interfere with the use of the telephone came before Mr. Justice Kekewich on Tuesday. Sir Richard Webster, Q.C., M.P.; Mr. J. Fletcher Moulton, Q.C.; Mr. C. M. Warmington, Q.C., M.P.; Mr. Nath. Micklem, and Mr. R. W. Wallace; instructed by Messrs. Waterhouse, Winterbotham and Harrison, appeared for the plaintiffs. The Solicitor-General (Sir John Rigby, Q.C., M.P.); Mr. W. R. Bousfield, Q.C., M.P.; and Mr. Alfred Dunham; instructed by Mr. Clarence Leighton, appeared for the defendants. Mr. Morton Daniell, instructed by Mr. F. W. Kite, held a watching brief on behalf of the Thomson-Houston International Electric Company.

Sir RICHARD WEBSTER, in opening the case for the plaintiffs, said that he appeared on behalf of the National Telephone Company and a subscriber, of the name of Lupton, against Mr. Graff-Baker, the contractor working the electric tramways at Leeds. The action was brought in order to restrain the defendant from so using his tramways as to interfere with the convenient and ordinary use of telephones which had been established for a great many years at Leeds. He did not think there would be much dispute upon the facts, although, of course, there might be substantial argument as to the legal rights of the parties. The question was whether the defendant, without being legally liable, could so conduct his business as to interfere with the telephones. Counsel then explained at length the technicalities of the telephone and electric tramway. For upwards of fifty years the earth had been used as the common return for telegraphic messages, and that would be found to have a not unimportant bearing when he came to deal with the legal rights of the parties; because, as his lordship probably knew, it had been decided many years ago now in the Court of Exchequer that a telephonic message was a telegraphic message, and since that decision of the Court of Exchequer, which was a decision at the instance of the then Attorney-General, the telephones had been worked under a licence from the Post Office as part of the Government monopoly. It would not be suggested, and it could not be suggested, that the plaintiffs' use of the earth as a return did harm to any one. He believed he was under the mark when he said that nine-tenths of the telephonic business had been carried on with the earth return. The electric tramways at Leeds were worked under a Provisional Order, and except the authority to lay the rails down in the road, and authority for stables or depôts and things of that kind, there was no statutory authority for occupying the soil of the roadway with any telegraph posts or posts of any sort or kind. By Clause 16 of that Provisional Order it was provided, "the carriages used on the tramways may, subject to the provisions of this Order, be moved by animal power, and with the consent of the Board of Trade to be signified in writing during a period of seven years after the opening of the same for public traffic, by means of haulage with wire ropes or other appliances placed underground or by means of electrical power, pneumatic power, steam power, or any mechanical power." The Board of Trade had no power at all except in connection with the safety of the public. They had nothing to do with authorising any particular method of carrying out the work. It could not be suggested, nor was it suggested as a matter of law, that the statute authorising the Tramway Company to work by electricity in any particular method would in any way justify the defendants, if otherwise liable, in disturbing the telephones. In Section 51 protection was given to the Postmaster-General in respect to working tramways by electricity. It might be said against them, "You have not got any special statutory protection in this Provisional Order with regard to your telephonic wires." His answer would be at once that their rights depended upon the established principles of common law, and not upon any special statutory protection. It was a fact that in numbers of Provisional Orders which had since been obtained, Parliament had inserted express protection for telephonic wires; but, in this case, he was driven to rely on the rights at common law, and not on any special statutory protection. It would be proved, beyond controversy, that there were certainly two, if not more, means by which electrical power could be used without in any way disturbing the telephone wires. He did not admit that economy was at all a necessary part of his proof. It was no answer that if the defendants could only avoid doing damage by extra expense that was a justification of what they did. Perfectly independent people would give testimony that, speaking of the effect of the working of the cars on the telephonic circuit, it was to render the telephonic circuit for commercial and business purposes absolutely useless. His clients would be prepared to prove, from the point of view of expense, and from the point of view of facility of working, that the method of working by a return conductor would be as good if not better, and as cheap if not cheaper, than using an earth return. He must now address the Court for a very few moments on the law of the case He based his argument upon established cases, which enunciated the principle, in the first place, that no statutory authority could justify an interference with private rights, if that statutory authority did not involve the necessity of interference. The best case was *Vaughan* v. *The Taff Vale Railway Company*. In that case, where, without negligence, sparks came out of an engine, it was held by the House of Lords that where a statute allowed one to run locomotive engines, if the sparks came out without negligence, no action could be brought against the Railway Company. In the *Gas Light and Coke Company* v. *The Vestry of St. Mary Abbotts*, in 15, Queen's Bench Division, page 1—what was the case there? A gas company laid down mains; the mains might go through private property, they might go through the streets; they were lawfully there, but there was no obligation or any restriction as to the particular place in which the mains should be put. It was suggested by the defendant in that case that the mains might be sunk deeper, and that if the mains were sunk deeper, they would have nothing to fear from rollers. It was only a question of expense. The Vestry was minded to repair roads, and they wished to do that cheaply and quickly, and accordingly they used fifteen-ton and twenty-ton rollers, and the steam rollers in many places broke the pipes. It was held that inasmuch as it was not necessary for the defendants to do this damage, they were liable. If in that case the defendants had been expressly authorised by statute to use steam rollers of such a weight as necessarily to injure the plaintiffs' pipes, the plaintiffs would have had no ground of complaint. In the case of *Evans* v. *The Manchester, Sheffield and Lincolnshire Railway*, which is in the 36th Chancery Division at page 627, a canal, constructed under the authority of an Act of Parliament, was, in consequence of the working of a coal mine by somebody else, caused to subside. The water leaped from the canal into a mill. It was held that though the company was authorised by an Act of Parliament, and was not under the same liabilities as a private person, it was liable for damages if guilty of negligence, and that the canal company had been guilty of negligence, inasmuch as it might have prevented the damage, and was bound to compensate the mill-owner. In this case it was suggested it was not negligence, because some other person had undermined the canal. However, it was decided that the company had to keep the water in, and it was no good saying it imposed an extra burden. Sometimes it had been suggested that they required to have a property right. That was disposed of altogether in the case of *Ballard* v. *Tomlinson*, 29, Chancery Division. In the course of the case he would satisfy his lordship that, with clearly less cost, certainly with no loss of efficiency, the defendants could conduct their tramways by electricity if they were so minded. It was sufficient for his purpose to point out that they had no statutory power whatever to use any particular kind of electricity, or to use it in any particular way. They only had permission to use electricity. If they used it so as to interfere with and do an injury to persons who were lawfully carrying on business in which electrical currents were essential, he submitted that the action could be maintained, and he asked his lordship to remember that Mr. Graff-Baker and the Tramway Company could not say that the Telephone Company were interfering with them in the slightest degree. It made not the slightest difference to the tramways whether the telephones were there or not.

Dr. JOHN HOPKINSON was then called and examined by Mr. Warmington. Witness stated that he was consulting engineer to the plaintiff company, and proceeded to explain the *modus operandi* of the telephone to the Court. There must be a complete closed circuit, but it was not necessary that there should be an earth return. The Exchange system did not in the least bit alter the mode of operation. Currents used for telegraphy varied, of course, but were measured in thousand parts of an ampere. For traction purposes they had currents of 200 amperes, or 300, and figures of that magnitude. For lighting purposes it was not at all infrequent to have currents of 1,000 amperes. For telephones the currents were vastly smaller again than for telegraphs.

Mr. JUSTICE KEKEWICH: Give us some instances.—I do not know that I can. I do not know that they have been actually measured with any degree of accuracy, but I imagine they would be perhaps not more than the one-hundredth part as great, possibly not so great as that. It is the weakest for any public useful purpose.

Continuing, Witness stated that a current used for telegraphic purposes was exposed mainly to the danger that they might get a return of a lighting current by earth, if the return conductor was not insulated. Witness then explained to the Court the various methods of electric traction by accumulators, overhead trolley, underground conductor, with and without an insulated return.

Mr. WARMINGTON: Assuming that no one is interested other than the persons who are interested in the exercise of this traction power, simply from that point of view, which in your opinion is the most efficient and economically good?—In my judgment, that with the two conductors both insulated.

WITNESS said there were two or three reasons for that. First of all, there was the economy. In order to secure safety, the Board of Trade

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required that the difference of pressure between a conductor and earth should not exceed 300 volts. The purpose of that was to ensure the public against serious shock. Now, if they used both conductors insulated, it was practicable to take out the current at 300 volts above the earth, and take it back at 300 volts below the earth, and in that case they had only the difference between earth pressure over each of the currents of 300 volts, so that they were able to work at an effective pressure of 600 volts, and therefore with conductors of half the size. Further, if with an earth return anything went wrong with the outgoing conductor the whole thing came to a stoppage. The most likely accident to arise was that one of the conductors should come into contact with the earth. With both conductors insulated no mischievous consequence would happen. They only had one line of defence broken down. At Buda-Pesth, where they had the double conductor under ground, they told him that they would not on any account be without it; they had found it of very great practical advantage. In order to disturb the telephone they must first of all have a variable current, and they had variable contacts with tramways between the trolley and the wire overhead, and between the wheels of the car and the rails. Every variation in contact caused a variation in the current, and that variation was at once reproduced upon the telephone in two ways. Then, again, they got variations in current from the commutator of the dynamo. With a return of uninsulated conductor through the earth, they got disturbances of earth pressure, and, in fact, a part of the current returning to the station, not by the rails and not by the non-insulated conductor, but through the telephone instrument, through the telephone line wire, and through the telephone receiving instrument. That was leakage disturbance. There were also disturbances due to electro-magnetic and electrostatic induction. There was nothing abnormal in the system adopted by the plaintiffs. It was the same system that was to be found in almost all the large towns in the country, and all over the world. He had tested some of the plaintiffs' wires for the purpose of ascertaining whether there was any disturbance by reason of the defendants' working. On November 13, 1891, there was a great deal of disturbance. On November 29th of this year, he tested some lines with Mr. Dalziel, the plaintiffs' manager. They went to the Leeds Exchange. They were connected in succession to a number of subscribers who were disturbed. He arranged them in order of loudness in four classes. In the noisiest class, which was an exceedingly noisy class indeed, he had three. There was 114, which was close by the loop; that was the call office of the Telephone Company. There was no mistake what it was which occasioned the noise heard. They could hear the cars start, and as the velocity increased the pitch of the note went up.

Mr. JUSTICE KEKEWICH: Applied to the ordinary purposes of commerce for which the telephone is largely used in commercial towns like Leeds, would it interfere with two business men carrying on their business communications?—Of course they can use every moment, and speak through when it is not quite so loud. I should say it would interfere seriously as regards the three first-named. What I should do as regards the other is, that I should always make a clerk talk for me. I would not talk myself—I certainly should not.

Continuing, Witness stated that the noise was in some measure, no doubt, caused by leakage; but the greater part of the disturbance was due to electro-magnetic induction. He had tried some special experiments to satisfy himself of that. All the numbers higher than 1,600 were connected to a subsidiary exchange at Chapeltown. From Chapeltown Exchange they were connected to the Leeds Exchange by cables underground, with an outgoing and a return conductor, both insulated; but to the Chapeltown Exchange the conductors were arranged on poles overhead. He tested the number of lines by dividing them, and satisfied himself that much the larger portion of the disturbance—not all of it, but the larger portion of the disturbance—was caused by electro-magnetic induction. Then he tried a subsequent experiment to satisfy himself that it was not electrostatic induction. In his opinion there was absolutely no difficulty in the defendants so constructing their works as to prevent the disturbance described. At Buda-Pesth there was altogether about 22 kilometres of single track. Six months ago they had 63 cars running, weighing 4½ tons each. In that case they had two conductors under ground, both insulated. There was no disturbance of the telephone excepting that they occasionally got an earth connection on one side, and then they did find a disturbance. He went to the head administrator of the telephone, and asked him particularly whether there was any disturbance. He had heard of nothing since the very start of the tramway. The plaintiffs, no doubt, could obviate the disturbance by duplicating throughout their wires.

Mr. JUSTICE KEKEWICH: Would the multiplication of wires in that way have any material effect in increasing or multiplying the risk of interruption and failure in the electric current?—No; I do not think it would make any difference. They would be quite as secure as they are now.

Cross-examined by Mr. BOUSFIELD, Witness stated that, as far as his knowledge went, it was the fact, broadly speaking, that nine-tenths of the electrical tramways in existence were worked upon the system which the defendants had adopted in Leeds. There was no difficulty in the Buda-Pesth system, owing to the fact that they had to work through a narrow slot into the conduit. At Buda-Pesth the slot was an inch and a third. It could be diminished to about an inch. Witness did not think that the diminution in the width of the slot would materially affect the efficient working of the system. The Vevey system would really be practically applicable to a place like Leeds. He had not thought much about the application of the Vevey plan to a complicated crossing, but the Buda-Pesth plan he had no doubt about. Witness was then handed a photograph of the crossing at Boar-lane, Leeds, and stated that he thought there should be no difficulty in applying the two-wire plan to such a crossing. There was no crossing whatever in Vevey.

Mr. BOUSFIELD: Do you know of any case where the system of double overhead conductors, either in the Vevey form or any other form, has been successfully worked out in practice to a complicated case of this kind?—No; neither successfully nor unsuccessfully. The only case of overhead conductors and an insulated return that I know of is Vevey, and in that case, as far as I remember, there is nothing but mere branches, which of course does involve a difficulty in an elementary form for the purpose of passing the cars.

Continuing, the Witness said that the system at Vevey did not give absolute immunity from noise in the telephones. He had never heard anything so bad in London as he did in Leeds, except a disturbance caused by the Grosvenor Gallery installation some years ago. In that case they had an open circuit. The Telephone Company complained, and they duplicated their circuit and cured it. He doubted whether in some districts of Leeds, quite out of the sphere of the working of the tramway, there were disturbances in the telephone as great as those caused by the tramway. Some of the tram wires were six feet from the telephone wires, and less in some places, even as low as three feet. If the telephone wires were taken twelve feet distant, then the disturbance would be vastly less.

Mr. BOUSFIELD: If your wire ran twenty feet off, that might possibly remove what is complained of?—It would very largely diminish it, undoubtedly; whether it would remove it or not, of course, I can hardly say.

Continuing, Witness stated that the telephone was perhaps the most delicate instrument in existence for detecting stray vibratory currents of electricity; but it was not a fact that in all cases a telephone without a metallic return was an extremely imperfect and unreliable instrument. One did hear a certain amount of disturbance from parallel lines, undoubtedly; but as to that, that amount of disturbance was not so great as to cause any insuperable trouble. It was true that even the ordinary telegraphic currents occasionally made serious disturbances in telephone circuits. On the line from London to Birmingham it was absolutely impossible to speak. He had never heard that for long lines earth currents had been found to be sources of interference. He had never had any experience of talking in London in which the noises were intolerable. He could not say that, owing to the delicacy of the telelephone, in every case where Her Majesty's Government erected telephones, they invariably used a metallic return, and not an earth return. He did not know that in the New York telephone system they had in all cases a metallic return. Neither did he know that the same was true of Paris, and of the New Telephone Company. In all long-distance telephone work a metallic return was used.

Mr. BOUSFIELD: Let me ask you this—it is perfectly simple, is it not, and feasible to have part of your system furnished with metallic returns and part with earth returns?—Yes. Of course, there are drawbacks in doing that, but it is possible.

So that here in Leeds this disturbance could be got rid of by duplicating the disturbed wires that I have pointed out and carrying them to earth near the Exchange instead of at the distant point?—Yes, I think you would get rid of it in that way.

So that at a comparatively small expense the Telephone Company could in that way make the system efficient, notwithstanding our tramway system?—I can hardly give you an estimate of the expense.

Comparatively small?—It would not be gigantic, I agree.

Supposing we did have metallic returns overhead for our tramways, as you suggest, there would still be some disturbance?—There might be a little, but it would be exceedingly small. I venture to say this, that at all events there would be nothing of which the Telephone Company would be justified in complaining.

We have a three-fold conductor, have we not, laid in the earth—the two rails and the copper conductor besides?—Yes.

So that 999-1,000ths of our current would pass along conductors and not pass into the earth?—I could not put any figure upon it, but no doubt a large part of it will go back to the rail.

At all events this I have got from you—that substantially the bulk of our current goes through our conductors, and not through the earth?—I should say so.

So we do not rely in any way upon the earth for the efficiency of the system?—No: I have tried to state that without the earth I think you could have a better system than you have.

Whereas you do, in fact, rely on the use of the earth at present for your system?—Entirely; we return entirely to the earth. We provide no special conductor for the return.

In continuation of his cross-examination, Witness stated he had not practically tested the truth of his hypothesis that the shaking of the trolley-wheels caused the current to vary. The cost of laying a slotted conduit-line would be about £2,000 a mile. If by Board of Trade rule the difference of voltage between the two suspended conductors was not to exceed 300 volts, then that would do away with the suggestion he had made. He had, however, ascertained from the Board of Trade that if an application were made to them to take the 600 volts, both leads being insulated, they would regard it with favourable consideration.

Re-examined by Mr. WARMINGTON, Witness stated both the length of parallelism and the distance apart were factors in the question of mutual induction between any two wires. With regard to the disturbance from the Grosvenor Gallery installation, which occurred some years ago, the Telephone Company complained they had a disturbance immediately the Grosvenor Gallery installation was started. The Grosvenor Gallery Company were working alternating currents, and it was found at once, on looking into it, they had a single conductor running out over a considerable circuit and coming back by another route. The Telephone Company suggested to them to run out their conductor, and then go back again by the same course or nearly the same course—within six or eight inches of the outgoing conductor. They did that and the disturbance was practically reduced to nil. With regard to the Vevey system, it did not appear to his mind that there was any insuperable difficulty in applying it to places where there were numerous crossings. The model put in, of course, gave rather

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an extensive idea of complication, from the accident that the connections, as well as the insulated parts, were shown in the same way. At Leeds the problem to be solved *at present* was a vastly simpler one even than at Vevey, and beyond all comparison simpler than Buda-Pesth, where there was really a very complicated system of tramways. There would be no difficulty so far as Leeds was concerned in applying either plan.

The Court then adjourned until Wednesday.

WEDNESDAY, DECEMBER 14TH.

On the hearing of this action being resumed, Dr. JOHN HOPKINSON was re-called and examined by Sir RICHARD WEBSTER with regard to some photographs of the Buda-Pesth tramway

LORD KELVIN, examined by Sir RICHARD WEBSTER, stated that he had considered and investigated the question of the disturbance of the telephones at Leeds by the electric tramway. He knew of no cases in this country, except a part of the telephone system in Newcastle, and of no place in Great Britain or Ireland in which the metallic circuit was employed. Paris was the only place in Europe in which the double wire was used. He went on June 3rd last to Leeds for the purpose of examining the question. The disturbance was very severe. One could hear perfectly when the tramcar started and stopped. It made conversation almost impossible—for ordinary subscribers quite impossible. After explaining to the Court the way in which the Leeds line was worked, and his theory of how the disturbances arose, Witness stated that it was not necessary that a system of single insulated wire overhead should be used. There would be no practical difficulty in constructing a tramway in Leeds on the Buda-Pesth system. A question had been put as to whether or not the disturbances could not be got rid of by duplicating the telephone wires for a limited portion only of the circuits, and then taking the rest of the circuits to earth. He believed the disturbance might be cured for a particular subscriber by duplicating his wire and keeping his system wholly insulated, but that would be exceedingly inconvenient. He had reason for this view in the fact that duplicated wires, perfectly insulated wires, did get over the difficulty of ordinary induction disturbance, but when one point was put to earth the disturbances were immediately heard. He had tried it since the Court rose the day before. He went to the Central Exchange of the National Telephone Company in Oxford-court, and several cases were shown to him, taken according to what lines were free at the time, and in each case the most marked disturbance was produced by touching the previously insulated metallic circuit with a wire leading to earth. Practically nothing but an absolute and complete establishment of the telephone system throughout on the double wire would have the effect of curing. The Glasgow telephone system, a large one and earthed, worked admirably. A few times he had heard something like the Leeds noises, but not nearly so bad. That was due to the electric lighting of a train between Queen-street and Charing-cross.

Cross-examined by Mr. BOUSFIELD, Witness stated that the suggestion that, instead of taking the subscriber's wire to earth at his house, it should double back along the line, and go to earth near the exchange, would not be a cure. The electro-magnetic induction might be neutralised, but there would be an electrostatic effect. Witness was next examined at length upon the conditions of his experiments of the previous night, and admitted that he knew nothing whatever as to what the different disturbances on the route might be, and as to what disturbing element might be introduced into the system when he took the insulated circuit to earth. Nevertheless, the results obtained would be an auxiliary towards a theory. Cross-examined with regard to the Giant's Causeway tramway, Witness stated that there had been some complaints that one or two horses had met with their deaths from it. Country people came to get cured of rheumatism by touching the rails. He had touched the rails himself with wet hands and got a severe shock. That sort of thing could not happen at Leeds. Witness could not quite agree that where they had switches and crossings, and so on, they were a great deal easier to manage, and simpler with a single conductor than with a double conductor. He had no practical experience of the application of double conductors to the tramway system. Witness was next cross-examined on a model of a crossing on the double-wire overhead trolley system.

Re-examined by Mr. MOULTON, Witness repeated in detail an account of his experiments on the previous night. All was silent when he first put the telephone to his ear; then he spoke through to Birmingham to make sure. Then he stopped speaking and listened, and found perfect silence. Then the earth wire was put on. There was a loud disturbance. Then the wire was shifted and there was a loud disturbance. He heard the phonopore line from London to Leicester quite distinctly. Ten miles of the single phonopore line, which was a single insulated wire with earth return, was beside the telephone line to Birmingham. Of those ten miles for about eight the phonopore wire was within a very few feet (20ft.) of the telephone wire. There was only ten miles out of the whole distance that could be considered as practically near enough to produce disturbance, and yet, notwithstanding that, it was quite marvellous to hear the phonopore. There was no mistaking that it was the phonopore, because he heard the musical note, and the transmission of the musical note which gave the signals, according to the Morse alphabet, on the phonopore. He attributed that to the process of static induction by the duplicate circuit. With regard to the train at Glasgow which caused trouble to the telephones, electricity was supplied to it from outside through the central iron rail nearly midway between the two rails that carried the carriage, and the return was through the wheels on which the carriage rested.

Mr. EDWARD HOPKINSON, examined by Mr. MOULTON, stated he was Managing Director of the firm of Mather and Platt. He was requested on behalf of the plaintiffs to make an estimate for working the Leeds Tramway with insulated overhead metallic circuits. He worked out three different methods. First he followed out the line adopted in Leeds—that was to say, overhead conductors insulated, and a return partly through the earth, and partly through the rails, and partly by a conductor laid in the earth. Secondly, he worked out a double overhead conductor, all the conductors being insulated from the earth. With regard to the second method, he worked it out on a higher voltage—that was to say, 600 volts. Thirdly, with all the conductors insulated from the earth, but with a difference of potential of 300 volts between the two conductors, instead of 600, for the reason that 600 had never been actually sanctioned by the Board of Trade, and it was possible that they might take exception to the use of such high voltage. The amount of No. 1 estimate was £14,251, of No. 2 £12,698, and of No. 3 £14,665. That included boilers, engines, generators, cars with the motors upon them, and conductors, but no buildings or builders' work. He thought there was no doubt that the one of the two systems in which there was no connection to the earth would be the cheapest and most satisfactory in working, because if they had earth connections making use of the earth for the return there were various joints in the system, each of which was liable to introduce rust, which would increase in course of time by the oxidation of the joints and the actual wearing away of the tram lines themselves by the traffic, so that, although in the first instance it might be fairly satisfactory, it would, no doubt, tend to become less so in course of time. He had not in arriving at these amounts allowed for that defect in the first system. He had assumed that the defect would not exist. The prices were the prices at which his firm would be very pleased to obtain the contract.

Cross-examined by Mr. BOUSFIELD, Witness stated that, according to his view, the defendants were very foolish not to have adopted the second system. He was not aware of the Board of Trade regulation, which said that two overhead conductors near one another must not have a difference of potential between them of more than 300 volts. If that were so his second estimate then would have to be modified.

Mr. BOUSFIELD: Can you tell us why, this double conductor system being superior, you carried out the Bessbrook-Newry line on the single conductor system?—Yes, in that case it was desirable for many reasons to place the conductors approximately in the plane of the rails carrying the cars. There were other reasons which perhaps I need not go into, but in that case there are certain advantages with regard to simplicity in the single conductor which do not hold in cases where you have either conduit or an overhead conductor.

Are there not always certain advantages of simplicity obtained from the single conductor?—Certain advantages, yes.

Your firm, I think, put up the line at Giant's Causeway also?—My firm did not do it, but I superintended the erection personally.

That is also a single conductor?—It is.

Why was the single conductor preferred there to the double conductor?—I cannot give you the reeson in that case. It was the first railway I had ever put down, and it was put down under the supervision of Sir William Siemens, and I suppose for reasons of that kind which appear important he made use of his single conductor.

Your firm had to do with the City Electric Railway?—It had.

That is a single conductor, is it not?—Yes.

Can you tell me why in that case the single conductor system was preferred?—For exactly the same reason that I mentioned in the case of the Bessbrook and Newry Tramway. There it was desirable to have the conductor in the plane of the rails.

But you have got one conductor between the rails, have you not?—Yes.

It would have been just as easy to have two conductors between rails, so as to have the return independent of the rail, would it not?—No, it would not.

Why not?—There is great difficulty at the points and crossings.

That is where I suggest the difficulty comes in. Where you have points and crossings you do get a difficulty if you have a complicated system with two conductors instead of one—that is so, is it not?—In the case of the conductors being in the plane of the rails, not otherwise.

You have to have certain breaks and so on, whether they are in the plane of the rails or above the plane?—Yes.

After re-examination by Mr. MOULTON, witness withdrew.

Dr. JOHN HOPKINSON, recalled and further examined by Mr. MOULTON, said that he had seen the Leeds Tramway on three occasions. On the last occasion he carefully observed the cars as they ran on the rails in broad daylight, and in every case he could see sparks between the wheels and the rails.

Sir FREDERICK JOSEPH BRAMWELL, examined by Sir RICHARD WEBSTER, stated that he had been acquainted with telephone working ever since the introduction into England. Witness then gave evidence with regard to the general use of the single-wire telephone system in the United Kingdom. He had tested the telephone lines at Leeds with practically the same results as the other witnesses.

After some objections from Mr. BOUSFIELD, Witness was examined with regard to the Northfleet Tramway. With regard to the Buda-Pesth slot system, witness had not the slightest doubt that the slot could be reduced to a width of $\frac{3}{4}$in. With regard to the alleged complication at crossings which would be brought about by the adoption of the double overhead conductors system, witness did not think there could be any practical difficulty. There was one thing which seemed conclusive to show it could be done. The wheels of the tramcars on the defendant's system were the means which made the electric connection between the motors on the car and the rails, and the intermediate wire. Whenever they came to one of these complicated places, such as was suggested at Boar-lane, Leeds, they were compelled to have provision for these wheels to pass—that was to say, if passing was to take place. He could not see any greater difficulty in making a provision for the positive conductor to pass than in making a provision for the negative conductor to pass. If they could do the one they could do the other.

Cross-examined by Mr. BOUSFIELD, witness stated that he did not think he could say it was a fact that wherever, owing to any cause, there was a liability to disturbance by other electrical influences, the plaintiffs.

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fell back on the system of metallic return. He did not know of any case of a long-distance line in which they had not duplicated their wires. On the other hand, he did not know whether there was a long-distance line which did not go near some telegraph wire.

Mr. BOUSFIELD: Then I think generally in any case where there is disturbance from some external influences, whether of other wires, or telegraph wires, or whatever it may be, the plaintiffs do fall back on the system of doubling their wires with a metallic return?—I am not connected with the direction of the Company, and I cannot therefore answer you, but I think I may answer you safely in this way, that wherever they find it desirable to have the double wires they use them. That I think I may safely answer you, and perhaps they possibly avoid expense to them and something more than expense. I am thinking of the great snowstorm of four or five years ago, and what did happen then, and what would happen now to overhead wires if they were doubled.

Perhaps, as you have mentioned that, you can tell us what the dividend of the National Telephone Company has been?—I ought to be able to, because I am a somewhat considerable shareholder, and perhaps I ought to have mentioned that before; when I say considerable, I mean considerable for a man of my means. I really do not remember what the dividend is.

It pays very handsomely at present?—I am glad to say it does.

And it might still pay handsomely if in certain disturbed places they doubled their wires?—I do not know. If you make a large capital expenditure and get no more return, my humble arithmetic points to a reduced dividend.

I believe the present dividend is somewhere about 12 per cent.?—All I know is the shares are only just at par—the £5 shares. I happened to be reading the paper while the Court was adjourned, and I happened to see the £5 shares have fallen seven-eights to 5⅛, which does not look like a state of bloated affluence.

As a matter of fact that commercial implement, Sir Frederick, even as you know it and use it in London, the earth return, is a very imperfect implement indeed, is it not?—It is a very imperfect one as compared with a complete metallic return, but you may buy anything too dear. The thing as at present arranged works, and works commercially.

Continuing, Witness stated, with regard to the Northfleet Tramway, the electric working had been abandoned. He was not surprised. It was a remote spot. Where they had a complex crossing, such as that which illustrated the end of Boar-lane at Leeds, the number of breaks in the two overhead conductors would be very considerable. It was perfectly practicable, notwithstanding that. He had never had to apply his mind to a case of that kind with double conductors, and to try to scheme it out so as to make a practicable tramway system out of it.

Mr. CHARLES LUPTON was then examined by Mr. WARMINGTON, and stated that he was a Leeds solicitor, and one of the plaintiffs in the action. His private residence was near the Roundhay-road. His telephone was No. 1,617. His office was in the centre of the town. Since 1889 he had been one of the plaintiffs' subscribers for No. 1,617. Until the defendants commenced running cars the service was very fairly satisfactory. Since November, 1891, it had become so difficult to use the telephone that practically he never used it unless somebody wished to telephone to him professionally. He heard a noise like a hum in the distance, which rapidly became more and more acute. It very often stopped and went on again. There was a breakdown in the defendant's works, and the cars did not run. During that period he could use his telephone quite as well as ever. When the cars started working again, the noise was as bad as ever.

Cross-examined by Mr. BOUSFIELD, Witness stated that he first complained to the National Telephone Company on December 15, 1891.

Mr. JUSTICE KEKEWICH: If it will help you for me to assume that the National Telephone Company and this gentleman, one of their subscribers, are working together in the most friendly way for the purpose of making their case technically and practically against you, I will make that assumption without anything further. I do not think you need prove that.

Mr. BOUSFIELD: I ask for the letters because they are undisclosed.

Mr. JUSTICE KEKEWICH: I will assume that Counsel advised the National Telephone Company that it would be better if a subscriber joined them as a plaintiff. They thought a solicitor would make a capital plaintiff.

Mr. BOUSFIELD: This was one of the cases where we were informed it was exceedingly trifling.

Mr. JUSTICE KEKEWICH: I venture to suggest to you that sometime during the Christmas holidays two gentlemen, one named by you, and one named by Mr. Moulton—competent men, not necessarily Dr. Hopkinson, or anybody else—should meet and try several of these places when the tramcars are running, and when they are not running, and be prepared to give me the result when we meet again in January. Between persons representing such large interests as you both do, there ought not to be the slightest doubt about this question of fact. The scientific and legal questions are two entirely different things. The facts ought to be beyond dispute.

Mr. BOUSFIELD: We have evidence in detail about these different things by our witnesses. I do not know that one differs very substantially from Dr. Hopkinson.

Mr. JUSTICE KEKEWICH: If they worked together as sensible men would, if two were to go and take care to have an hour while the tramcars are running, trying two or three places, and trying the same places in the hour after the tramcars have ceased, that given in evidence in the witness box would settle the whole question of fact.

Mr. BOUSFIELD: We will consider what your Lordship has said.

Mr. JUSTICE KEKEWICH: However, you go on, and cross-examine Mr. Lupton.

Mr. BOUSFIELD: I will only put two or three questions as to this.

Mr. JUSTICE KEKEWICH: You need not go into the question as to the union of the two plaintiffs; it is a thorough union of hearts, no doubt.

Dr. THOMAS RICHARD JESSOP was then called, and examined by Mr. WARMINGTON, and stated that he was a surgeon carrying on his profession at Leeds. He had been a subscriber to the plaintiffs' telephones from the beginning. Until 1891 he did not suffer from any disturbance. In November, 1891, when the defendants started their trams, he experienced very great difficulty.

Cross-examined by Mr. BOUSFIELD, Witness said the nuisance was not one people were likely to get used to in time.

On the Witness being re-examined by Mr. WARMINGTON, the following letter, dated November 15, 1891, and written by witness to the Telephone Company, was put in:—"Dear Sir: I desire to draw your attention to the very serious inconvenience that is experienced from the effect upon the telephone produced by the electric tramcars. The continuous loud hum heard whenever a car is in motion, almost precludes the possibility of hearing a conversation. To-day, Sunday, and on several occasions, I have not only been unable to hear anything above the loud buzzing of the car, but the effect upon my ear has been lasting and most unpleasant. During this week, since the line was opened, several of my family here complained, and to-day I have found that their complaints are well founded. I shall be glad to hear what your opinion upon the point is, and whether you think any remedy can be provided."

Mr. ROBERT MIDDLETON, examined by Mr. MICKLEM, also gave evidence as to the telephonic disturbances caused by the electric cars.

Cross-examined by Mr. BOUSFIELD, Witness stated he certainly did occasionally telephone home from his works, but that it was no uncommon thing for his orders to be misunderstood.

Mr. BOUSFIELD: I might tell your Lordship that our case is that there is disturbance, no doubt, but in no case is it such even in the worst cases as to interfere with the use of the instrument so as to make it useless.

Mr. JUSTICE KEKEWICH: Then of course you must destroy all the evidence I have heard. I should have thought, unassisted by your observation, that the great advantage of the telephone was to hear quickly what otherwise might have been transmitted at least as surely by message verbally or in writing, and that if anything interfered with the promptitude with which it could be done, it interfered with the advantage of the operation altogether.

Mr. BOUSFIED: I am not in a position to say there is not some interferance with the enjoyment of the telephone.

Mr. JUSTICE KEKEWICH: I have given you a pretty clear indication of where my mind is at the present moment.

The Court then adjourned.

THURSDAY, DECEMBER 15TH.

On behalf of the plaintiffs, Sir Frederick Bramwell, Mr. D. Sinclair, and Mr. W. H. Massey were called and examined. The last witness objected to overhead conductors altogether, and was in favour of underground conduits. This evidence closed the plaintiffs' case. The Counsel for the defence deferred his speech, and at once called Mr. George Wood, Water Works Superintendent, who stated that the telephone wires were everywhere connected to the water pipes; Mr. W. H. Preece, who gave evidence as to the freedom from disturbance with twin-wire metallic circuits; and Mr. James Swinburne, who described experiments he had made at Leeds, which showed that the disturbance was not so serious as was suggested. The case was then adjourned to January 12th. A full report of Thursday's proceedings will appear in our next issue.

Laurence, Scott and Co. v. Greenard.

In the Ipswich County Court, on Wednesday, Messrs. Laurence, Scott and Co. sued E. S. Greenard, manager of the City Clothing Company, for the sum of £1. 9s.

Mr. SISLING, manager of the plaintiff firm, explained that this was for renewal of lamps and breakages.

In answer to the Judge, the Witness said the verbal agreement was that the contract should be the same as with other customers, and as mentioned in the firm's circular. The firm never renewed the lamps, which were left to the care of the consumers in the same manner as gas burners.

His HONOUR: I do not see any analogy between the electric lamp and the gas burner.

Mr. SISLING contended that there was, though perhaps the electric lamp wore out quicker. In the previous year the defendant paid for a small renewal, and since the rendering of the disputed account had promised it his attention and made no objection.

The DEFENDANT said the bill he agreed to settle was for the supply of the electric light, and not for the renewal of any fittings. In the first instance he inquired most particularly of Mr. Sisling what the cost would be, and he told him £12 a year, to include everything. At first he only had one lamp, but when the firm put in others he paid the cost. He had never paid any charges of this kind. An inexperienced youth sent by the plaintiffs had attempted to make a little alteration in the wires when the current was on; consequently he burnt his hand and "knocked the whole thing over." On previous occasions, when similar charges were in the accounts presented to him by the plaintiffs, he had struck them out and paid only the residue of the account. He contended that these lamps were an essential part of the contract inasmuch as they contained the light itself, and the current was merely the motive power.

The JUDGE expressed the opinion that the necessary lamps and fittings were as much part of the light as the current itself. Unless it could be shown that the repairs had been rendered necessary by the negligence or carelessness of the defendant, he did not see that the latter was liable.

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Mr. SISLING: It is the universal custom in the trade to supply only the current, and the consumer pays for the apparatus, which remains his property all through. We only supply electricity, and not light.

The JUDGE: The Act of Parliament and the public call you electric light supply companies.

Mr. SISLING pointed out that there were gas burners which largely corresponded to electric light lamps, and which the gas companies did not repair. All the other customers of the firm in Ipswich and elsewhere had renewed their lamps at their own expense, and often got double the light by so doing.

The JUDGE: It is perfectly clear that, at the time he took this from you, you were supplying electricity; he wanted light—he did not want electricity. These peculiarly constructed globes are as necessary to produce the light as electricity. There is no analogy between gas and the electric light so far as the burner is concerned. Gas will burn without any burner. If you turn it on to a plain lead pipe you can get a light. The gas burner is only an adaptation by engineers, or whoever make these things, to economise the gas. Your peculiarly constructed globes are a *sine quâ non*.

Mr. SISLING replied that the electric light might be obtained by a simple conjunction of wires.

The JUDGE: But you don't suppose a man will stand holding them together.

The DEFENDANT said he had had seven or eight renewals before the firm thought to charge him for one. They induced him to have the electric light by charging him nothing for the internal fittings, as they wanted to get the light before the public of Ipswich.

Mr. SISLING denied these statements; it was the external work which was put up at the firm's expense.

In the end judgment was given for the defendant, with costs, and in answer to Mr. Sisling's application for leave to appeal, his Honour said he did not think the appeal would lie.

Mr. SISLING: It is such an important principle, and the decision may have a disastrous effect on our business.

The JUDGE: Each case depends upon its intrinsic circumstances. Here you gave him to understand that you would keep up the electric light.

CORRESPONDENCE.

PRICE OF ELECTRIC SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There can be no doubt that supply companies from time to time feel the pinch of the conditions under which they are compelled to supply the electric current. An instance which has been recently given by the Chairman of one of the supply companies furnishes an example of this. A consumer having a place wired for 600 lamps, the supply company are of course obliged to have engine, dynamo and boiler power, and mains, sufficient to furnish a supply of current for the whole 600 lamps whenever the consumer chooses to turn them on; yet, as a matter of fact, the consumer in question hardly ever uses more than 12 lamps at one time. A still harder case is that of a large hotel in the North of England, in which there are 1,000 incandescent lamps. The owners of the hotel have furnished their own generating plant. When the contractor was arranging the plant in question, he drew attention to the necessity of having a duplicate plant. "No," said the wise owners, "there is no necessity for our putting in duplicate plant, we will give notice to the supply company that we have an installation of 1,000 lamps." Of course, the supply company must be ready at any moment to pass current through their mains for the supply of the whole of these 1,000 lamps, although no one of them will ever be supplied with current from the source of public supply unless the internal arrangements of the hotel break down.

Baldly stated in this way, the supply companies would seem to have a grievance, but, whether they have or not, they must certainly dislike having so much capital locked up—in the one case practically without return, but in the other at an absolute loss—as their plant will not be earning anything for years to come.

To meet such and other cases, Dr. Hopkinson, the House to House Company and others, have suggested various modes of charging by which the severity of the pinch may be lessened, and all those interested in any supply companies have been considering these and other suggestions with a view to seeing whether there was any fair and legitimate way out of this difficulty, and whether they could induce consumers to take a larger and more regular supply of electricity by giving them a preferential discount for so doing. Mr. A. B. Holmes, of Liverpool, has, given us the advantage of his experience, and draws attention to the fact that in the Licence granted to the Liverpool Electric Supply Company in 1888 a sliding scale of charges was introduced. It is instructive that Mr. Holmes should write, "It was found, however, that the consumers had some difficulty in understanding the scale, being accustomed to the sweet simplicity of the uniform rate charged by the local gas company, and that dissatisfaction was always expressed by consumers who used their lamps only a small number of hours, and, therefore, never reached the lower rates." Again he says, "Four years' trial of the above method of charging in Liverpool proved that its disadvantages were greater than its advantages, and in the Liverpool Electric Lighting Order of 1892 the sliding scale was repealed, and a uniform rate of charge substituted."

This seems the probable final solution, and fixed and easily understood prices will prove the most acceptable, and after a time we shall almost certainly find that one uniform price will be charged throughout each district.

It is hardly a matter of question that the Provisional Orders cannot over-ride the Electric Lighting Acts of 1892 and 1888, under which these Orders are granted; and if a case ever comes before the Courts in which the Provisional Order gives certain powers which in excess of, or contrary to, those contemplated by the Electric Lighting Act itself, the Provisional Order will have to give way, and the conditions of the Electric Lighting Act carried into effect. Now, Clauses 19 and 20 seem to a layman absolutely to debar the supply companies from making preferential prices. As it is a very important question, and one which seems to have escaped attention, I think it advisable to quote these two clauses:—

19. Where a supply of electricity is provided in any part of an area for private purposes, then, except in so far as is otherwise provided by the terms of the Licence, Order, or Special Act authorising such supply, every company or person within that part of the area shall, on application, be entitled to a supply on the same terms on which any other Company or person in such part of the area is entitled under similar circumstances to a corresponding supply.

20. The undertakers shall not, in making any agreements for a supply of electricity, show any undue preference to any local authority, company, or person, but, save as aforesaid, they may make such charges for the supply of electricity, as may be agreed upon, not exceeding the limits of price imposed by or in pursuance of the Licence, Order or Special Act authorising them to supply electricity.

There may be a loop-hole in the words "under similar circumstances" in Clause 19, and the supply companies might think that a man who was using his maximum current daily was not being supplied under the same circumstances as a man who only used the tenth part of such current. I am afraid, however, that the words of the 20th clause might enable a consumer who was charged at the rate of 8d. per unit because he did not use as much current as his neighbour alongside, who was paying at the rate of 5½d. per unit owing to his using his maximum of electric current, to claim to be charged at the lower rate. It is a matter for lawyers to determine whether a small consumer under Clauses 19 and 20 of the Act could claim to be supplied at the same rate as a consumer who receives the preferential discount. My own experience shows that, while under certain circumstances a gas company is entitled to give a large consumer a preferential discount, yet in another case a gas company, which was most anxious to meet large consumers, declared that it was unable to do so from the terms of its Act, even to consumers using a most exceptional amount of gas.

The conclusion of the whole matter, therefore, seems to be that even if a preferential discount might legally be given to those whom all supply companies would recognise as the best customers, the difficulties of arranging these preferential charges, and the still greater difficulty of making the general public understand them, will render their working so difficult that the supply companies will follow the example of the Liverpool Electric Supply Company and have only one charge.—Yours, &c.,

S. FLOOD-PAGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The correspondence which is now going on in your columns on the various methods of charging for the electric energy supplied from central stations is of great importance,

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not only to consumers, but especially to electric light companies. Broadly speaking, there are four methods in use: (1), the fixed charge of so much per unit, irrespective of the number of units supplied; (2), the same as (1), but with a discount to large consumers; (3), a sliding scale; and (4), a differential rate according to the purpose for which the supply is required. The last-mentioned method is in use at St. Pancras, and has been devised by Mr. Baron, the superintendent at that station. Under it a consumer requiring power as well as light must wire his premises with two distinct circuits, one for the power and the other for the light supply. In the former is placed a meter registering at 3d., and in the latter a meter registering at 6d., an ingeniously arranged switch being provided whereby the consumer can only get the cheap supply for the motor when he does not use the light; but if he wants to use the light at the same time as the motor, both supplies pass through the 6d. meter. This enables the consumer to get cheap electricity during the day, and is an advantage to the supply company, because tending to fill out the load diagram during the hours of light load. How far this object is attained depends on the relative importance of the two circuits. If the lighting circuit is of so much importance to the consumer that he must use it when he works his motor, then the supply company is certain to get 6d. per unit supplied to the consumer during the hours of heavy load; but suppose that the power circuit is of far more importance to the consumer than the lighting circuit, and that he can manage to do without the light at any time that he wants to use the motor, then the company has to supply energy at 3d., even during the hours of heaviest load, and this is, of course, very undesirable. What the company wants is not an increase of load in the evening, but a moderate and steady load all day long.

This object may be, but is not necessarily, attained by the St. Pancras system of metering, and it is only incidentally, if at all, attained by any of the previously mentioned methods of charging. It is incidentally attained when a discount is made to large consumers, because a large number of units cannot be supplied unless the time during which the supply is taken extends beyond the few hours during which the load diagram is highest; but there is no inducement to a consumer to take his heavy supply rather in the day than in the evening. Take the case of a manufacturer who uses light and power. If he knows that during daylight hours he gets his power for 3d. a unit, and that in the evening he is charged 6d., he will naturally so arrange his work that the heaviest jobs are done in the day and the light jobs or no work at all are done in the evening. But if he is charged equally in the day and evening, he will not trouble to organise his work in any other way than that which suits his own convenience, and thus his motor will increase the load at the station at the very time when the maximum number of lights in the district is in use. The discount system, therefore, whilst tending to increase the total business done by the company, also tends to heighten the peak of the load diagram, and this is undesirable. The same reasoning applies to the sliding scale, which is only a modified form of discount, and both labour under the disadvantages pointed out by Mr. A. B. Holmes.

In my opinion, the only way of charging which is attractive to the consumer and, at the same time, profitable to the supply company, is by supplying at a cheap rate in the daytime and at full rate in the evening. Whether the consumer uses the current for cooking, heating, lighting, or any other purpose does not concern the company. All that the company cares about is that he should use a good deal of current during the daytime and not too much in the evening, because in this way the load diagram will be filled out without its peak being raised. Thus, the company can do a larger amount of business without having to instal additional machinery; there is no need for complicated accounts which the consumer does not understand; he need not instal special circuits for the different supplies, and no switching over from one circuit to the other is required; and last, but not least, he requires but one meter, on which he can see at any time what amount he owes to the company in precisely the same manner as he has been accustomed to do with the gas meter.

As regards the apparatus required for effecting such a method of charging for the supply, there need be no great difficulty. It may be done in various ways, of which the simplest, perhaps, is a clock, which at predetermined hours throws a mercury switch in and out, thus shunting part of the current round the meter during the time that the cheap supply is given, or the clock may be arranged to periodically alter the speed ratio of the registering mechanism.—Yours, &c.,

GISBERT KAPP.

31, Parliament-street, Westminister,
December 10, 1892.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The interesting letter of Mr. Bromley Holmes in your last issue shows very clearly the disadvantages of basing a sliding scale of charges upon the maximum demanded supply when this is taken to mean simultaneous supply to all the lamps, &c., fitted on the consumer's premises, and it does not appear that the use of a maximum current indicator in connection with each consumer's meter, as suggested by Professor Kennedy, would quite meet all the difficulties.

We may suppose that, by using the heating effect of the current to operate the indicator, or by the use of a dash-pot, the indicator movement might be made so slow as to prevent the record from being seriously affected by a momentary increase in the current, such as would be required to blow a fuse. Otherwise an accidental short-circuit might considerably increase the price per unit for that unfortunate consumer for a whole quarter, and thus lead to undue friction with, if not to sparking at, the collector. It may be said, however, that the ultimate effect would be desirable, inasmuch as it would tend to the more general adoption of such arrangements as would almost abolish the chances of accidental short-circuits on any but the smallest branches, *i.e.*, at the lampholders, &c.

We may further suppose the indicator would be re-set at the proper time only, and after its reading had been duly recorded by a trustworthy inspector. Even then this system of charging, although it is sufficiently complicated to be troublesome in actual work, does not always tend to produce the effect required alike in the interests of the supply company and of its consumers, viz., a large load factor.

For instance, churches requiring supply on Sundays only would have to pay the highest rate, but it would be to the interest of the supply company that the rate should be reduced on Sundays in order to develop demand when a large part of the plant would remain idle if the higher price prevailed.

Similarly, during the two summer quarters business places and many other customers would have to pay the higher rate. The demand would thus be repressed in the summer time, when in the interests of the supply company it should be developed by reducing the charge. Shop windows would probably be kept alight if supplied at a lower rate after business hours, and motors would be more extensively used for intermittent work and purposes requiring supply for only one or two hours daily, if the supply were charged at a low rate, always excepting during the time of heaviest demand for lighting purposes. This would frequently result in arrangements being made to avoid taking supply just at this time, thus increasing the load factor.

From the concluding clause of Mr. Holmes' letter it might be supposed that in matters which affect the system of charging there is no essential difference between the supply of gas or water and the supply of electricity. It may, therefore, be well to refer to the differences. For convenience let that part of the total annual cost which is made up of interest on capital, depreciation, and such other expenses as vary very little with the duration of the demand, be called the fixed expenses.

In the supply of gas and water, owing to the cheapness of storage and the large variation which is allowable in the pressure at the consumers' terminals, a comparatively small increase in the fixed expenses enables the produce of the machinery to be delivered to consumers when required at about ten times the rate at which it is produced at the works.

In the case of electricity, owing to the lack of any efficient means of modifying the pressure, such as would be equivalent

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to the reducing valve commonly used with branch gas pipes and burners, it is necessary to maintain the pressure within very narrow limits at the consumers' terminals. For reasons well understood the fixed expenses are proportional, not to the greatest consumption during a period of, say, two days, as in the cases of gas and water, but to the maximum rate of supply provided for, although this rate may be demanded for less than one hour in the year.

Consequently the problem of charges for supply is essentially more complicated in the case of electricity than in the cases of gas and water; and the central stations which are able to vary their rates of charge in such a way that their customers reap the benefit of fitting in their demands to produce a large load factor will, other things being equal, pay better dividends, and develop a larger and more varied demand than the stations with a fixed scale of charges.—Yours, &c., W. B. Sisling.

THE DISCUSSIONS AT THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I wish to protest, through the medium of your columns, against the gross encroachment made on the valuable time of the Institution of Electrical Engineers by some of its members speaking on subjects which are totally foreign to the Paper under discussion. At the last meeting of the Institution Mr. Crompton spoke for nearly a quarter of an hour on his own capabilities, and the advantage of the direct-current system, both, doubtlessly, subjects of intense interest to anyone who had never heard Mr. Crompton's views before; but I do think, Sir, you will agree with me that, when so able a Paper as Dr. Fleming's is being discussed, the above behaviour should not be tolerated.—Yours, &c.

J. Leslie Fuller.

THE REGENT STREET FIRE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Heaphy, in his letter of the 6th inst. in your last issue, has taken an exaggerated and erroneous view of my letter to you of November 28th. I made the remarks on what I believed to be reliable authority, but, as I am not permitted to publish the names of my informants, who, however, I may add, are not connected with Insurance Companies, I am bound to withdraw the remarks and express regret for publishing them.—Yours, &c., J. D. F. Andrews.

London, Dec. 13, 1892.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

Tenders Invited.—The date for the receipt of tenders invited by the municipal authorities of Brescia, Italy, for the electric lighting of the town has been extended to January 31st.

——— The civil authorities of Turn-Leverin, Roumania, are inviting tenders until January 10, 1893, for the electric lighting of the town.

Tenders Accepted.—The tender of Messrs. King, Mendham and Co. has been accepted for the erection of the electric signals in connection with the Clifton Rocks Railway. The arrangements to be made include means for signalling, from the lower end to the top of the line, the number of passengers to be carried up the railway each journey, replying and starting signals, and telephones.

——— The tender of Messrs. Crompton and Co. (Limited) has been accepted for the lighting of the two Courts at the Shire Hall, Chelmsford, by the incandescent light.

——— At the last meeting of the Electric Lighting Committee of the Whitehaven Town Trust, it was decided to accept the tenders of the Locca Engineering Company for setting new boilers at the Whitehaven Central Station for £700, and the tender of Messrs. Higginbottom and Mannock was accepted for the supply and erection of an overhead travelling crane at West Strand, at £138. The Chairman explained that the crane was invented by Dr. Hopkinson.

Tenders Received.—The following is a complete list of the tenders received by the Wolverhampton Town Council for the electric lighting of the borough, the tender marked * being recommended for acceptance. The first eight tenders were for supplying the complete plant.

	£	s.	d.
Messrs. Siemens Brothers (Limited), scheme 1	27,105	5	0
Messrs. Siemens Brothers (Limited), scheme 2	29,345	5	0
Electric Construction Corporation (Limited), scheme 1	*28,614	10	0
Electric Construction Corporation (Limited), scheme 2	30,525	0	0
Messrs. Crompton and Co. (Limited), scheme 1	28,628	10	0
Messrs. Crompton and Co. (Limited), scheme 2	31,559	0	0
Brush Electrical Engineering Company (Limited)	31,229	10	0
Messrs. Mather and Platt (Limited)	42,671	10	0
Messrs. C. A. Parsons and Co., boilers, condensers, engines, dynamos, switchboards, and mains	21,563	0	0
Messrs. J. G. Statter and Co., boilers, engines, dynamos, switchboards, arcs, and transformers	18,387	4	0
Messrs. Woodhouse and Rawson United (Limited), boilers, engines, and dynamos	16,610	0	0
Callender's Bitumen, &c., Co. (Limited), scheme 1, mains	8,512	0	0
Callender's Bitumen, &c., Co. (Limited), scheme 2, mains	9,438	0	0
British Insulated Wire Company (Limited), scheme 2, mains	8,671	0	0
Messrs. Thompson, boilers	3,650	0	0
Messrs. Babcock and Wilcox (Limited), boilers	3,780	0	0
Messrs. Johnson and Phillips, arcs	2,014	17	6
Messrs. Reid Bros., arcs	2,240	0	0
Munro Manufacturing Company (Limited), switchboards	1,560	19	6

Plant for Sale.—Messrs. Wheatley Kirk, Price and Goulty have for sale three loco-multitubular steam boilers. Further particulars are given in our advertisement columns.

Sale by Auction.—Messrs. Garrod Turner and Son will sell by auction at 31, Carr-street, Ipswich, on Monday, 19th inst., at 12 o'clock, the electric light plant of the Ipswich Electricity Supply Company.

Partnership.—Mr. Joseph Kincaid, M.I.C.E., is about to enter into partnership with Messrs. Waller and Manville, and from January 1st business will be carried on under the style of Kincaid, Waller, and Manville, at 11, Great George-street, S.W.

Partnership Dissolved.—Messrs. E. Bohm and Co., carrying on business in Little Britain, E.C., as glass blowers and electrical engineers, have dissolved partnership.

Poole and White (Limited).—The first meeting of the creditors of this Company (in liquidation) is to be held on December 22nd, at 11:30, at the Inns of Court Hotel, Lincoln's Inn-fields, and a meeting of contributories is to be held on the same date at 12:30, at 33, Carey-street.

W. T. Henley's Electric Light and Power Company (Ltd.).—A meeting of this Company (in liquidation) will be held at Messrs. Ball, Baker and Co.'s, 1, Gresham-buildings, Basinghall-street, E.C., on January 16th, at two p.m., to receive an account of the winding up.

The Edison-Swan Company.—To meet the requirements of the provincial trade and shippers, it has been decided by the Edison-Swan Electric Light Company (Limited) to open branch depôts in the provinces, to be in charge of superintendents appointed by the Company. The advantage which the Company offers to the trade by this arrangement is that after January 1st next Ediswan specialities can be obtained, carriage paid, at the Company's depôts. Depôts are to be opened in Glasgow, at 153, West George-street; Dundee, 19, Castle-street; Leeds, 127, Albion-street; Hull, Carr-lane; Cardiff, 111, Bute Docks; and at Birmingham, Liverpool, and Newcastle. The positions selected for these depôts are central. As our readers are aware, no installation work is, or will be, undertaken by the Company.

Omnibus Lighting.—With reference to the lighting of the London General Omnibus Company's vehicles alluded to last week, it appears that about 70 omnibuses have already been fitted with the Bristol Electric Safety Lamp, and 140 additional are expected to be completed by the end of the year. The battery is charged from a small station fitted up near the terminus at Victoria, S.W., the current being taken from the Westminster Company's mains. The battery weighs about 8lb., and is placed in a wooden box under one of the seats. The box is provided with two brass spring terminals, which make automatic contact with the cells when they are placed in position. The lamp is of special manufacture, and is placed in the centre of the roof horizontally, thereby giving a maximum of light, and avoiding risk of breakage.

Electrical Company (Limited).—This Company are issuing a new catalogue of electrical fittings, &c., containing a number of new and original designs, some of which are of special excellence. A large choice is offered in electroliers, brackets, suspension lights, vestibule lamps, and lamps for office and general domestic purposes. The list also includes samples of a variety of glass shades.

Mr. Ronald A. Scott.—On Monday the 5th inst., Sir Augustus Harris placed an order with this firm to supply and fix a 30,000-c.p.

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projector on the roof of the Palace Theatre, to be in working order at seven o'clock in the evening of the 9th inst. Over 200ft. of cable had to be fixed under awkward circumstances. The installation, however, was complete and the light running by the time specified.

RAPID TELEGRAPHING.—The *New York Daily Recorder* of the 8th inst. describes a smart piece of telegraphic work over the lines of the Direct United States Cable Company. An ordinary business inquiry was handed in at the New York Office by the United Press to the Central Press, London, and in 10½ minutes a reply was handed in to the General Manager of the United Press in New York. Quicker work has been done, not only by the Direct Company, but by other cable companies; but on this occasion no extraordinary effort was made, and the message was of an ordinary business character.

CHISWICK.—The clerk to the Local Board has communicated with the Board of Trade in reference to the arrangements with Messrs. Bourne and Grant for the electric lighting of Chiswick. It is stated that it will be necessary to advertise again, and the further consideration of the matter has, therefore, been adjourned by the Local Board for a month.

DOVER.—The agreement with the Brush Electrical Engineering Company has now been finally agreed to, and the Mayor at the last meeting stated that the Company had given a satisfactory undertaking as to proceeding with the work.

DUBLIN.—At the last meeting of the Corporation, Alderman Pile moved the adoption of the electric lighting estimate for 1893, at the sum of £10,180. 3s. He said it was unnecessary to make any provision out of the rates for this expense, as it was more than balanced by the estimated income and savings, the credit being £12,745, leaving a balance of £2,565. Mr. Mayne stated that, practically, the streets were lighted by the electric light for nothing, and the Lighting Committee were not disposed to stop with the 80 lamps at present in use, because the plant now at the central station would allow of an extension of the number of lamps. By a singular coincidence, immediately after the discussion upon the electric lighting scheme, the light went out, leaving the Council Chamber in darkness. It subsequently transpired that the transformer cellar had been entered by means of a false key and the connections severed. It is singular that similar extinctions of the light have previously occurred in different parts of Ireland. We remember a case at Carlow, when it was freely declared that the light had been tampered with; and it will be remembered that the light also suddenly went out in the Dublin Mansion House a short time back.

DUNDEE.—It has been decided by the Dundee Police Commissioners to remit the question of the lighting of the public clocks and of the central police office by electricity to a sub-committee for consideration.

EAST MOLESEY.—The Electric Lighting Committee have decided against Mr. Everett's proposed scheme of electric lighting, but they are willing to see the electric light adopted if found practicable, and are desirous of receiving other proposals on the subject.

ECCLES.—At a special meeting of the Town Council on Monday it was resolved "that application be made to the Board of Trade for a Provisional Order authorising the Council to purchase land, to construct works, and to produce, store, and sell electricity for lighting, motive, and other purposes."

EDINBURGH.—At the meeting of the Town Council on Tuesday a deputation of seven members was appointed to visit other towns, and to obtain information on the subject of electric lighting.

FALMOUTH.—The Town Council have under consideration the adoption of the electric light, and are making inquiries as to the cost.

GLASGOW.—It having been reported that a hitch had occurred in the electric lighting scheme for Glasgow, and that the original programme was likely to be departed from, Mr. W. Arnot, of the Corporation's gas and electric lighting department, writes to say that there is no truth in such rumours, but that the work is being carried out in accordance with the original plan.

HOLBORN, LONDON.—The Board of Works have agreed to a sum of £650 being expended in installing the electric light in the Holborn Town Hall.

LEYTON.—At the last meeting of the Local Board Messrs. Lorini and Bowman (Limited) stated that they had been requested to form a Company for lighting a portion of the main road of Leytonstone by electricity, and they wished to know if the Local Board would allow them any concession of the mains, and also they wished to know if they would take into consideration the advisability of lighting the remainder of the high road. Ultimately a motion to the effect that the Local Board make application to the Board of Trade to supply electric lighting to the district was carried.

NORTHAMPTON.—The increase in the demand for the electric light in this town has necessitated the laying down of additional plant, and the local company are issuing 5,000 Six per Cent. Cumulative Preference Shares of £1 each on easy terms, to enable them to purchase this plant in the best market. The consumption at the present time is 2¼ times what it was a year ago.

NOTTINGHAM.—In his report, which has now been adopted, to the Town Council on the electric lighting of the town, the engineer, Mr. H. Talbot, advises that the buildings at the generating station should be at first designed to contain sufficient plant for 13,000 8-c.p. lamps, but that plant should at first be only put down for 10,000 lamps. Boilers should be provided capable of supplying power for 20,000 lamps, and the types recommended are Galloway or Lancashire, with a feed water heater. With regard to engines, Mr. Talbot speaks highly of the Willans central valve engines, and the open type vertical engines made by Messrs. Davey, Paxman and Co., and Messrs. G. E. Belliss and Co. He advises that the dynamos should be tendered for by the best known makers, and that in the specification there should be clauses:—(1) Asking the contractor to state the amount of water he will guarantee shall not be exceeded per electrical horse power at dynamo terminals per hour. (2) The dynamos to be subject to an eight hours' continuous run at full load at the contractor's works in the presence of the Corporation's electrical engineer. (3) At the end of the run the selected dynamos to pass the Admiralty specification as regards heating, &c. Reference is made in the "Notes" to the discussion upon this and the Lighting Committee's report, which took place on Monday last.

REDRUTH.—The application of Messrs. Mitchell, Tangye and Tweedie for permission to light Redruth with electricity was approved by the Local Board at the last meeting.

SCARBOROUGH.—We are informed that the capital of the Scarborough Electric Supply Company (Limited), recently issued, has been allotted, and that work will commence at once. It is anticipated that the electric light will be supplied by June next. The alternate-current system has been adopted, with 1,000 volts pressure on the high-tension mains. Mr. A. A. Campbell-Swinton has been appointed the managing director of the Company.

SHEFFIELD.—The Highway and Sewerage Committee of the Town Council have given the usual notice that they intend to lay underground mains in certain streets of the town.

SUNDERLAND.—The Electric Lighting Committee have decided to recommend the Corporation to call in an expert to advise them as to the best course to pursue in reference to the electric lighting of the Borough, and as to the probable cost. In the meantime, the Borough Engineer has instructions to make all inquiries as to the probable demand for the light.

YORK.—The temporary arrangements for lighting the Law Courts at York have been completed, and have proved very satisfactory. The installation includes a Crossley gas engine and Crompton dynamo, and the electric lighting work has been carried on by Messrs. Benham and Sons (Limited), of London, under the supervision of Mr. W. Smith, that company's electrician.

PATENT RECORD.

The following list of applications for patents and specifications has been compiled for this journal by MR. J. C. CHAPMAN, *patent and registration agent, Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any available information may be obtained.*

APPLICATIONS FOR PATENTS

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

November 15, 1892.

20,606. C. A. DAY. London. Improvements in electric are lamps. (The Higham Electric Company, United States.)

20,610. G. L. ANDERS and W. KOTTGEN. London. Improvements in telephone circuits.

20,611. B. J. B. MILLS. London. Improvements in governing electric motors. (R. Lundell, United States.)

20,621. H. T. WILSON and N. SCHWAB. Manchester. Improvements in electric burglar alarms.

20,641. G. MURRAY. London. The carriage electric light apparatus.

20,665. P. RABBIDGE. London. An improved electro-magnetic alarm or call.

20,670. Sir C. S. FORBES, Bart. London. Improvements in the arrangement of telephone circuits and switching devices therefor.

20,693. F. HANSEN. London. Improvements in electric arc lamp.

20,698. H. H. BOYLE. London. An improved electric arc lamp.

20,700. D. JONES. London. Improved means for lighting trains by electricity.

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November 16, 1892.

20,729. J. A Kingdon and Woodhouse and Rawson United, Limited. London. Improvements in dynamo-electric machines.

20,789. J. G. Lorrain. London. A method of and apparatus for transmitting vocal and other sounds electrically. (C. Clamond, France.)

20,792. W. W. Horn. London. An improved watchman's electric time recorder. (E. R. Heyser, United States.)

November 17, 1892.

20,854. R. Pollitz. London. Improvements in telephone transmitters.

20,894. H. Wetzer. London. Improvements in and relating to telegraphic or telephonic call systems.

20,900. E. Bailey and J. Dunham-Massey. London. An improved process of manufacturing and depositing spongy lead for secondary or storage batteries or receivers.

20,901. E. Bailey and J. Dunham-Massey. London. Improvements relating to the electric lighting of railway carriages and other vehicles.

November 18, 1892.

20,912. R. J. Urquhart. London. Improvements in or connected with telephone apparatus.

20,959. F. W. Suter and S. J. Suter. London. An improved electric arc lamp.

20,964. W. S. Smith and W. P. Granville. London. Improvements in electrical relays and apparatus for telegraphing to lighthouses either floating or on rocks at a distance from the shore or for telegraphing to and from vessels.

20,989. A. W. Upcraft. London. The detachable electric light bracket.

November 19, 1892.

21,020. E. Ward. Southampton. An electric-governed night latch.

21,041. J. A. Kingdon. London. Improvements in and connected with electromotors and in their application to electric tramcars and locomotives.

21,074. F. C. James. London. Improvements in galvanic batteries.

21,033. J. E. Kingsbury. London. Means for measuring or comparing sounds produced with telephones by the transmission of electric currents over a circuit. (The Western Electric Company, United States.)

November 21, 1892.

21,136. J. Taylor. London. Improvements in shade carriers for electric light pillars and brackets.

21,147. C. R. Garrard and T. W. Blumfield. London. Improvements in and relating to electric vehicles for use on roads.

21,167. J. Dulait. London. Improvements in regulating apparatus for electric arc lamps.

November 22, 1892.

21,193. G. E. Cassel and F. A. Kjellin. London. An improved method of producing zinc from blende by means of electrolysis.

21,243. F. W. Webb and A. M. Thompson. Crewe. Improved method of forming junctions between electric light cables and electric lamps.

21,268. S. Porter and J. R. White. London. Improvements relating to suspension devices, chiefly designed for electric incandescent lamps.

21,273. M. V. B. Ethridge. London. Improvements in and relating to electric clocks.

November 23, 1892.

21,292. A. McMeekin and J. Logan. Antrim. An electric alarm for gill drawing frames as used for flax and other fibres.

21,339. R. H. Kettle and C. Graham. Barnes. Improvements in electrical indicators and connections therewith.

21,348. W. Wright and J. B. Hamond. London. Improvements in the treatment of zinc produced by electrolysis.

21,372. B. A. J. Espeut (widow and executrix of the late W. B. Espeut). London. Improvements in insulators for electric telegraph wires and other electric conductors.

21,376. H. Edmunds. London. Improvements in electric resistances.

21,377. H. Edmunds. London. Improvements in electrical conductors.

November 24, 1892.

21,435. J. Ferrier and J. W. Ferrier. London. An electric automatic repeater cut-out.

November 25, 1892.

21,480. G. L. Anders and W. Kottgen. London. Improvements in the means or apparatus for measuring electricity.

21,506. H. A. Fergusson. Glasgow. Improvements in electrical governors for marine engines.

21,530. J. Atack. Blackburn. Automatic electrical signalling on locomotive engines.

21,533. G. C. Fricker. London. Improvements in apparatus for measuring electric potentials and quantities.

21,554. R. E. Disher, R. H. C. Hall and C. Crockford. London. Improved manufacture of battery plates and employment of ingredients therefor.

November 26, 1892.

21,602. W. H. Scott. Norwich. Operating electric meters from a central position in such a way that charge for the current can be varied according to the time of day.

21,613. A. Groper. Liverpool. Improvements in telephonic transmitters.

21,621. D. von Mito. London. Improvements in and in the manufacture of incandesceent lamps.

November 28, 1892.

21,693. P. Feys and J. Lorwa. London. An improved electrical meter and recorder.

21,696. T. L. Willson. London. Improvements in electric smelting of aluminous and other refractory ores or compounds.

21,701. T. L. Willson. London. Improvements in the reduction or treatment of refractory metallic compounds by electric smelting.

November 29, 1892.

21,750. A. D. Neal and H. F. Eaton. London. Improvements in means or apparatus for use in type-writing, or type-writing inter-communication with the aid of electricity.

21,782. Siemens Bros. and Co. (Limited) and J. Nebel. London. Improvements in electrical resistances.

21,794. E. Andreoli. London. Improvements in the manufacture of electrodes for ozonisers.

21,803. C. E. L. Brown. London. Improvements in electric transformers.

21,811. C. E. L. Brown. London. Improvements in multi-phase alternating current motors without separate excitation.

21,830. C. W. Atkinson and The Electrical Coal Cutting Contract Corporation, Limited. London. Improvements in apparatus connected with flexible electric conductors and in electrical connections therefor applicable for use in mines.

November 30, 1892.

21,874. H. L. T. Lyon. London. Improvements in electric light and other pendants.

21,906. A. Liedcke and P. Jacobi. London. An electric alarm of danger from fire and water.

21,919. C. Olivetti. London. Improvements in the method of making electrical connections and the disposition of circuits carrying induced currents.

December 1, 1892.

21,951. W. Allen. Salop. Improvements in the manufacture of porous earthenware pottery articles for electrolytic purposes.

22,034. G. Binswanger. London. Improvements in and in connection with electricity meters.

22,035. G. Binswanger. London. Improvements in electrical switches and other fittings.

22,038. J. Cathrein. London. Improvements in and relating to stands for incandescent lamps.

December 2, 1892.

22,085. J. Perry. London. A varying price electric supply meter.

22,087. J. A. Colquhon. Glasgow. Electrical variable resistance apparatus.

December 3, 1892.

22,129. C. J. Wharton. London. An improvement in electric switches for currents of high potential.

22,131. F. W. W. Goodall and H. E. Wright. London. An insulating material for covering electric and telephone wires, bicycle tyres, and carriage wheels.

22,164. G. H. Nisbett. London. Improvements in or relating to electric switches for high tension currents.

22,187. R. Belfield. London. Improvements in lightning arresters. (The Westinghouse Electric and Manufacturing Company, United States.)

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

17,042. MacHaffie. Dynamo-electric machines.
19,134. Teague. Electric meters.
19,972. Mayer. Telephone circuits.
19,975. Maquaire. Electric arc lamps.
19,996. Nicholls. Electric alarum clocks.
21,668. Marr. Electric switches.
22,184. Rettig. Telephones and microphones.
22,339. Wladimiroff. Secondary batteries.
22,582. Sanders. Electroliers, &c.
22,837. Bigland Burns. Electric arc lamps.
22,852. Teague. Electric meters.

1892.

372. Benardos. Soldering, &c., metal by electricity.
475. Swinburne. Electric testing apparatus.
499. Newton and Hawkins. Current transformer.
1,641. Siemens. Electro motors.
10,303. Carstarphen. Electrical reciprocating tools.
13,989. Gibboney and Thompson. Telephony.
14,217. Palmer and Desisle. Electric heat alarm.
16,822. Craney. Electrolytic apparatus.
17,223. Thompson (Coffin). Welding metals electrically.
17,225. Thompson (Coffin). Electrically welding metals.
17,563. Wynne. Electric lamp jointing.
17,647. Foster. Galvanic curative appliances.
17,743. De Pass (Bardon). Arc electric lamps.
17,774. Cowan and Fawcus. Dynamo-electric machines.
18,077. Paiste. Electric switches.
18,142. Booth. Electric railways.

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COMPANIES' MEETINGS & REPORTS.

Electric Construction Corporation (Limited).

The following report of the Directors of this Company is to be submitted to the shareholders at the ordinary general meeting, to be held at Cannon-street Hotel, E C., this day (Friday), at 12 o'clock :—

Notwithstanding many unexpected difficulties which were encountered during the last twelve months, the result of the year's working shows a satisfactory balance to the credit of profit and loss account. The profit for the year is £46,693. 11s. 7d., after deducting the expenditure on plant, machinery, and patents, paying the interest on debentures and other loans, and placing a sum of £10,000 to a reserve for bad and doubtful debts. Including the balance of £10,721. 19s. 4d. from last year, there is a surplus to be dealt with of 57,415. 10s. 11d.

The amount of work executed during the last twelve months compares favourably with that of previous years. The contracts with the Liverpool Overhead Railway Company (Limited), and the South Staffordshire Tramways Company, have been nearly completed. The Liverpool overhead line is expected to be in full working order by the end of the year, and the Staffordshire Electric Tramway has already been passed by the Inspector of the Board of Trade, who has expressed himself thoroughly satisfied with the system employed and the work done by this Corporation. A very successful system has been carried out for lighting the City of Oxford, and the Directors have every reason to believe that these important works will serve to bring large additional contracts to the Corporation.

During the past year valuable experiments have been carried out at the laboratory of the Corporation at Bushbury, in connection with the present methods of producing zinc, chlorine, and alkalies. Mr. Parker cousiders the results which have been obtained highly encouraging, and a company has been formed for the purpose of commencing the manufacture on a commercial scale and to demonstrate the value of the patents.

Of the Preference Shares offered for subscription, 2,926 shares were taken up. The capital thus provided has not been sufficient for the purposes of the Corporation. With a view, therefore, to improve its general financial position, the Directors have consulted the Electric and General Investment Company (Limited). That Company has obtained a special report from the auditors, Messrs. Broads, Paterson, and Co., and has also caused an examination to be made of the works and plant at Wolverhampton by Messrs. Wheatley Kirk, Price, and Goulty, who have reported generally on the manufacturing business of the Corporation. As a result of obtaining these reports, and of their own investigation of the affairs of the Corporation, the Electric and General Investment Company (Limited) has agreed to issue £100,000 additional capital for the further development of the business, and has guaranteed that the subscriptions shall not be less than one-half of the issue ; such additional capital to be raised by the issue at par of Second Mortgage Debentures of £10 each, bearing interest at 6 per cent. per annum, and redeemable, at par, by half-yearly drawings over a period of about 15 years, and entitling the holder, by way of bonus, to an income bond of like amount, carrying interest as from the date of the redemption of the corresponding debenture at a rate for each year equal to the dividend declared on the ordinary shares for the preceding year. In order to secure for the shareholders the full benefit of this arrangement the Directors have stipulated with the Electric and General Investment Company (Limited) that the whole of the debentures shall be allotted to the shareholders in proportion to their respective holdings. All allotments not taken up by the shareholders or their nominees on or before the 19th inst. will be cancelled.

In accordance with the understanding arrived at with the Electric and General Investment Company (Limited), the Directors do not propose that any dividend be paid upon the ordinary shares for the past year, but they recommend that a dividend at the rate of 7 per cent. per annum be paid on the preference shares up to September 30th last ; that £30,000 be placed to a suspense account, and that the balance of £26,862. 1s. 5d. be carried forward.

Several retirements from the Board have taken place during the year, and as arranged with the Electric and General Investment Company (Limited), the Right Hon. David Plunket, Q.C., M.P., 12, Mandeville-place, W., and Mr. James W. Barclay, 5, Clarendon-place, Hyde Park, W., have been elected Directors, and will take their seats after the general meeting. The Directors who retire by rotation are Mr. James Pender and Mr. John B. Verity, who offer themselves for re-election. Messrs. Broads, Paterson and Co., the auditors, retire, but offer themselves for re-election.

The Directors are determined during the ensuing year to give their special attention to effecting economies in the expenses of administration, and they rely upon the next account showing material retrenchments in this respect, and that no occasions will arise for the exceptional expenditure shown in the accounts of the past year. They are confident also that the additional capital proposed to be raised for the purpose of developing the manufacturing business will be the means of largely increasing the net profits.

Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited).

The following is the Directors' report to be presented at the annual meeting to be held at the Cannon-street Hotel on December 23rd, at 2 p.m. :—

The Directors have pleasure in submitting the balance-sheet and profit and loss account for the financial year of the Company ending December 31st last, showing a balance at that date of £132,203.

The year in question has been one of establishment and development of the French and German Elmore factories, which were started in the latter part of 1890 under the auspices of this Company, and the Directors are glad to be able to say that the Company working in France has now thoroughly proved the process on a large scale. The German Company, although they have had their difficulties, are now also making good progress, and will in the near future certainly make a success of their business. The Elmore manufactures are now admitted to be superior to anything else of the kind in competition with them, and this fact is being recognised by the highest authorities and the most exacting customers.

The recent report issued by the Directors of the French Company, in which this Company holds a very large interest, shows the comparatively low price of manufacture, whilst the steadily increasing output, and the fact that that Company is supplying a great number of consumers without any complaints from them, in several cases having received over 20 repeat orders, is the best proof of the success of the process on a large scale, and of the uniform quality of the products.

The Directors cannot at this time recommend the payment of a dividend, but they hope to be able, in the course of 1893, to make a distribution to the priority shareholders, leaving a handsome amount in hand for distribution among the founders. At the present moment, taking the Company's assets at par value, and after setting aside £5 per share and a fourth of the balance for the priority shares, or an extra £2. 15s. per share, there remains an amount equal to £13 per share for the founders.

The Company still hold a large number of patents for working the Elmore process in various foreign countries, the most important being Belgium, Italy, South America, India and the Colonies, and negotiations are on foot for the sale of some of the more valuable of these.

In accordance with the Articles of Association, one-third of the present Board of Directors retire from office. Upon this occasion Mr. F. L. Rawson retires, and being eligible, offers himself for re-election. Messrs. Jackson, Pixley, Browning, Husey and Co. offer themselves for re-election as auditors of the Company.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322, *&c., &c.*]

ANDERSON, LAVERICK AND CO. (LIMITED).—This Company was registered on the 8th inst., with a capital of £10,000 in £5 shares, to acquire, take over as a going concern, and carry on the business of shipbuilders and repairers, iron and brass founders, mechanical and electrical engineers, toolmakers, metal workers, &c., carried on by Douglas M. Anderson and Stanley D. Laverick, at the Mushroom Slipway, St. Lawrence, Newcastle-upon-Tyne.

BLAIBERG AND MARSON (LIMITED).—This Company was registered on the 12th inst., with a capital of £25,000 in £10 shares, to acquire and take over as a going concern and carry on the business of engineers carried on by Joseph Blaiberg and Joseph Marson, at the Bute Works, Oozells-street, Birmingham, and to carry on the business of mechanical, electrical and general engineers, and designers, constructors and manufacturers of engineering and other machinery, screwing tackle, screwing machines, stocks and dies, wrenches, tube vices, &c.

ENGINEERING AND GENERAL CONTRACT CORPORATION (LIMITED).—This Company was registered on the 10th inst. with a capital of £100,000, divided into 60,000 preference and 40,000 ordinary shares of £1 each, to acquire and take over as a going concern the business of the Hopcraft Furnace Company (Limited), and to carry on the business of manufacturers of and dealers in boilers, engines, furnaces, and machinery of every description, iron and brass founders, machine and engineering tool makers, brass finishers, metal workers, metallurgists, machinists, and electrical engineers.

M'ONIE, HARVEY AND CO. (LIMITED).—This Company has been registered in Edinburgh, with a capital of £35,000, in £10 shares, to carry out an agreement for the purchase from the firm of M'Onie, Harvey and Co., engineers and machinery makers, Glasgow, the whole estate, property, and business, and certain patents, and to carry on the business.

RAWDON FOUNDRY COMPANY (LIMITED).—This Company was registered on the 8th inst., with a capital of £2,000, in £10 shares, to carry on the business of mechanical and electrical engineers, machine and engineering tool makers, boiler makers, iron and brass founders, &c.

GENERAL ELECTRIC COMPANY (LIMITED).—The annual return of this Company made up to November 30th, has been filed. The Company was registered on July 25, 1889, with a capital of £60,000, divided into 7,000 first preference shares of £5 each, 1,000 second preference shares of £5 each, and 4,000 ordinary shares of £5 each. At the time of making up, 4,000 ordinary, 1,000 second preference, and 6,325 first preference shares have been taken up, of which the ordinary and second preference shares have been issued as fully paid. Upon the 6,325 first preference shares, the full amounts have been called, and all calls (£31,625) paid.

HOLLOWAY ELECTRICITY COMPANY (LIMITED).—The statutory return of this Company, made up to November 8th, has been filed. Out of a capital of £2,000 in £10 shares, only seven shares have been taken up ; no calls have been made. The original signatories to the Memorandum of Association are the only shareholders.

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JAMES SIMPSON AND SONS (LIMITED).—An agreement, dated October 10th, between John and Samuel Simpson, of Darlaston, Staffs (called the vendors) and the above-named Company, states that the Company thereby agrees to buy the business of bolt and nut manufacturers, mechanical and electrical engineers, &c., carried on by the vendors, for £24,942, to be satisfied by the allotment to the vendors of 1,000 fully paid shares of £10 each, and £14,942 by payment of debts of the vendors to that extent.

JULIUS SAX AND CO. (LIMITED).—An agreement, dated November 14th, between this Company of the one part and Alfred L. Sax and Charles W. Sax (called the vendors) of the other part, states that whereas, by a former agreement between the vendors and the Company, it was agreed that the vendors should sell to the Company the business carried on by them at Ridgmount-street, Smithfield Market, and elsewhere, in consideration for £19,930, the present agreement provides for the allotment of 2,000 shares of £10 each to the vendors in full satisfaction of their claim.

CITY NOTES, &c.

CALLS DUE.—*December 30th.* ISLINGTON AND GENERAL ELECTRIC SUPPLY (LIMITED), £1 (final) on 45,000 £5 shares.

CASSEL'S GOLD EXTRACTING COMPANY (LIMITED).—A meeting of the members of this Company was held in Glasgow on Wednesday, at which a dividend of 5 per cent. was declared, making 15 per cent. for the year.

CHILI TELEPHONE COMPANY (LIMITED)—The Stock Exchange Committee have ordered the additional shares Nos. 40,001 to 44,000 to be quoted in the Official List.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended December 11th were £932, as against £815 for the corresponding period of last year, being an increase of £117. The total receipts for half-year amount to £19,739, against £17,798 in the corresponding period of 1891, being an increase of £1,941.

CROMPTON ELECTRIC SUPPLY COMPANY OF AUSTRALIA (LIMITED)—The third annual meeting of the shareholders of this Company is to be held at the offices, Mansion House-buildings, E.C., on Monday next, at three o'clock. The meeting is called in conformity with the Articles of Association; but the data for the statement of accounts from the Company's offices in Sydney have not yet been received, and a resolution will be proposed to adjourn the meeting to await the arrival of these accounts. The statement will be made by the Australian Chairman of the Committee, who is now in London.

EASTERN TELEGRAPH COMPANY (LIMITED). — This Company announce the payment on January 13th next, of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum on the preference shares, for the quarter ending December 31st; and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits for the quarter ended September 30th. The transfer books will be closed from January 6th to 13th, both days inclusive. Application has been made to the Stock Exchange Committee to grant a quotation to a further issue of £94,100 Four per Cent. Mortgage Debenture Stock.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend for the quarter ended 30th September last of 2s. 6d. per share, free of income tax, payable on 16th January next. The share register will be closed from the 7th to the 14th January, both days inclusive. The coupon on this Company's Five per Cent. Australian Government Subsidy Debentures, due on the 1st January next, will be paid on and after the 2nd proximo, at Messrs. Barclay, Bevan and Co's. Bank, 54, Lombard-street, E.C. Coupons must be left three clear days for examination.

ELECTRIC CONSTRUCTION CORPORATION (LIMITED).—The Electric and General Investment Company (Limited) invite applications from existing shareholders, at par, for an issue of £100,000 Second Mortgage Debentures to bearer of the Electric Construction Corporation (Limited), bearing interest at the rate of 6 per cent. per annum; redeemable by half-yearly drawings, and entitling the subscriber of each debenture, by way of bonus, to an Income Bond of corresponding amount, payable: £1 on the 19th inst., £3 on January 16th next, £3 on March 15th, and £3 on May 15th. These debentures are to rank next after the existing First Mortgage Debentures of £150,000 as a charge upon the whole undertaking and property of the Corporation, present and future, and are secured by trust deed made between the Electric Construction Corporation (Limited) and the Electric and General Investment Company (Limited), the trustees. The debentures are redeemable at par by half-yearly drawings over a period of about 15 years. The Income Bond above referred to will carry interest from the date of redemption of the corresponding debenture, as regards each year, at a rate equal to the dividend declared on the ordinary shares for the preceding year, and will, in a winding-up, rank for payment next after the preference shares of the Corporation.

ELMORE'S PATENT COPPER DEPOSITING COMPANY (LIMITED).—Application has been made to the Stock Exchange Committee to grant a quotation to additional shares, Nos. 82,441 to 91,240.

FOWLER INSULATOR SYNDICATE (LIMITED).—A meeting of this Syndicate was held on Saturday last, at the offices, 5, Lime-street, E.C. The proceedings were private.

GEORGETOWN (DEMARARA) ELECTRIC LIGHTING COMPANY.— A meeting of this Company was held in September last, and the report and accounts of the Directors were duly approved by the shareholders. The *Georgetown Argus* of the 10th September contains an amusing digest of the Directors' report and accounts.

HOVE ELECTRIC LIGHTING COMPANY (LIMITED).—A prospectus has been issued this week inviting applications for 8,000 shares of £5 each in the above Company, of which amount the prospectus states that nearly 2,000 have been subscribed by the Directors and their friends.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The report of the Directors of this Company was given in our last issue, and at the meeting held on Tuesday last the dividend of £5 per cent. on the called-up capital of the Company was declared. Mr. Twyerould was elected Chairman of the Company in place of Mr. William Morgan.

PANAMA CANAL SCANDALS.—In the course of the inquiry being made in Paris on the alleged malversations by the Directorate of the Panama Canal Company, Dr. Cornelius Herz, who is well known in Paris in connection with telegraphs and telephones, and who is the director of *La Lumière Électrique*, has been charged with receiving large sums as bribes. These accusations Dr. Herz alleges are without foundation.

PANULCILLO COPPER COMPANY.—A general meeting of the shareholders of this Company was held on Tuesday last under the presidency of Sir John Pender, G.C.M.G., M.P. In the course of his remarks the Chairman stated that, notwithstanding the very disappointing character of the business of the past eighteen months, he had known the Company's affairs to be in a much worse state. He did not, therefore, despair of the Company's future, but believed that the period of deficit and depression was passing away. For his part, he had seen the Company pass through its various phases of success and ill-success, and, while he might have disposed of his large interest in the Company to great advantage, he intended to keep his holding, as he had every faith in the Company's future prospects. The future possessed several features likely to increase the business of the Panulcillo Company. He pointed to the enormous quantity of copper that was likely to be required in the development of the electric light and other applications of electricity. Lord Kelvin had, in the course of some remarks at a recent gathering of scientific men, asserted that he considered copper was the most valuable metal of the day. Taking into consideration the material progress of the world, he (Sir John) considered this a most important statement from so eminent a man as Lord Kelvin. Copper was more valuable than gold, inasmuch as electricians were so much engaged in the extension of the applications of electricity not only to lighting, but to all kinds of motion, that he looked to copper as being not only the most valuable, but the most useful, and in this opinion he felt he could endorse Lord Kelvin's remarks. He would speak of what had been done in the use of copper in connection with submarine and land line systems of telegraphy, and he was convinced that, with a greater disposition than ever to use copper wire rather than iron wire, the consumption of copper must very materially increase, and in this increase the Panulcillo Company must receive considerable access of business. As a proof of his confidence in the future of the Company he still remained by far the largest proprietor.

TELEPHONE AMALGAMATION.—In reference to the matter of the amalgamation of the New Telephone Company with the National Telephone Company, *The Stat·st* of the 10th inst. contains an article setting out the terms upon which this amalgamation is to be effected. The article deals with the question from a financial standpoint, and refers in particular to a feature in the arrangement for which due allowance will have to be made by intending subscribers, namely, the fact that the City of London Corporation may have something to say with regard to the laying of the telephone wires underground in the "ways" provided by the City of London Electric Lighting Company (Limited), who do not appear to have obtained the all-necessary consent of the City authorities before putting down these extra "ways." The terms upon which the amalgamation is to be effected are set out in the circular as follows:—

"THE NEW TELEPHONE COMPANY (LIMITED).

"58, London Wall, E.C., December 10, 1892.

"DEAR SIR: You are aware of the interest (apart from his position as Chairman) the late Duke of Marlborough took in this Company, and in the system which it was one of its principal objects to promote, and the Directors are sensible of the great loss the Company has sustained by his death, at a time when the Company had only just come before the public. For some time he, in conjunction with his colleagues, had been considering the desirability of more closely allying the interests of this Company with the National Company, and on what basis this could be effected, consistently with the due carrying out of the objects and policy of this Company; but his sudden death prevented his bringing the matter to a conclusion. A continuance of the negotiations has, however, resulted in an arrangement (which has been concurred in by some of the most influential shareholders in the New Company) whereby, on transferring their shares to the National Company, the shareholders in the New Company can receive in respect of every share held by them with £4 paid, either one ordinary share of the National Company of £5 fully paid, or the sum of £5 in cash, or, at their option, 23 fully-paid ordinary shares of £5 each of the National Company for every 10 fully-paid ordinary shares in this Company. Shareholders adopting the latter option must forthwith pay up the balance remaining uncalled on their shares. I am now instructed to inform you of this arrangement, and in case you desire to avail yourself of either of these options, to request you to return to me, on or before Friday, the 23rd instant, one or other of the enclosed forms, duly signed.

"Yours faithfully, W. C. GOULD, Secretary."

In some accounts of this amalgamation it is stated that a condition which the Directors of the New Telephone Company have insisted upon is that the National Company shall take over the introduction of the twin-wire system, for which the former Company was specially started. This is, of course, a mistake, as quite three years ago the National Company adopted the twin-wire system, and set to work gradually converting their London lines into twin-wire lines. At the present time a large pro-

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portion of the London Exchanges are worked on the twin-wire system. Between three and four thousand miles of these wires are already laid, and the system is being pushed forward as fast as circumstances will permit.

WOODHOUSE AND RAWSON UNITED (LIMITED).—We have been unable to obtain the report and balance-sheet issued by this Company for the year ended July 31st last; but we understand that the accounts show a loss of nearly £87,000, after taking credit for the balance brought forward from last year of £8,000 and taking £35,000 from the reserve fund.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Dec. 9, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,865.

WESTERN UNION TELEGRAPH COMPANY.—The official announcement of the usual quarterly dividend of 1¼ per cent. on stock was made on Wednesday. The earnings of the Company are about the same as for last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 7.	Price Wednesday, Dec. 14.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 14. Highest.	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	50 51	49½ 50¾	4 19 0	Jan., Apr., July, Oct.	50	49
£2,876,140	Stock	25/0	Do. Preferred	91 92	91 92	5 16 4	" "	92	91⅛
£2,876,140	Stock	5/0	Do. Deferred	11 11½	10¾ 11¼	.. " "	" "	11	..
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July	..	..
130,000	£10	4/0	Brazilian Submarine xd and bonus	10⅜ 11¼	10⅜ 11¼	5 15 7	Mar., June, Oct., Dec.	11⅛	10¼
£68,200	£100	5%	Do. 5 per Cent. Bonds	101 104	101 104	4 16 2	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	106 110	106 110	4 10 11	June and December	..	
$7,716,000	$100	$1¾	Commercial Cable Capital Stock	178 182	178 182	3 16 11	Jan., Apr., July, Oct.	182½	180⅝
16,000	10	8/0	Cuba Submarine	11½ 12½	11½ 12½	6 19 2	February and August	11¾	..
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	" "	17¾	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2½ 3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	
60,710	20	3/6	Direct United States	11½ 11½	11⅜ 11⅝	6 3 4	Jan., Apr., July, Oct.	11½	11⅛
400,000	10	2/6	Eastern	14¾ 15	14½ 14¾	4 8 2	" "	14⅛	14½
70,000	10	6%	Do. 6 per Cent. Preference	15¾ 16½	15¾ 16½	3 13 10	" "	16½	16
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109 112	109 112	3 11 5	May and November	111	109½
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	14¾ 15	14½ 14¾	4 14 11	Jan., Apr., July, Oct.	15	14¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104 107	107 110	4 10 11	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	104 107	104 107	4 13 6	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	109 112	3 11 5	February & August	..	..
180,227	10	1/9	Globe Telegraph and Trust	9¾ 10	9¾ 10	4 15 0	Jan., Apr., July, Oct.	9⅞	9¾
180,042	10	6%	Do. 6 per Cent. Preference	14⅞ 15½	14⅞ 15½	3 19 4	" "	15⅜	15
150,000	10	5/0	Great Northern	19¼ 19¾	19¼ 19¾	4 6 1	Jan., April, and July	..	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104 107	104 107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	43 45	44 45	5 11 1	May and November	45	..
38,348	10	4/0	London Platino-Brazilian	6 7	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	107 110	108 111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October	..	..
3,381	£100 Cert.	30.0	Submarine Cables Trust 8%	116 120	116 120	5 0 0	" "	119	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	..	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	103 107	104 108	7 8 2	June and December	..	..
88,321	10	6d.	West India and Panama	1¼ 1½	1¼ 1½	..	" "	1⅜	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10 10½	5 14 3	May and November	10⅜	10
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8 9	8 9	6 13 4	" "	..	..
64,242	15	3/0	Western and Brazilian	7 7½	7 7⅜	6 0 0	" "	7⅜	7⅛
33,129	7½	3.0	Do 5 per Cent. Cumulative Preferred	5½ 5¾	5½ 5¾	6 10 4	" "	5⅝	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¼ 2	1¼ 1¾	.. " "	" "	1⅜	1⅛
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106 109	106 109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106 109	106 109	5 10 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	121 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
224,850	14/0	1½d.	Consolidated Telephone Const. & Maintenance	⅝ ⅝	⅝ ⅝	7 16 5	May and November	⅝	..
220,000	£1	4⅜d.	Oriental (11s. paid)	1⅝ 1⅝	1⅝ 1⅝	7 18 2	Yearly	..	..
438,984	5	3/6	National	4⅞ 5⅛	4⅞ 5⅛	5 17 1	June and December	5 1/16	4 11/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½ 15½	14½ 15½	3 17 5	" "	14 11/16	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13⅜ 14½	13⅜ 14½	4 4 3	" "	14 11/16	..
£20,000	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112 114	112 114	3 18 11	January and July	113⅜	113
48,000	£10	..	New Telephone, Limited (£4 paid)	4⅝ 4⅝	4⅜ 5	..	..	4⅝	4½
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July	2 5/16	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	—	..	—
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	—	City of London Electric Lighting (fully paid)	10¼ 10¾	10¼ 10¾	..	—	10⅝	10 5/16
20,000	£10	..	Do. 6 per Cent. Preference	5 5½	5 5½	10 18 2	..	5½	5⅛
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	2½ 3½	2½ 3½	..	—	—	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5½	5 5½	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	5½ 5¾	5½ 5¾	..	January and July	..	..
30,000	£5	4½% '91	Liverpool Electric Supply (£3 10s. paid)	3 7/16 3 9/16	3 7/16 3 9/16	3 15 9	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 1/16 5 3/16	5 1/16 5 3/16	4 6 9	March	..	..
111,000	5	..	London Electric Supply	⅝ ⅝	⅝ ⅝	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	—	6⅞	6⅝
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40) xd	101 104	101 104	4 16 2	June and December	103	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	—	—	..	..
18,680	£5	2/6	St. James' and Pall Mall	7¾ 8¼	7¾ 8¼	—	—	8¼	7⅞
7,900	£5	7%	Do. 7% Preference	8¼ 8⅝	8¼ 8⅝	—	—	..	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5¾ 6¼	5½ 6	2 10 0	—	5 1/16	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/9⅜	Brush Electrical Engineering	3 3½	3 3½	..	—	3 3/16	3 1/16
69,996	2	6%	Do. 6 per Cent. Preference	2½ 2⅝	2½ 2⅝	5 1 1	—	2⅝	2½
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July	5½	..
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	2⅜ 3½	2⅜ 3½	..	—	..	..
45,000	10	12/0	Electric Construction	3½ 3⅝	2½ 3	..	—	3	1⅝
70,000	2	10/0	Elmore's Patent Copper Depositing	1½ 1⅝	¾ 1	—	—	1⅛	¾
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	..	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21 22	21 22	5 13 6	February & August	22	21⅜
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	4/0 4/6	3/9 4/3	..	..	..	..
78,949	5	4/2⅝	Swan United (£3. 10s. paid) xd	3 3½	3 3½	10 0 0	May and November	3½	3 1/16
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July	47	45½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103 106	103 106	4 14 4	January and July	..	..
—	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	¾ ¾	¾ ¾	—	—	..	..
—	£5	8%	Do. Preference (fully paid)	2½ 3	2½ 3	—	—	..	..
			RAILWAYS AND TRAMWAYS.						
£50,000	£10	..	City and South London Railway	3 4	3 4	..	—	..	—
600,000	Stock	½%	Do. Stock	.. ..	35 38	1 6 1	—	—	—

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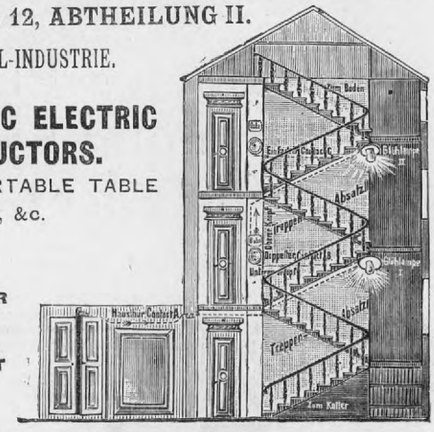

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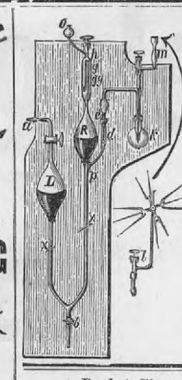

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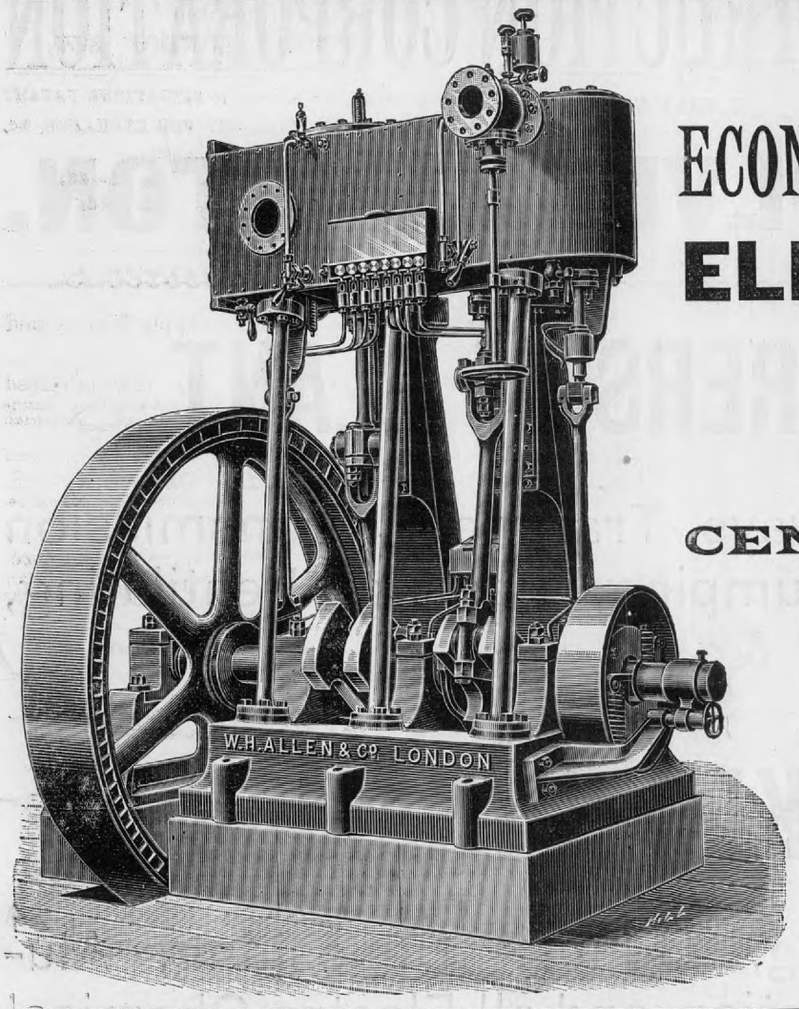

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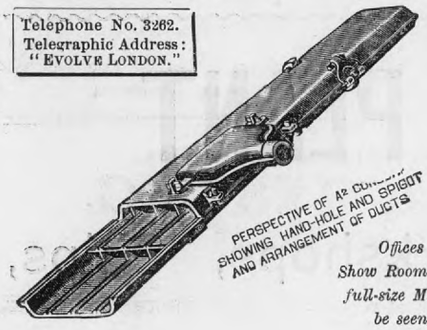

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Sealed Tenders, endorsed "Electric Lighting, Town Hall," and addressed to the Chairman of the Town Hall and Parks Committee, must be delivered at the Town Clerk's Office, Town Hall, Burnley, on or before WEDNESDAY, the 18th day of January, 1893.

The Committee do not bind themselves to accept the lowest or any Tender, and parties tendering must do so at their own expense.

F. S. BUTTON, Assoc.M.Inst.C.E.,
Borough Surveyor.

Town Hall, Burnley, 21st Dec., 1892.

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By order,
F. E. HESSE, Secretary.

Winchester House,
50, Old Broad-street, London, E.C.
14th December, 1892.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

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Coupons must be left at the above Bank, three clear days for examination.

By order,
RICHARD COLLETT, Secretary.

Winchester House,
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December 21st, 1892.

AFRICAN DIRECT TELEGRAPH COMPANY, Limited.

NOTICE is Hereby Given, that the Coupons on this Company's FOUR PER CENT. MORTGAGE DEBENTURES to Bearer, due 1st January next, will be PAID on and after MONDAY, the 2nd January, at PARR'S BANKING COMPANY AND ALLIANCE BANK, Bartholomew-lane, London, E.C. Coupons must be left at the above Bank three clear days for examination.

Warrants in payment of the Interest on the Registered Debentures will be sent out on the 31st inst.

The DEBENTURE REGISTER will be CLOSED from TUESDAY, the 27th, to SATURDAY, the 31st inst., both days inclusive.

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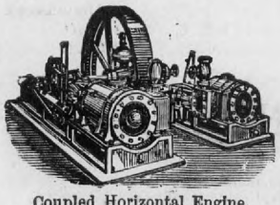

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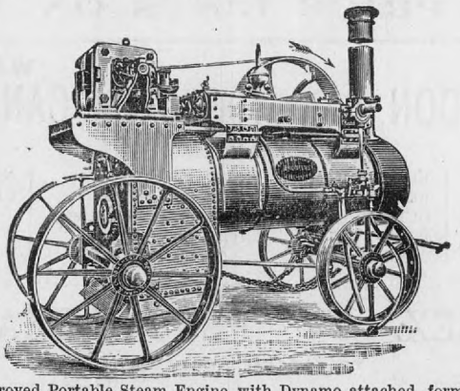

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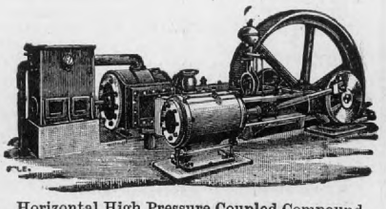

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THE ELECTRICIAN:

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No. 762.—Vol. XXX. FRIDAY, DECEMBER 23, 1892. PRICE FOURPENCE. *Annual Subscription (U. K.), 19/6.*

NOTES.

Until the publication of a properly audited balance-sheet, it is hardly fair to criticise the attempts of the St. Pancras Vestry to compete with private companies in providing an electrical supply. The report which has been issued, although it purports to show "the cost and the financial and general results of the first year's working," must be regarded as a popular epitome of the undertaking. No details of engineering interest can be extracted form the statements of expenditure and revenue, since the number of units supplied is not given. The receipts for current supplied amount to some £7,500 for the first year's working, while coal cost £2,306, wages £2,301, and salaries £689. The general result is a "balance" of £1,068 "towards payment of interest and repayment of loans," allowing nothing for depreciation. We hope to see the St. Pancras Vestry making a profit at 6d. per unit at night and 3d. during the day, but they can hardly expect to do so for some little time to come. Certain calculations for the future are based on an income of £1 per 16-c.p. lamp per annum; and at a meeting of the Vestry, Mr. Eccleston Gibb observed that he had this on the authority of an expert. While some supply stations in London fail to get even 6s. per 8-c.p. lamp per annum at 7d. a unit, this statement is, indeed, worthy of an electrical expert.

At the opening meeting of the year now drawing to its close the President of the Institution of Electrical Engineers commenced his vigorous defence of "Electrotechnics" as follows:—I beg to thank you for the great honour you have done me in electing me your President for this year—a year which the need for a new complete Index of this Society's Journal marks out as closing the second decade of its life . . . It was, therefore, highly satisfactory to learn at the last meeting of the year that this hint had borne fruit, and that so invaluable an index was approaching completion.

Index-making has ever been deemed a fine art by bookmen, but with the deluge of printers' ink continuing to pour down upon us with ever-increasing intensity, intelligent and intelligible index-making bids fair to become an absolute necessity. Unless, indeed, we are prepared to calmly contemplate the spectacle of scientific investigators frequently devoting the best years of their lives to a barren repetition of experiments, buried perhaps, in the guideless maze of some Society's journal, unprovided with even the rudiments of an index to lighten the toil of looking up the results obtained by previous workers in the field.

Dr. Fleming has recently directed attention to two phenomena which sometimes occur at the moment a transformer is connected with, or disconnected from, the mains. One is a sudden rush of current, the other a momentary rise of voltage. These effects may be closely connected, and, indeed, one may cause the other; yet they must be carefully distinguished, since only the second effect, the rise of voltage, is likely to have any harmful influence on the transformer. The sudden rush of current is over so soon that there can be no injurious heating caused in this way; but an impulsive rise of potential, however momentary, may quite possibly break down the insulation of the transformer. In our correspondence columns this week Mr. Lucas calls in question Dr. Fleming's explanation, and suggests that the sudden rush of current is due to condenser action in the coils of the transformer. The suggestion of a capacity effect is an important one; but the coils of an ordinary closed magnetic-circuit transformer have a very minute capacity, considered as a condenser, and we cannot credit that any appreciable change in the current can be caused in this way.

As regards the importance of the phenomenon which our correspondent calls in question, it must be remembered that it is only supposed to occur under a rare combination of circumstances. When the conditions are better understood it will probably be a very easy matter to prevent the phenomenon ever causing a breakdown to occur; but until they are known it seems that a perfectly good transformer may occasionally give way in an unaccountable fashion. Unless we are mistaken it was experience of this kind that led Mr. Mordey to experiment on the subject immediately after Dr. Fleming published his paper.

Alternating currents in ordinary use are generally assumed to be of so high a frequency that they are incommensurable with most of the mechanical motions of every-day experience, and the recital by Mr. Mordey of experiments in which contacts were made and broken by hand actually at different portions of a single period, was received with some surprise. It might have been supposed that the inevitable arc would have bridged over several periods, but experiment showed that this

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was not the case. It might also have been supposed that the application of ordinary alternate currents to an induction coil through the usual contact breaker would have given rise to confusion with troublesome sparking at the wrong end of the apparatus, and that, on the other hand, a coil containing one hundred turns on the primary and eight thousand on the secondary, acting as a one to eighty step-up transformer simply connected with an alternate current supply would have given some noticeable result. Experiments made by Dr. Lewis Jones, and described in our correspondence columns this week, show, however, that the contact breaker worked as comfortably with alternating currents, as with direct, and the usual length of spark was given at the terminal of the secondary, viz., one and a-half inches, being equivalent to about 35,000 volts. But, as is well known, this high voltage is due to the sudden make and break of the primary, and accordingly, when the contact breaker was screwed up, less than 1,000 volts were produced, and the current being a minute fraction of an ampere, the sparks were hardly measurable.

In the course of an interesting letter which Mr. Tesla sends us this week in connection with the subject of high-frequency alternators, it is stated that the ordinary rules of the magnetic circuit do not hold good for such rapidly changing currents. Our experience with these currents is so limited that it is quite impossible to say whether the striking phenomena to which they give rise can or cannot be accounted for by the old and well-known laws of electricity. Mr. Tesla has suggested that high-frequency currents are quite harmless physiologically, but no one has ever measured them, and the "skin effect," caused by the tendency of currents to crowd towards the surface of conductors, is of so great importance at these high frequencies that the actual currents are probably very much smaller than they are generally supposed to be. For a similar reason, before applying the laws of the magnetic circuit, the effect of eddy currents in the iron must be carefully borne in mind. Profs. J. J. Thomson and Ewing have shown that, even with such slow alternations as 100 $\sim$, eddy currents considerably disturb the distribution of the lines of force in plates of iron of only half a millimetre thickness. With a frequency of more than 100 times that of ordinary alternating currents, these effects will be of very great importance, and it is idle to talk of the laws of the magnetic circuit unless the eddy currents have been taken into consideration. As regards the power of iron to follow the changes of the magnetising force, it has been conclusively proved by the experiments of Prof. J. J. Thomson and others that iron does really remain magnetic for currents which reverse 20,000 times per second.

The problem of distributing and diffusing light from powerful sources, especially from arc lamps, by strictly optical means, is one of great geometrical interest, and has the appearance of practical utility. A note by M. Frédureau in the *Comptes Rendus* describes globes of moulded glass, the surface being covered with prismatic rings. The fascination of this problem lies in the complete and perfect solution which is possible. But on putting it into practice, among the troubles which arise are the exact focusing of the source of light, the warping of the glass during annealing, and the difficulty of moulding large pieces of glass. But when all this has been overcome an insuperable objection is presented by the task of keeping such globes clean. Anything deeper than the pattern of glass used in the street lighting of the City of London will give trouble by the lodging of dust in the grooves. A minor difficulty, but one which has prevented the adoption of such diffusing glass, is the ugliness of the outlines which are demanded, either by theory or by the exigencies of glass moulding, but, as we have seen no illustrations of M. Fredureau's designs, we cannot tell whether he has avoided this.

Although the electrical engineer undoubtedly occupies in the United States "a position of greater freedom and less responsibility" than anywhere else, it would seem that it is not in England alone that the species is beset with difficulties. In France the fancy for supplementing direct municipal taxation by an indirect income from various monopolies has resulted, so far as electric lighting is concerned, in something like a complete *impasse*. Gas is in possession, and, as the Americans say, "has come to stay." An appreciable proportion of the French local authorities have divested themselves of all right to moderate the demands of the gas companies by introducing a little wholesome competition, and the opening of the public roads by anyone but a gas man seems to be a crime of the first magnitude.

The curious result of this curious state of things has been that the down-trodden consumer has risen in his might. A Fédération Nationale des Consommateurs has been formed; a meeting has been held at Lyons, and half-a-score of resolutions have been passed, No. 8 of which runs somewhat as follows:—"Although electricity offers far greater advantages than gas, municipalities shall not grant it any monopoly or privilege whatsoever, but shall facilitate the laying down of central stations *in order to force the gas companies to lower their prices*." A very obliging, but hardly encouraging, proposal. Reactions of all sorts are apt to be violent, and that against monopolies is evidently no exception to the rule. It must, however, in fairness, be stated that the protestants have, in several instances, had the courage of their convictions. In one town gas consumers recently "went back to oil," rather than tamely submit to the charges of the local gas company. In another, our French friends propose to give an even greater proof of their being in earnest; rather than pay a high price for a bad service they swear to abstain from talking—at least, through the telephone.

Colchester.—The Town Council has approved of the draft Electric Lighting Order.

Royal Institution.—Sir Robert Ball will deliver three "juvenile lectures" on Astronomy at the Royal Institution on December 27th, 29th, and 31st, at 3 p.m.

Liverpool Overhead Railway.—The Liverpool overhead railway is to be opened on February 4th next. The Marquis of Salisbury has accepted an invitation of the Directors to perform the inaugural ceremony.

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Bridgend.—At a meeting of the Local Board last week it was resolved that application should be made for a Provisional Order to enable the Board to construct works for the purpose of lighting the town with electricity.

The Proposed Land Lines Across Africa.—It is understood that Mr. Rhodes will personally urge on the Egyptian Government his proposal to link Egypt (telegraphically) with South Africa by land line through Central Africa.

British Association.—A movement is on foot in Canada to invite the British Association to visit Canada in 1895. The Canadian Institute is now sending a formal invitation to the Association. Toronto is suggested as the place of meeting.

Ogmore.—On Monday evening last Tynewydd and Nantymoel in the Ogmore Valley, near Bridgend, were lighted by electricity for the first time. The low-pressure system is employed. The light has been adopted by nearly all the principal shops.

Junior Engineering Society.—A visit to the Central Telegraph Office and the General Post Office, St. Martin's le Grand, will be paid by the members of this Society to-morrow (Saturday). Meeting at the main entrance of the former building at 2.30 p.m. Groups D, E, and F.

Kingstown.—At the last meeting of the Town Commissioners the Surveyor and the Solicitor handed in a joint report in reference to the proposed adoption of electric power in working the tramways between Dublin and Dalkey. They were of opinion that the adoption of electricity would confer the most signal advantage upon the township and the general public.

The Hampstead Vestry.—At a special meeting of this Vestry held on Thursday evening last week, it was decided by 30 votes to 4 that the Vestry should itself undertake the supply of electricity in the parish, that a Central Lighting Station should be erected in the parish stoneyard, and that application should be made to the London County Council to advance the sum of £25,000.

Bordeaux.—The Directors of the Bordeaux Gas Company have decided to institute proceedings against the Municipality for having, contrary to their agreement with the Gas Company, allowed electric lighting stations to be established. During the year ended June 30th last, 970,000 thousand cubic feet of gas were sold, as against 977,000 thousand cubic feet during the preceding twelve months.

The St. Luke, Chelsea, Electric Lighting Company.—We are informed that this Company will commence to lay the mains on the 1st of January, 1893, and will be ready to supply current by the end of January. We are informed that the Company intend to lay mains along Cheyne-walk, up Oakley-street by King's-road and Church-street to Elm Park Gardens, with an eastern branch supplying Tite-street, Tedworth-square, Smith-street and the eastern end of King's-road.

The Proposed Teaching University for London.—The following memorial, numerously signed, has been presented by Sir Henry Roscoe to Earl Cowper, Chairman of the Royal Commission on the Gresham University:—"The undersigned desire hereby respectfully to record their strong opinion that the foundation of a Teaching University for London, without due provision being made for higher education and original research, would be unworthy of the metropolis, and would entail the neglect of an admirable opportunity for promoting the advancement of science and learning."

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St. Thomé-Loanda*	November 24, 1892
Penang-Medan.....	December 1, 1892

* Communication with South Africa is still maintained by the East Coast route.

The City and South London Railway Extension.—At the last meeting of the Lambeth Vestry the General Purposes Committee reported having considered the memorial in opposition to the shaft with a hoarding round proposed to be erected by the City and South London Railway Company in Clapham-road, opposite the present station of the Company. The Committee directed the officers to give notice to the Company that the proposed site was objected to by the Vestry, and the Committee suggested that if any shaft in a public thoroughfare was absolutely necessary, then that the same would be less objectionable if placed in Studley-road. After some discussion the recommendation of the Committee was adopted.

Obituary.—The death is announced of Mr. Thomas C. Hodgkins, whose munificent gift of £20,000 to the Royal Institution was made a few weeks since. Mr. Hodgkins was born in England. Emigrating while young, he established a confectionery business in New York and made a fortune. Thirty years ago he retired and took to farming on the coast of Long Island. About a year ago Mr. Hodgkins sent a donation of £40,000 to the Smithsonian Institution at Washington, and still more recently he gave £20,000 to the New York and Brooklyn Societies for the Prevention of Cruelty to Children, and another £20,000 to societies for the protection of animals. Among other benefactions was the gift of a public library at Setanket, Long Island. Not long ago he handed a "retainer" of £6,000 to a physician in return for a promise of constant attendance as long as medical services might be required.

Electricity in Railway Signalling.—In his report on the recent railway accident at Kentish Town, where a train travelling to Victoria was run into from the rear by an express train from Bradford to St. Pancras, Major York, who attributes the accident to the negligence of the Kentish Town signalman who allowed the train to enter the next block without notifying the signalman in charge of the section, calls attention to what he considers a weak point in the present mode of block working, viz., that part of it which depends on the obedience of signalmen. Regulations of the most careful and satisfactory nature may be drawn up, but absolute compliance with them cannot at all times be ensured, and he suggests, for the consideration of the Company, whether it would not be possible to adopt on busy sections of the line some system of electrical interlocking which would prevent a signalman from lowering his starting signal without the permission of the man in the cabin next in advance.

Windsor.—There is a good deal more, writes a correspondent, than meets the eye in the dispute between the Town Council of Windsor and the Windsor Electric Lighting Company, which culminated in the police-court proceedings reported in another page. Technically and strictly, the Company have been in the wrong all through; but, on the other hand, the Town Council have played fast and loose with them to a large extent, and the sympathy of the bulk of the inhabitants is with the Company. The truth is that if they had not thus taken the bull by the horns and forced the hand of the Town Council, they would have been indefinitely stultified, and the machinery they had already set up would probably have gone to rust before the Corporation would have removed their prohibition. Declining to undertake electric lighting on their own account, and for the benefit of the community, the Corporation as a body have, from the granting of the Provisional Order, discouraged and obstructed the efforts of the Company.

The Taxation of American Electrical Manufacturing Companies.—As we have several times stated, manufacturers are dealt tenderly with by American tax-gatherers. In this connection an important question of taxation has been decided by the Supreme Court of Pennsylvania, in the case of the Commonwealth against the Westinghouse Electric and Manufacturing Company. This Company, organised under the laws of Pennsylvania, claimed that it came within the provisions of the statutes of that State, exempting from taxation the capital stock of corporations "organised exclusively for manufacturing purposes." The Court of Common Pleas of Dauphin county held that the Company *was* a corporation organised exclusively for manufacturing purposes, and actually carrying on manufacturing within the State, and, therefore, that no portion of

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its capital was taxable. The Supreme Court of the State, however, have reversed this decision. Looking to the Acts under which the Corporation was organised, it was found to be empowered to engage in enterprises so vaguely defined that it would be unsafe to say what it was *not* authorised to do, except to issue its own obligations as currency.

The Australian Cable Service.—*The Times* of Monday contained the following:—

The representatives of New South Wales, Victoria, South Australia, New Zealand, Tasmania, and Western Australia, have signed, on behalf of their respective Governments, an agreement with the Eastern Extension Telegraph Company increasing the charge upon Australasian telegrams by 9d. per word—*i.e.*, making the rate to Australia 4s. 9d. instead of 4s. per word, which was the amount paid last year under the guarantee arrangement entered into between some of the Colonial Governments and the Company, under which the rate was reduced from 9s. 4d. to 4s. per word, the loss being equally divided between the two contracting parties. Up to the present the Indian Government have made no sign of abandoning their expressed intention of increasing the transit rate upon Australasian messages from 35 to 50 centimes per word. The Secretary of State has conveyed to the Indian Government the strong representations which the Colonial Governments have made against this decision, which they regard as most unreasonable, inopportune, and unfair to the colonies; but since no response has been made, it is thought that the Indian officials will be hard to impress. As it was important that the changes of tariff should be brought into operation on the 1st prox., it became necessary to sign the agreement without waiting for a definite reply from India. The Colonial Governments will continue to press their objections to the increased Indian transit rate, as they have placed on record that if it is insisted upon it will involve the colonies in very serious loss, and may lead to a return to the former high tariffs.

The City Lighting.—At the meeting of the Commissioners of Sewers held on Tuesday, the Streets Committee brought up a report in reference to a letter from the Board of Trade, asking the opinion of the Commission as to an application of the City of London Electric Lighting Company to be allowed to keep all accounts for the public lighting in the three City districts as one account. The Committee recommended that no objection should be offered, providing the accounts for public and private lighting were kept distinct. This was adopted. Mr. C. T. Harris, however, observed that the Company were constantly seeking concessions from the Commission without giving anything in exchange in the public interest. In regard to an application by the same Company for permission to construct 21 converting stations beneath the public ways, the Committee suggested that the application should be complied with under the engineer's direction, but the Court adopted an amendment by Mr. Morton, M.P., restricting the number of stations to twelve, and making them subject to removal at the pleasure of the Commission. At the same meeting Mr. Wood called the attention of the engineer to the effect that the electric light had failed in Cheapside and on Ludgate-hill.

Long-Distance Telephony.—An experiment in long-distance telephony was tried at the residence of the editor of the *Yorkshire Post*, at Leeds, on Sunday evening last. For about two years Christ Church, Birmingham, has been fitted with telephonic transmitters. On a few occasions the effect has been tried in towns at a distance of 50 or 60 miles, and, as a rule, the service has been successfully transmitted. The distance between Birmingham and Leeds is, however, 150 miles, and the transmission had in this case to pass through three exchanges before it reached the listeners. The experiment was, it is said, highly successful. The visitors, says the *Yorkshire Post*, took their seats fifteen minutes before time, and found much preliminary interest in the tolling of Christ Church bell, which rolled into the ear 150 miles off with an almost deafening clang. It was noticeable, too, that the sound of the bell was associated with that subdued rustle and velvety footfall which is a part of the atmosphere of a church during the few minutes preceding the service. At 6.30 the bell suddenly stopped, and then for a few minutes the imps of "induction" were in possession. When they surrendered the wire to its lawful uses the congregation were found to be in the middle of a hymn, which, however, was heard intermittently.

Derry.—The *Gas World* is our authority for the following statements:—Some members of the Londonderry Town Council caused application to be made to the Local Government Board for a loan of £40,000 to carry out an electric lighting scheme, and when that body pointed out that this was in excess of the borrowing powers of the city the sum was reduced to £35,000. Then, when it was stated that it would be necessary to have a public inquiry, the amount asked was again reduced, this time to £15,000. One little fact elicited in the evidence given at a public inquiry last week, may, says our contemporary, to a certain extent, explain the conduct of the councillors. Originally it was intended to supply current for private and public lighting; but the proposal to use electricity for the former purpose was so coldly received that it was abandoned. Perhaps if efforts had been made to ascertain whether the ratepayers desired the streets to be lighted by electricity it would have been found that there was no need to make application for a loan, or to incur the expense of a public inquiry. However this may be, the inquiry has been held, and in many respects it was a farce. The representatives of the Corporation repudiated their own application for £35,000; they also repudiated the map of the scheme, which is said to be officially endorsed; and they disclaimed responsibility for some of the features of that scheme.

The Chicago Exhibition.—The recent public announcement of the proposal of the authorities to close the Exhibition after sunset has naturally caused considerable dissatisfaction, especially in electrical circles. The *Street Railway Gazette* delivers itself as follows on the subject:—"The position which the Directors of the World's Fair have been in the habit of assuming has been a curious one. Since the start, their method of ascertaining the will of the people on any subject relating to the Exhibition has been to take some outlandish position, and then to watch the howl of remonstrance immediately set up in every corner of the country. It would be too great a discredit of the common sense of the management to consider them capable of believing that the real wishes of the people demanded the transformation of this fairyland into a dungeon at sundown. To say that everybody is heartily disgusted with these unrivalled exhibitions of wire-pulling and selfishness is putting it very mildly."—The Royal Commission for the Chicago Exhibition are arranging for a series of introductions to the different sections of the catalogue of the British Section. Amongst those who have promised to contribute articles are:—Sir Douglas Galton, "Railways"; Prof. Francis Elgar, "Ships and Shipping"; Prof. Roberts-Austen, "Metallurgy"; Prof. Le Neve Foster, "Mining"; Mr. W. H. Preece, "Electricity"; Mr. H. Graham Harris, "Engineering"; Capt. Abney, "Photography." The general introduction to the catalogue will be written by Sir Henry Trueman Wood, the Secretary to the Royal Commission.

Taunton.—Sir Thomas Blomefield and Major Cardew conducted an inquiry at Taunton on Friday last, on behalf of the Board of Trade, into an application made by the Town Council for permission to undertake the lighting of the town by means of electricity. Mr. Fleetwood Pritchard appeared as counsel for the Corporation, and Mr. Austin for the Gas Company. Mr. C. P. Clarke represented the memorialists against the grant. Mr. Pritchard said that the existing system of electric lighting was excellent, and contended that there was a general desire to purchase the Electric Light Works. The price of the Works was to be £9,300, and if the Works were not bought by the town they would be closed. Three and a-half miles of streets were now lit by electricity, and the number of incandescent lamps now in use in the town was 915, as against 490 twelve months ago. Evidence supporting these statements was called. Mr. Austin and Mr. Clarke, speaking for the opposition, contended that the purchase of the Works would entail a most serious burden; that, although the light was good, the Company had been carried on at a great loss, and if taken over by the town it would be disastrous to the ratepayers. The Company had become virtually bankrupt. In support of this contention Mr. Gisbert Kapp was called. He estimated that with the necessary extensions, new plant, &c., the Works would cost the town £19,500, including the purchase money. It would cost £3,640 per annum to keep the Works going, and he estimated the income at £2,650. In closing the inquiry Sir Thomas Blomefield said Taunton was one of the best-lit towns he had visited.

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THE TEACHING OF SCIENCE IN SCHOOLS.

BY HENRY CUNYNGHAME.

One of the most striking characteristics of our modern system of education is what is known in public schools as the "modern side." The middle and elementary schools may be described as having nothing but a modern side. With the growth of the modern side has sprung up what is termed the teaching of science. The name science is usually reserved for chemistry, physics, physiology, biology and botany, which have been introduced gradually into all our schools with a view, as it is thought, of affording a logical mental training on the one hand, and of being practically useful upon the other. Against these sciences, when properly taught, there is, of course, nothing to be said. Against the present mode of teaching, then, there is very much to be said. The burdened ratepayer, who feels that the zeal of the School Board has almost eaten him up, who sees his rates increase, but without any apparent increase in the capacity of the men who come to mend and to bungle over his drains, his roof, and his waterpipes, may well be pardoned if he sometimes feels tempted to doubt the efficiency of our boasted school system, and to say of science that we could do without it. The puzzled mother, whose daughters come home from the Board schools with their heads full, not of sewing or cookery, but of skeletons and human anatomy, has long ago given up in despair the attempt to understand what objects our modern education has been attempting to achieve, and contents herself with the remark that it is all very wonderful but she does not understand it. The truth is that no one can understand it, and the more he learns and knows the more incomprehensible it all appears.

If there is one maxim in education more certain than another, it is this, that what is learned should be learned thoroughly and intelligently, and that ill-digested knowledge is useless, nay, positively detrimental to the intellect. And yet it is not too much to say that our present methods of teaching physics to the young entirely violate this maxim. If any one wished that his boy should attain a competent knowledge of physics he would of course ground him in the three R's of science, namely, geometry, algebra and trigonometry. Without these very little progress can be made. How much of the pages of *The Electrician* could be understood by one ignorant of them? Nay more, how much could he understand of the simplest mechanical newspaper? And yet, incredible as it may appear, the money, the time, and the energies of the School Board teachers are being at present spent, not in preparing a modest yet firm foundation upon which a future knowledge of science can be raised, but in going through a jargon of science primers, literally building in the air, without any foundation at all. It is, of course, a pretty experiment to show a class the Leyden jar, and the attractions of some pith balls. As they become more advanced the magic word "potential" is introduced and a sort of pretence made at giving them some notions of "energy," but what a farce the system is when considered as a mental training. And how deplorable, nay tragic, the farce becomes when we reflect that the money and time are being wasted which might have been used in equipping the boys with the machinery by which they might easily master these things for themselves. The whole system is precisely like the curriculum of the ladies' finishing schools, in which were taught flower painting in water colours, and the use of the globes. And what is the result? That after a certain number of years of misspent time our young workman, or as he is now termed, young gentleman, comes from his Board school with the airs of a monkey who has seen the world, but without the monkey's mother-wit and intelligence. His mind, exercised in being made to pretend to understand things, but always being taught to evade the difficulties, becomes apish, effeminate, and unfit to cope with the difficulties of life.

A distinguished professor of science, whose name were I to mention it would be familiar to the readers of *The Electrician*, declared to me that with a few exceptions his whole class consisted of a set of self-satisfied prigs—and these exceptions were young men who had been brought up on the classical side. And no wonder. In classics a boy at least acquires habits of careful thought and accurate expression, while the wretched untrained student of our modern text-books, in which whole branches of study have to be compressed so as to sell for 3s. 6d., never even comes in contact with a mental problem.

Let anyone take up one of these text-books. Let us select one of the very best of them, written by a man who in point of knowledge is probably the highest authority in England on the history of his subject—let us take Prof. Silvanus Thompson's "Electricity and Magnetism." Imagine an unfortunate reader, ignorant of mathematics, trying to get through this book. He commences with attractions of pith balls, induction, Holtz machine, and is introduced to that interesting animal, the electric eel. This in 70 pages. He next commences magnetism, and gets on pretty well till he comes to the law of magnetic force which varies as the inverse square of the distance. If he is fortunate enough to know what the word inverse means he, perhaps, surmounts this, but two pages further on he finds himself entangled in the method of oscillations, and informed that he is to take it for granted that the square of the number of vibrations of a pendulum made in a given time is proportional to the accelerating force acting on the pendulum. Having a few pages further on reduced his mind to confusion by the introduction of some trigonometry, the professor's heart softens, and, filled with compunction, he proceeds in a small printed note to explain what a sine and a tangent are. The reader then passes to a description of batteries, which is fairly comprehensible, but soon all hope must desert him, for in a moment, in the brief space of three pages, he finds himself struggling with the theory that the force of the current i acting on a magnetic pole m at a distance r is equal to $2\pi i/r\ m$ dynes. If he looks out "dynes" in the index he finds it is explained at p. 208, and now let him follow the professor, if he can. Unless he has had a preliminary training in dynamics *he cannot*, and no wonder. Can the problems which puzzled Galileo, and which were even left half solved by Newton, be comprehended by a reader with the help of two pages of small print in a note? We pass over the fact that when treating of water-electrolysis chemical symbols are introduced and manipulated (another slight difficulty), and that knowledge is presumed of atomic weights, and chemical equivalents of Dalton's laws. These are merely by the way. The real difficulty is now to commence, for we are at p. 194 introduced to "potential." From that time forth the reader who is not fairly well versed in mathematics had better close the book.

The above remarks are not intended as anything but complimentary of this excellent work, but it is nothing less than a farce, that in a book of such difficulty the writer should be obliged to pause and give his reader some notion of trigonometry. It shows that he knew that it was to be read by those ignorant of mathematics, and who were miserably cramming, or rather being crammed, to go through some grant-earning or prize-getting examination. It is time that there should be some plain speaking upon this subject. The professors and teachers know the truth. It is time that the public knew it also. It is time that smatterings of astronomy without geometry, smatterings of electricity without algebra, and smatterings of light, sound, and heat, without a knowledge even of the laws of harmonics, should cease, and that parents and School Board members should know that in sending boys to learn those subjects without the necessary equipment of mathematical knowledge, they are wasting the time and muddling the brains of those to whose abilities we must trust for the future greatness of England. The amount of mathematics required for elementary physics is not large, and could be acquired without any very great difficulty. As a ratepayer, I have no objection to contribute to teach the sons of other people geometry, mathematics, and trigonometry and mechanics. When they have learned them I have no objection to contribute to teach them the physical sciences, but I have an objection, and believe that others share it, to seeing my hard-earned money wasted in a manner that would disgrace a fashionable ladies' school, and that is calculated to produce a set of scientific *dilettanti*, not an educated class of artisans and engineers.

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SPARKING AT COMMUTATORS.

BY F. M. WEYMOUTH.

(*Continued from page 190.*)

Fig. 6 shows diagrammatically a complete circuit, including a coil with iron core. A generator is indicated at *a*, and a gap which can be closed at *g*, while for the present the dotted line *c c* may be disregarded. Now a current flowing steadily as represented by the arrow heads, will cause the same polarity of the coil here as in Fig. 1; though this would of course be only when the gap *g* was closed, as otherwise the circuit would not be complete. Let it now be imagined that in the first instance the gap *g* is open. There will then be no current flowing, and so no lines of magnetism within the coil. Suppose, then, the gap to be suddenly closed. We may note the immediate effect. A sudden generation and increase of lines of magnetic induction will take place within the coil, which will exercise a counter tendency to make the current flow round the coil in the *opposite* direction to that shown. It will thus momentarily retard the full establishment of the normal main current. But the full current becoming at length established, let the gap *g* be suddenly opened. The result will be a cessation of the main current, with consequent decrease of magnetism within the core. But a sudden decrease of magnetic lines will cause a current to flow round in the same direction as the main current. Hence at the moment of breaking contact, the main current is reinforced with more or less strength and difference of potential, according to the dimensions of the coil and the rapidity of the break. In consequence, a disruptive spark, due

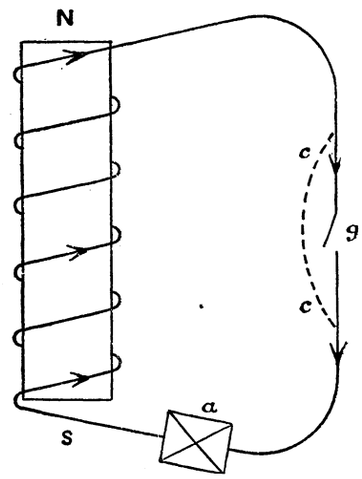

FIG. 6.—Diagram Illustrating Self-Induction.

to the sudden and great increase of potential between the opposing ends, will take place at *g*, leaping across in the same direction as the main current, as in Fig. 3. Yet further, inasmuch as we are dealing here with the main current itself, and not a secondary, if the points at *g* (Fig. 6) are not pulled too far asunder, the current may continue crossing the gap as an *arc*, in the manner already described. It is to be noted that in the cases of Figs. 2 and 3 these self-inductive retardations do actually take place in the primary coils; and while induction sparks are produced in the secondary, self-induction sparks may be produced at the moment of break in the primary.

We thus find in the case of a self-induction spark the effect of Lenz's law again. For the momentary counter current tends to retard the cessation of the main current, although it is the very act of this cessation to which the counter current and the sparks owe their existence. But, as already intimated, these induction and self-induction effects are entirely due to the intervention of magnetism. It is thus that the phrase "electric inertia" is not a safe one to use instead of "self-induction." It is not the *inertia* of the current *per se* that causes it to fly on after a break of contact, and cross the gap in a spark. A high electromotive force may accumulate at the positive electrode at the break; but this is not, correctly speaking, analogous to the high-pressure that may occur behind a valve in a pipe containing water flowing under pressure, when it is suddenly closed. In this latter such pressure is due to the *momentum* of all the water behind the valve, which is suddenly brought to a stop. Momentum implies *weight*. But there appears to be nothing whatever of the nature of weight in the electric current. Hence the cause or causes of effects manifested by an electric current that might seem due to something like momentum must be looked for in an earlier state of things. This is made clear by the fact that if the wire circuit, as in Fig. 6, be pulled out so as to form a simple circuit without any coils in it, and with the iron core also absent, there will be scarcely any self-induction left; and on breaking the circuit at the gap there will be little or no spark, although the actual total length of the wire is unaltered. Thus the absence of any accumulation of electromotive force at the positive electrode in this latter case, shows that there is not anything akin to momentum in the electric current, as with the flowing water suddenly stopped by the valve. With the coils it is a pure case of a sudden *generation* of an extra electromotive force in accordance with the laws of magneto electricity, already dwelt on. This newly-generated electromotive force, impelled by the magnetic forces to which it owes its origin, rises to so high a potential in the positive electrode at the moment of break—it may be to some hundreds or thousands of volts—that it is able at the instant to send a disruptive spark through the air and across the gap in the manner described.

We may turn now to the fifth order of sparks which we have assumed. It has been stated that the sparks of the first three orders are the effects of a high potential difference between the electrodes; though in the second and third orders this will be higher than normal. Our classification is however based on the causes rather than on the effects themselves. Thus, our fifth order of sparks are those that result from a high potential of the normal or main current itself, without any magnetic or other augmentation. It is again an effect of current electricity. Two electrodes, for instance, in a circuit of either continuous or alternating current electricity, of say one ampere and 20,000 volts pressure, if held a few millimetres apart, would have a continuous disruptive discharge passing between them from positive to negative, and that *without previous contact*. This latter characteristic thus alone would distinguish it from an arc. But their brilliancy, as compared with the low luminosity of the arc, that is, of the arc itself, disregarding the intense light from the white hot carbons, and the absence of the intense heat of the latter, together with a difference of the sound produced, would form further distinguishing features. This fifth order, moreover, is not to be confounded with the stream of sparks that may be obtained from a Ruhmkorff or other induction coil. For these latter belong to our second order, having for their cause magnetic generation.

This continuous disruptive discharge of our fifth order, and indeed all disruptive discharges have however a yet further distinct difference from the arc. This is, that they take the most straight and direct course to the negative. An arc, especially of any length, is easily made to take a circuitous path; as for instance in the experiments by Messrs. Siemens Bros. at the Crystal Palace, already alluded to. For here the electrodes instead of being held the one vertically over the other in the usual manner, were held level with each other in the same horizontal plane. Being also about a foot or 18in. apart, the arc then rose from the one 18in. or 2ft. upwards, coming down again to the other electrode, thus forming the shape of a horseshoe or arch. Yet this great divergence from the straight line to the other electrode was chiefly caused by the air draught due to its own heat and the mutual repulsion of its different parts. The arc moreover in this case, was not of a smooth regular form like for example a rainbow, but waved and oscillated, and behaved in a manner that may be better likened to an arched blue flame of fire. The rupturing character on the other hand of the disruptive discharges, is entirely due to their intense proclivity to adopt a straight course. Hence, rather than be turned aside by any obstacle that may be in the way, they prefer to break it up or pierce it, and so attain their desired consummation.

(*To be continued.*)

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INVESTIGATION OF THE ENERGY CONSUMED BY INCANDESCENT LAMPS.*

BY CH. HAUBTMANN.

The article which I recently published (*see* Abstract in *The Electrician* of September 30th, Vol. XXIX., page 590) on the energy consumed by incandescent lamps has been honoured by a somewhat warm protest from Messrs. Siemens and Halske (*see The Electrician*, December 9th, page 173). Messrs. Siemens and Halske assert generally that the results of my tests are inaccurate, and that their inaccuracy is due either to errors of calculation or defective instruments. The warmth of their letter does not alter my opinion, and I am ready to maintain both the correctness of my figures and the accuracy of my instruments.

First of all, Messrs. Siemens and Halske point out not an error, but an enormity which crept in in connection with the "La Française" lamp of 16 c.p. tested at 110 volts. Well, the figures in columns 3, 4, and 5 of the table relating to this test (see *The Electrician*, September 30th, Vol. XXIX., p. 590) are not the right ones, a fact which I noticed when correcting my proofs. The mistake arose in this way. In transcribing the figures from my note book for the press, pressed for time, I copied candle-power and watts absorbed column by column, and accidentally missed out the first row in the third, fourth, and fifth columns, with the result that I placed opposite the first row of figures of the first two columns figures which ought to have ranged with the second row. In short, the total amperes, candle-power, and watts absorbed per candle related to a test made 250 hours later, the figures relating to the initial test having been omitted. Whether it was that I did not make my correction clear, or whether it was that the compositors forgot to carry it out, the correction was not made, and when the article was published I noticed the mistake, and several others of minor importance, and in the next issue the following erratum was made :—

"*La Francaise*" *Lamps marked 16 c.p. and 102 volts (110 volt Test).*

Instead of					Read				
No. of lamps under test.	Hours.	C.p.	Amp.	Watts per effective candle.	No. of lamps under test.	Hours.	C.p.	Amp.	Watts per effective candle.
10	0	15·7	0·480	3·36	10	0	22·4	0·480	2·36
10	250	13·5	0 475	3·87	10	250	15·7	0·480	3·36
8	500	12·1	0·475	4·30	8	500	13·5	0·475	3·87
7	750	10·0	0·475	5·20	7	750	12·1	0·475	4·30
6	1,000	7·9	0 460	6·40	6	1,000	10·0	0·475	5·20

If, as Messrs. Siemens and Halske assumed, I really had obtained 15·7-candle power for the initial illuminating power of these lamps at 110 volts, I should not have omitted to make note of the fact, since I had already observed that at 102 volts the effective initial power was below the nominal figure.

Messrs. Siemens and Halske next reproach me for leading the public to have a bad opinion of their lamps by the publication of my tests. I would remark that I abstained from any comment as to the value of each type of lamp, and that it is Messrs. Siemens and Halske who have brought me to a subject which I did not anticipate I should have to touch upon. I am confronted with measurements of 16-c.p. 102-volt Siemens and Halske lamps, carried out at the Physico-Technical Institute of the German Empire, which lamps apparently only take 2 watts per candle at 110 volts. It is unnecessary to point out that amongst 100 lamps of the same maker, 10 groups of 10 lamps may give very different results, both from the point of view of energy consumption, and candle power. Now, Messrs. Siemens and Halske naturally forget to tell us that they did not choose the worst lamps manufactured by them for the Physico-Technical Institute tests, yet it would have been fair to have done so, and it is an essential matter from the point of view of efficiency. Not wishing to place myself in the same position, I took any 10 lamps, so that it is not surprising that I did not get the same figures that they give in their letter—that is to say, 2 watts per candle at 110 volts. I do not suspect that their result was obtained by carefully choosing and specially manufacturing the lamps intended to be tested. But are we to conclude that the figures with which I am confronted represent accurately the average article manufactured by this firm? As a matter of fact, the lamps which I tested were bought in the open market in order that I might get a good idea of the manufactured article as sold to the public.

In April last 40 Siemens lamps were obtained in Germany. Of these 10 were tested at 102 volts and 10 at 110 volts. The 102-volt test seems to be in agreement with that at the Physico-Technical Institute, since it is not criticised, and will, therefore, be passed over for the moment, and I will only consider the 110-volt test. The difference between the results obtained at Charlottenburg and by myself are merely due to a difference between the lamps themselves, as may be seen by the following extract from my experiment note book. We thus have an average of 25 candles and a current of 0·62 ampere. The difference between the candle-power of the various lamps are, it will be seen, very large, the maximum difference being 12 candles ($c=32$ candles and $i=20$ candles).*

10 Siemens Lamps marked 16 c.p. and 102 volts (110 volt Test).

Number of lamp.	Candle-power.	Amperes.	Life (hours).	Order of extinction.
a	23·5	0·62	210	3
b	24·0	,,	300	6
c	32·0	,,	860	10
d	30·5	,,	850	7
e	21·0	,,	240	4
f	27·0	,,	800	8
g	21·5	,,	45	1
h	29·0	,,	650	9
i	20·0	,,	175	2
j	22·0	,,	260	5
	25·05	0·62		

In the above table there is, therefore, a lamp giving 32 candles and taking only 2·13 watts per candle. It was probably a batch of lamps like this that Messrs. Siemens and Halske had tested at Charlottenburg. However much it may be to the interest of Messrs. Siemens and Halske to prove the contrary, I think they will do me the honour of admitting and accepting as accurate the above results. In practice, two tests made side by side on the same type of lamp taken from the same batch may, I repeat, widely differ. *A fortiori*, two tests made on lamps of more or less recent manufacture, may give very widely different results. My conclusion, therefore, is that the Physico-Technical Institute experiments no more imply the inaccuracy of my own than mine involve the falsity of those.

It is, moreover, inadmissible that, on the same day and with the same instruments, I should make 20 measurements on 102-volt lamps which Messrs. Siemens and Halske recognise as accurate, and on the other hand, 20 measurements, all too high or too low by 20 per cent., on 110-volt lamps. However, in order that it might not be said that I made a mistake and would not acknowledge it, I, on receipt of Messrs. Siemens and Halske's letter, took five of the ten remaining lamps and tested them, with results as given below, from which it will be seen that the average is 26·8 candles per lamp, with 2·54 watts per candle, a figure which differs but little from that previously given (2·7 watts), but 20 per cent. higher than that arrived at in the Physico-Technical Institute tests. I think it would be waste of time to go on carping at the figures. My second test corroborates the accuracy of the first, and if Messrs. Siemens and Halske desire them, the five or six remaining lamps are at their disposal, so that they may themselves confirm what I state.

Lamps.	Candle-power.	Current.
a	27·0	0·62
b	25·5	,,
c	26·0	,,
d	31·0	,,
e	24·5	,,
	134 candles.	0·62

As to the 10-c.p. 102-volt "Gabriel" lamps, I am in a much less favourable position to discuss the matter, since the tests, as was pointed out in a foot-note, were carried out in the laboratory of the Compagnie Continentale Edison. Nevertheless, I am responsible for anything misleading that the tests may have for people who do not read between the lines.

Lamps which have the highest efficiency are also generally those which last the longest. The bad ones—that is to say, those which absorb the most energy per effective candle—having given out, it may happen that the average of the remaining lamps under test is apparently discrepant from the results previously obtained. For that reason I invariably gave the curve of a single lamp of each series in order to avoid in some degree this defect, which is inevitable when one is working with a few lamps. However, to my

* From *L'Electricien* of December 10, 1892.

* In the 102-volt test the maximum variation is only 3·5 candles.

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mind this defect is not so serious as may be thought. In fact, in these experiments my aim was to ascertain one thing only, namely, the behaviour of a given type of lamp in an ordinary installation. It is the average values which especially concern private consumers or manufacturers employing incandescent lighting; the manner in which the average values are evolved are, doubtless, very interesting, but if I may be allowed to say so, it is secondary.

In a recently published pamphlet Messrs. Siemens and Halske extol the merits of long-lived lamps having an initial consumption of 3 to 3·5 watts per candle, and at the end of the letter addressed to me they boldly vindicated the quality of their lamps. It is no part of mine to notice or deny their good qualities. Nevertheless, I may remark in passing that the 16-c.p. 102-volt Siemens lamp is not what I should call an ideal one. At 102 volts the candle-power falls rapidly, whilst the watts absorbed per candle increase equally rapidly, and, as to the life of the lamp, not a single one of the ten tested by me lasted 1,000 hours. A similar test made at the Compagnie Continentale Edison on six lamps resulted in only one being alight after 600 hours, and the candle-power of that one had fallen by 60 per cent.

I have no more intention than Messrs. Siemens and Halske of discussing the matter any further, although I also have much to say. Our reasons, however, are different; on their side there is self-interest, on mine only truth. Moreover, they would gain nothing by the prolongation of this debate over details. However, I hold myself at their disposal to maintain my own statements and controvert theirs. I am not concerned with men, but with facts. I do not allow myself to be dazzled by the apparent authority of my opponents, accustomed as they are to believe in German supremacy even in the matter of logic, which has no frontiers; and if I have pressed the point it is because I am giving an indefeasible proof of my my sincerity at the same time that I place my figures beyond suspicion.

[M. Haubtmann also reproduces Figs. 10 and 11 of his article. We have not followed his example, since the correction to Fig. 10 is microscopic, and Fig. 11 was not published in these columns. We take this opportunity of mentioning that Fig. 10, p. 591, *The Electrician*, September 30th, refers, as stated in the text, to the "Zürich" lamp, and not to the lamp made by the Société Hongroise, as was erroneously stated in the foot line.—Ed. *E.*]

THE ACTION OF HIGH TEMPERATURES ON METALLIC OXIDES.

In two communications to the Académie des Sciences, printed in the *Comptes Rendus* for December 12th, M. Henri Moissan briefly describes the results of some high-temperature experiments, and an electric furnace by which the results were obtained.

M. Moissan's furnace was composed of two carefully trimmed blocks of quicklime placed one above the other, the lower one being grooved to receive the two electrodes, and hollowed out in the centre so as to form a crucible. In the first experiments a temperature of about 2,250°C. was attained from an expenditure of 1,650 watts (30 amperes × 55 volts). In the second series of experiments a temperature of about 2,500°C. was reached, some 4,500 watts (100 amperes × 45 volts) being expended in the furnace. Finally, with an expenditure of 45,500 watts (450 amperes × 70 volts), 3,000°C. was reached, at which temperature the very walls of the furnace melted and ran like water. The temperatures were measured by M. Violle.

The oxides to be experimented with were ground into powder. The carbon electrodes were previously submitted to the action of chlorine at high temperature, and were then cooled in a stream of nitrogen. The tips of the carbons were at the end of each experiment always found converted into graphite.

Calcic Oxide.—Pure lime submitted to the action of a 50-volt 25-ampere arc quickly become covered with bright white crystals. In the case of the ordinary commercial lime the crystals, very soluble in water, yielded on analysis the following composition:—Lime 97·3, alumina 1·6, silica 0·45, and traces of iron Complete fusion, followed by confused recrystallisation of the molten mass, was only attained by a 70-volt 350-ampere arc.

Strontian.—Strontic oxide crystallised at first like lime. At about 3,000°C. it melted into a transparent liquid, which became on cooling a confused mass of crystals.

Baryta.—Baric oxide became liquid at 2,000°C., and did not appear to decompose at 2,500°C. On cooling, it became a confused mass of crystals.

Magnesia.—Magnesic oxide was crystallised with far less ease than lime. At about 2,500°C it furnished transparent anhydrous oxide crystals. With 70 volts and 360 amperes it was melted.

Alumina.—Pure aluminic oxide melted at about 2,250°C. If a small quantity of sesquioxide of chromium was added, little red ruby crystals detached themselves from the mass. After exposure for twenty minutes to a 25-volt 75-ampere arc the alumina was not only melted but was volatilised.

Oxides of the Iron Family.—Sesquioxide of chromium exposed to a 55-volt 30-ampere arc melted and gave a black mass bristling with little black crystals corresponding to the formula of anhydrous sesquioxide of chromium. Binoxide of manganese on coming into contact with the arc melted, boiled, and liberated oxygen, furnishing the liquid protoxide which soaked into the lime. Sesquioxide of iron melted speedily, and also evolved oxygen, furnishing Fe_3O_4 (magnetic oxide) in a liquid or partly crystalline state. Protoxide of nickel left a fused mass, covered with little transparent green crystals. Protoxide of cobalt produced rose-coloured crystals.

Titanic Acid.—Submitted to an arc of 50 volts and 25 amperes titanic acid furnished beautiful black prismatic crystals, in appearance and properties like protoxide of titanium. If a current of 100 amperes at 45 volts was applied, this protoxide was melted in three minutes, and partly dissociated and completely volatilised after eight minutes.

Oxide of Copper.—Oxide of copper was completely broken up at 2,500°C.

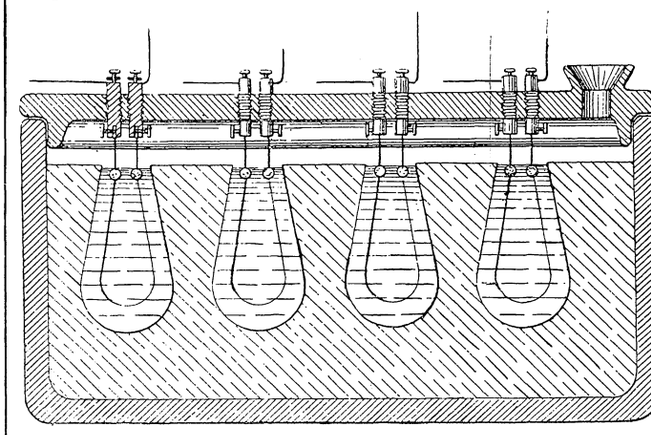
Oxide of Zinc.—Oxide of zinc was volatilised in a few moments. Long transparent flakes were deposited on the carbons, &c.

Oxide of Uranium —Oxide of uranium was reduced at 3,000°C., and in ten minutes a lump of uranium weighing 120 grammes was obtained. Sesquioxide of uranium, heated alone, was converted into long, black protoxide crystals.

In all these experiments a simple elevation of temperature sufficed to cause the metallic oxides to crystallise.

A NEW METHOD OF PREPARING FILAMENTS FOR INCANDESCENT LAMPS.*

The method of making filaments, described in the following article, is used by the Actien Gesellschaft für Elektrische Glühlampen in Budapest.



The filament is constructed in three layers, of which the core is the actual carbon thread. It is soaked with a mineral gum, and is covered with a non-conducting sheath of silicate which melts during the carbonisation and serves not only to protect the filament from burning during the process and from the air, but also to give it a smooth surface on which the third layer (which is necessary to adjust the resistance) can be finely and evenly deposited.

Hitherto the resistance of the filament has been adjusted after fixing in the bulb; but in the present case the thread is completed before being placed in position. It is usual to adjust the resistance by heating in a liquid or gas from which carbon can be deposited; but the currents set up by the heating hinder the process, owing to the contained oxygen acting on the depositing carbon, and spoiling its quality. The filaments are, therefore, heated in this process in a bath of paraffin or naphthalin, or some similar hydrocarbon, solid at ordinary temperatures. Since only the particles in the immediate neighbourhood of the filament become liquid, no appreciable convection currents are set up.

The construction of the bath may be seen from the annexed figure. The complete process is as follows:—The wooden, silk or cotton thread is steeped in a solution of—

Water glass	25 % to 30 %
Senegal gum	10 % to 15 %
Caustic soda	12 % to 13 %

* Abstract from *Zeitschrift für Electrotechnik*, November 1, 1892.

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It is then rolled, being bent into the form of an angle iron, this form having the advantage of possessing many sharp edges, which, says the *Zeitschrift*, are known to be more luminous than surfaces. The filament is then carbonised in the usual manner, and replaced in the paraffin bath, the paraffin solidifying round it; the necessary arrangements for measuring their resistance are made; the current is passed, and particles of carbon are deposited on the silicate sheath. When the filament attains the proper resistance the current is cut off, the bath of paraffin is melted, and the filament removed; the particles of paraffin are cleared off by alcohol; and the filament is then ready to be fixed in the lamp.

The method is said to possess the following advantages :—The gum gives the filament great toughness and strength. The silicate sheath again strengthens it and forms an evenly-constructed whole. The adjustment of the resistance is much easier, as paraffin is the most suitable hydrocarbon for the purpose of depositing carbon, while the solid bath prevents all access of air during the process.

THE PROPOSED INTERNATIONAL ELECTRICAL CONGRESS AT CHICAGO.

The following is a report made to the Committee of the Electrical Section of the Royal Commission for the Chicago Exhibition by a Sub-Committee, consisting of Profs. Ayrton and S. P. Thompson and Major-General Webber. The memorandum was prepared at the request of Prof. Elisha Gray, Chairman of the Electrical Congress, which it is proposed to hold next year at Chicago :—

The Committee think it well to prelude their recommendations by pointing out that the only International Electrical Congress which has met in the past under Governmental appointment and auspices was the International Congress of Electricians held at Paris in 1881, under the presidency of M. Cochery, Minister of Posts and Telegraphs. This congress was inaugurated by decrees of the French Government, and the French members were appointed officially. It sat during a period of about one month: its expenses were paid under a decree of the Republic dated December 6, 1880; and its objects were described as being intended to "fix" "*la langue electrique universelle.*"

It consisted of one President, three Vice-Presidents, 234 members, 23 officials and secretaries. The delegates represented 28 Governments. Although any delegate could elect to assist at any of the meetings, the representatives were divided generally into three sections, namely :—First: Physists, chemists, physiologists. Second: Telegraphists, telephonists, and railway engineers. Third: Electricians and engineers occupied in industrial and civil and military applications of electricity. The meetings were classified as follows: —First: Full meetings of the Congress. Second: Sectional and sub-sectional meetings. Third: Meetings at which members specially appointed read Papers on specially selected subjects.

At the meetings of the first-named class all subjects of first importance, including reports and recommendations from sections, were discussed, and resolutions of the Congress were recorded. At the second, discussions were held on various subjects, including the careful discussion of questions arising out of the Papers read at the third. At the third, to which the public by invitation were admitted, there was only general discussion, most of the time being allotted to the reading of the Papers.

The subjects to be dealt with at the meetings of the first-named class :—(*a*) Electrical units, and the means of obtaining international uniformity. (*b*) International telegraphy and telephony. (*c*) Discussion of large questions, such as the employment of electricity for lighting, electro-physiology, protection from lightning.

Of the second-named class :—In the First Section : Theoretical questions, electrical measurements, atmospheric electricity, terrestrial magnetism, lightning protectors, questions of electro-physiology. In the Second Section : Telegraphs, telephones, batteries and generators, telegraph lines, lightning protectors, for land lines and submarine cables, induction and interruption, railway telegraph signalling. In the Third Section : Industrial application of electricity, lighting; systems of distribution; transmission of power; time signals, automatic registration; electro-metallurgy and application of electricity to chemical processes.

As regards the meetings of the third-named class, events showed that papers of real scientific value were not easily secured, most writers of the first rank preferring to reserve such productions for the societies which especially deal with the respective branches of science. Besides, it was found that in the very nature of a congress more vitality was imported to the proceedings by the promotion of general discussion than by passing most of the time in listening to papers. For, however able they might be, they are naturally—if of real value—prepared more with a view of publicly recording the writer's views than of being merely suggestive.

The Committee believes, therefore, that the subjects which they enumerate below are of special interest at the present time, and are likely to bring about a useful interchange of information and possible coincidence of opinion; but that it will require careful previous consideration as to the best way of presenting them to the Congress. With this in their mind, the Committee has been led to refer to the work of the Congress at Paris in 1881, and, in connection therewith, to recall an incident which cannot but be gratifying and productive of good feeling at a moment when the great nation then principally concerned is about to undertake a similar task in the interests of electrical science and its applications. It was as follows :—At the meeting of the Congress on Sept. 20 1881, it was proposed by M. Cochery, and unanimously resolved, to suspend the day's proceedings in consequence of the news of the death of President Garfield, in the following terms:—"Je pense qu'en présence du deuil qui frappe une nation amie, l'assemblée voudra témoigner sa sympathie profonde en levant immédiatement la séance."

Subjects on some of which it is proposed that short and suggestive Special Papers might be read by specially selected Members.

Comparison between procedure in different countries.—Methods of avoiding electrical interference, and risks to persons and property.—Units of magnetic quantities, and mode of embodying them in concrete standards.—The adoption of the name "Henry" for the unit of self and mutual induction.—Adoption of the "kilowatt" instead of the "horse-power" as the unit of power.—International nomenclature for describing phenomena of alternate currents, and of electro-magnetic waves.—National and municipal testing laboratories.—Materials for standards of electric resistance.—Points of difference of the electrical vocabulary used in different countries.—The direct conversion of the energy of fuel into electric energy.—Comparison of the various methods employed for the electric transmission of power.—The cost of insulation in relation to high pressure for the electric transmission of power.—Comparison of the economics of the various systems of electric distribution.—Alternate current motors.—The behaviour of transformers when supplying power to alternate current motors.—The construction of condensers for alternate current purposes.—The measurement of power in polyphase currents.—Direct coupled and non-direct coupled dynamos.—The use of equalising dynamos in a three and a five-wire system.—The use of accumulators in central stations.—The proportions between output of dynamos, and the weight of copper and iron employed in their construction.—Electric traction.—Application of electric power in mining.—The adoption of a uniform method of distinguishing positive and negative mains.—Electric supply meters: American, British, Continental.—Criterion of sensibility of galvanometers.—Commercial instruments for measurement of electric quantities.—The relation between the voltage of the arc and the quality and composition of the carbons.—The ageing of glow lamps.—The electric working of metals.—The use of electric and magnetic tests for ascertaining the mechanical properties of metals and alloys.—The best material and mode of erection of lightning conductors in the light of recent researches in electric discharges.—The prospecting for iron by magnetic surveys.—International telegraphy.—Fast-speed and long-distance telegraphy.—The use of batteries or other generators for telegraphy.—Telegraphic lines, land and sea.—Harmonic telegraphy.—Writing telegraphs.—Long-distance telephony.—The possibility of providing telephonic communication without wires.—Application of electric signalling to the working of railways (alarms, time, &c.), and to naval and military purposes.—Magnetic separators.—The use of electricity in engraving and in art reproductions.

The Committee suggest that it would be desirable that a selection should be made as soon as possible, by the American organisers of the Congress, of the actual subjects that it is proposed to deal with, so that, even before it is decided who will be requested to prepare the Papers, and the order in which they will be taken, the delegates of the several nations may be made acquainted with the selected list of subjects. On receipt of that information the British Committee will be prepared, if desired, to suggest names of probable authors, and, if their suggestions be accepted, to arrange with the authors so that the Papers may be ready for the Congress. They suggest that a Committee for the organisation of the Congress shall meet at Chicago immediately before the date decided on for its opening, to arrange, amongst other matters, for the printing of the Papers in full, or in abstract if desirable, and for the preparation of the programmes of daily business.

BOOKS, &c., RECEIVED.

"Pioneers of Science." By Oliver Lodge, F.R.S. (London: Macmillan and Co.) Crown 8vo. Price 7s. 6d.

"Principles of the Algebra of Physics." By A. MacFarlane, D.Sc. (Salem, Mass. : Salem Printing Company.) 120 pp.

"Capital and Labour." By Lieut.-Col. Coates. (Bristol: J. W. Arrowsmith and Co.) 15 pp. 3d.

"Téléphonie Practique." By L. Montillot. (Paris: A. Grelot.) 500 pp.

"Notes on the Year's Naval Progress." Compiled for the use of naval officers and others. (Washington Government Printing Office.) 370 pp.

"Manual of Practical Medical Electricity." By Dawson Turner, M.D. 300 pp. demy 8vo.

"Modern Mechanism." Edited by Dr. Park Benjamin. (London: Macmillan and Co.) 900 pp. royal 8vo. Price 30s.

"Whitaker's Almanack for 1893." (London: Whitaker and Co.) 728 pp.

"House Lighting by Electricity." By Angelo Fahie. (London: E. and F. N. Spon.) 80 pp., paper covers. Price 1s.

"Calvert's Mechanics' Almanack." (London; John Heywood.) 70 pp., paper covers. Price 4d.

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CONGRESSES AND EXHIBITIONS.

It was inevitable that an Electrical Congress would be held at Chicago from the moment that it was decided to hold a large exhibition in that city, and so long as exhibitions continue to afford amusement to the public and to give opportunity for advertisement to manufacturers and others, so long, also, will such congresses continue to be held. There is reason for supposing that the exhibition mania is on the decline, and most of those energetic gentlemen who adopted exhibition-mongering as a profession have now found other fields for their talents. As a matter of course each show is bound to be bigger than its predecessors, and as an end must come to this sort of thing, since an asymptotic limit is out of the question, it is to be hoped that Chicago will see the last of it, although a World's Fair for London in 1895 is seriously threatened Exhibitions will, of course, continue to be held as attractions at such places as the Crystal Palace, and for special purposes such as the Naval Exhibition and the Frankfort Electrical Exhibition, and further excuses will no doubt be found for illuminated gardens and out-door music; but the progress of such affairs is not usually honoured by the holding of congresses, nor is their termination marked by the distribution of "honours."

Englishmen, it is well known, will celebrate any occasion, even the stranding of an ironclad, by a dinner; and a certain class of scientific men, among whom electricians are the most prominent, cannot pass a summer without a congress of some sort. The British Association, fortunately, satisfies this

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craving well enough; but every now and then they evince a longing for a feast of chatter, and since the delights of exhibitions naturally attract many visitors, congressers seize upon these opportunities for indulging in the joys of congressing. There is some reason in this; for all such exhibitions have some scientific departments, and many of the best scientific men of the day will brave the mob to see, as best they may, what they want to see; and to catch them and drag them from the turmoil into stuffy lecture halls, and to harangue them in various languages, and to induce them to vote upon sundry resolutions is, perhaps, after all, to do them a kindness, if not to add years to their valuable lives.

The success of the International Electrical Congress at Paris, in 1881, or perhaps it were better to say the importance of some of the subjects which were considered, will ever be held up as an excuse for further meetings. There have been congresses on subsequent occasions, but these have been nearly forgotten; not, we believe, because they were not under "Governmental appointment and auspices," but because there was nothing in particular to be done. A report, which we print in another column, emanates from a sub-committee of the Committee of the Electrical Section of the Royal Commission for the Chicago Exhibition. It has been prepared at the request of the Chairman of the Electrical Congress. No three men called together to prepare a menu for such a feast of reason would have been better able to throw out suggestions. They have evidently done their best to provide, not perhaps a menu, but a bill of fare from which a menu may be circumspectly devised. A good *résumé* of the 1881 congress is given; but it would be a mistake to go over the items, and to point out those which have left their mark as the ones which, after twelve years, should be again discussed; the general class of questions on which action can be taken is probably the same to-day, and will not be found to vary much twelve years hence. The sub-committee are fully alive to the fact that at the 1881 Congress "Papers of real scientific value were not easily secured, most writers of the first rank preferring to reserve such productions for the societies which especially deal with the respective branches of science." This is also true enough when applied to the British Association, and fully accounts for the feebleness of its transactions, and it is no doubt true of any other gathering of a similar kind. Another point of similarity between the gatherings of the British Association and those semi-official gatherings known as International Congresses, is the method of incubation. It is settled in the first place that a congress shall be held, and in the second place a sub-committee suggest topics and propose authors, and afterwards, no doubt, a few more or less honorary secretaries will worry certain unhappy men into sacrificing their time and brains to make a Chicago holiday; for doubtless the congress will lend an air of scientific importance to the show. If, on the other hand, one or two matters of real international importance were ripe for discussion, as in 1881, there would be a valid reason for the meeting. The question then arises, are there any such matters, and what are the subjects awaiting international decision?

On turning to the report of the sub-committee we find an enumeration of subjects which they believe to be of special interest at the present time. But the list contains, unfortunately, little else than suggestions for papers which might with advantage be read at the meetings of ordinary scientific societies, and we might add with distinctly less advantage elsewhere. The list is not unlike the annual circular of the Institution of Civil Engineers; some of the items are too vague—electric traction and electric working of metals; some are too limited—writing telegraphs and magnetic separators. We do not, for a moment, complain of this, for they are only put forward as suggestions from which selections may be made. But amongst them we find one or two matters which may well claim the attention of the congress, since it seems to be settled that a congress is to be held. The adoption of the name "Henry," and of "kilowatt," and the "points of difference of the electrical vocabulary used in different nations," are so distinct from the suggestions which we have just mentioned, that they ought to be placed in a separate class. These and similar questions are, without a doubt, worth settling, but whether it is worth the while of anyone to allow himself to be appointed as a delegate, and to endure a visit to Chicago at the height of its "refulgent summer," is a matter on which we prefer not to express an opinion.

LEGAL INTELLIGENCE.

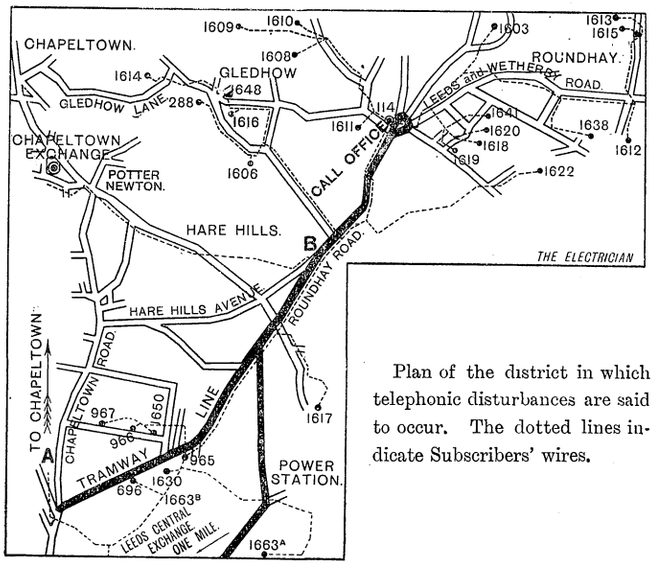
The National Telephone Company (Limited) and another v. Graff Baker.

THURSDAY, DECEMBER 15TH.

On the hearing of this action being resumed on Thursday last week, Sir FREDERICK BRAMWELL was re-called and further examined by Sir RICHARD WEBSTER with regard to the difficulty where there were two double trolley lines running like the head of a T.

Mr. BOUSFIELD: You know already that one of the objections to these double over-head trolleys and conductors is that there is great difficulty in keeping the trolleys on the lines, and they have come off from time to time in the working?—No, I did not know there was more difficulty than there was with a single conductor, except where you have two things you have double the chance you have where you have one thing. It appears to me that you can make those things take the various crossings in the same way as you can make the flanges of the wheel take the crossings of the rail. I should put the difficulty as being on a par with that which exists as to a tramcar getting off the points at a crossing.

Mr. REGINALD ALEXANDER DALZELL was then called and examined by Sir RICHARD WEBSTER. Witness stated that he was Manager of the North Lancashire district of the plaintiff Company. From September, 1891, until October, 1892, he was sub-Manager of the Yorkshire district, which included Leeds. He was thoroughly acquainted personally with the telephonic system of plaintiff Company at Leeds. The



Plan of the district in which telephonic disturbances are said to occur. The dotted lines indicate Subscribers' wires.

Leeds Central Telephone Exchange was at Commercial Buildings, in the centre of the town, with branch exchanges at Chapeltown, Morley, Stanningley and Headingley. There were about 1,200 subscribers, of whom about 1,000 were on the Central Exchange. The subscription was £10 a year. Leeds was practically connected with all the towns to the south, because it could communicate to any of them. The trunk lines were worked in a metallic loop. There were about 18,000 communications per day at Leeds. Up to October, 1891, the system was working very satisfactorily, as far as he knew. The electric tramway ran from two points in the suburbs, shown on the plan, to Roundhay Park. After the first and second days' working complaints began to come in, principally by telephone; people generally telephoned their complaints. Nearly everybody complained who

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lived or had a connection in the district in which the tramway ran. He did not think they could have retained their subscribers if they could not have improved the condition of affairs. He had personally tried the suggestion made in the Court of taking a subscriber whose earth return would be affected by the tramway back by wire to a distance. He took subscriber 114, who was near Roundhay call office. A line was looped from there to the Leeds Exchange, and one of the wires was put to earth at the Leeds Exchange. There was a slight improvement, but nothing that would do any good. There was certainly not a sufficient improvement to make it commercially useful. The suggestion, indeed, he knew from personal experience with other lines, would not cure the defect. Any part of a circuit passing over a disturbed area, if it communicated with a loop, would cause a disturbance of the whole line.

Mr. BOUSFIELD: When you are working a loop line through a disturbed district it must be insulated?—Yes.

You get to earth and get back the noise?—Yes.

As a matter of fact, it is your practice, is it not, wherever you run through a district where you find your earth return has been disturbed to use what you call a metallic return?—Yes.

Why did you not carry out that practice in the present case?—Because it is not necessary. We do not do it for subscribers' lines. We have no affected areas except where we have these long lines through the country from town to town.

You know that telegraphs do cause disturbances sometimes in your wires?—Certainly.

And if those disturbances are very serious, doubling the wire would cure those disturbances?—Yes, that is so, but I know no case where we have a disturbance on anything except on what we call a trunk line. I have never had to double a subscriber's line.

That will do for my purpose. If the line exceeds a certain length the telegraphic disturbance is serious?—Yes, that is so.

Witness then proceeded to repeat in detail his experiments with No. 114 at Leeds. He had not the slightest objection he said to its being repeated by experts if necessary.

Mr. BOUSFIELD: I suppose you did not test for insulation?—No, I think not; at the time we did not test for insulation.

If the insulation was imperfect, the experiment would be valueless?—I do not know that it would altogether. I am not prepared to say that. I take it, taking the earth back there makes the insulation imperfect; you cannot get a balance on your line with the earth there.

You brought it to earth at the Exchange; but if the insulation between the Exchange and the call office were imperfect, that would have destroyed the value of the experiment as an experiment, would it not?—To a certain extent it would. I think it was a spare subscriber's wire which was used for this return.

Continuing, Witness said he did not make any notes himself. He thought he could identify the wire which was connected. He did not think that in November, 1891, they had any serious snow. There was an interruption owing to snow; but it was not at that time, he thought. One or two trunks were interfered with.

Mr. BOUSFIELD: As a matter of fact, since this disturbance originally took place in Leeds, you have made certain alterations in your system?—None at all. We have made alterations just in the way of business, not in connection with this disturbance at all in any way.

Re-examined by Sir RICHARD WEBSTER, Witness stated that the alteration of 965, 966, and 967 was an ordinary working alteration. For the facility of getting better way-leaves and accommodating some other subscriber, they took the wire straight to the Central Exchange. He was able to state from personal knowledge that the complaints of disturbance from the tram proceeded and went on, and a snowstorm had nothing in the world to do with it.

Sir RICHARD WEBSTER: How was it you got the double metallic return from 114 to the Exchange?—I did it simply for experimental purposes.

Do you remember whether before you put it to earth at the Exchange, before you made your experiment, it was silent, so that you could talk through it in the ordinary way?—When it was a loop without an earth.

Yes?—It was silent.

So that there cannot have been a substantial defect in the insulation at that time?—No; if the one wire went to earth we should get the noise then.

It would not have been silent prior to your taking it to earth at the Exchange?—No; it would not.

Continuing, Witness stated that when subscribers wanted to speak to Liverpool, or distant places, they were charged extra.

Mr. BOUSFIELD: You told my learned friend, with reference to that experiment at 114, that before you grounded your two wires you connected them so as to make a complete metallic loop?—Yes.

And you say that then you heard no noise?—We heard no noises

You suggest that that is a test for insulation?—No; I suggest that both lines must have had about the same insulation. I have worked with lines for more than eight or nine years, and I know if you have a loop line, and there is a disturbance in the neighbourhood, if you put in one single earth on that line, I do not care where you get that earth, you get a disturbance on that line.

You know, probably, that that is due to the electrostatic induction upon the wire?—Yes.

And that experience of yours has been derived upon a long trunk line where you have occasionally, as you have said, got the branch of a tree against one of the wires?—No, I assure you, I was speaking just now about the junction wires—we have a great number of junction wires.

Mr. DANE SINCLAIR, examined by Sir RICHARD WEBSTER, stated that he was engineer and electrician-in-chief to the plaintiff Company. He had been connected with electricity for 21 years, and with telephonic working for 10 years. He superintended the construction of the telephonic system at Glasgow. The whole of the subscribers' wires were on the single-wire system. He had had a very large experience of metallic loops. Making a portion of the circuit metallic and the rest of it earthed would not get rid of disturbances. The metallic loop line, if it could be put over the whole system, would, of course, be the best system. There were, however, from a commereial and practical point of view, countervailing disadvantages in connection with way-leaves, snow, &c., &c.

Cross-examined by Mr. BOUSFIELD, Witness stated that the bulk of his experience with respect to metallic circuits was not confined to the line from Edinburgh to Glasgow. He had experience with almost every double wire in the country, and had tried and tested the system in Paris and throughout the Continent. He went specially round, and among other things he had tested that very thing of earthing such loops, and discussed it with several engineers. They had the double-wire system in Paris. He did not know that the Government had insisted upon the whole of the wires in Stockholm, where there were about 9,000 subscribers, being furnished with metallic returns. He knew that the Government exchange had metallic circuits. The subscribers on one of the exchanges could, he thought, communicate with the subscribers on the other, and the one exchange was worked with metallic returns substantially, and the other exchange was worked with earth returns. He did not try whether that particular part of the system was successful. The system he was very familiar with was working an earth line in conjunction with a complete metallic line, which was done by means of a translator. The cost of these translators varied from 8s. to 20s. He did not think any kind could be made for only a few pence.

Re-examined by Sir RICHARD WEBSTER, Witness stated that there was difficulty in ringing up if they got several of these translators in a line; they also reduced the effective talking. With regard to Paris, they were all underground wires. Overhead wires were not allowed. They had the use of the sewers for laying their underground wires. The Berlin Exchange, one of the largest exchanges in Europe, was all on the single-wire system. It was carried out by the German Government.

Mr. WIILLIAM HENRY MASSEY was next called, and, examined by Sir RICHARD WEBSTER, stated that he had heard the evidence given by Dr. Hopkinson, Lord Kelvin and Sir Frederick Bramwell, and, speaking generally, agreed with so much of it as he could understand. Looked at from an English point of view the overhead wire system was horrible. Of course, in America, it did not matter. English streets were not filled with telegraph poles and telephone poles and electric lighting poles as they were in America; one pole more or less did not matter over there. At Cardiff, they had come to the conclusion, on witness's advice, that an overhead system should not be allowed. If there was a discharge of the same character from an electric lighting as from an electric traction network, he would expect to find the same disturbance. He had been to Leeds himself. He did not go there specially. He heard the telephonic disturbance. In one case he could not get his message through. He prided himself on being able to speak rather well on the telephone.

Mr. JUSTICE KEKEWICH: You are rather good, you say, at speaking?—Yes.

Are you good at hearing?—It depends who is at the other end. I manage pretty well with the American voice, what I call the penny-trumpet voice, and shrill squeaky voice; it is suitable for the telephone. An American voice could go through a fearful noise, which I can discount.

Cross-examined by Mr. BOUSFIELD, witness stated that at Leeds he spoke from the Tramway Company's Central Station to the Steam Plough Works, and also to the Great Northern Hotel in Leeds.

Mr. BOUSFIELD: Do you know whether the gentleman at the other end had the penny-trumpet voice which is so admirable on these occasions? No, he had not; still he has got a pleasant voice—not a gruff voice.

We have not all of us the same idea as to what is a pleasant voice. You are the gentlemen called as a witness from the æsthetic point of view, are you not? No, I am called as a witness to speak to facts.

You do not like the overheard system?—No, I do not. I have seen so much of it that I think it is altogether wrong. I object to overhead things altogether, I think they are a nuisance and unnecessary.

Mr. JUSTICE KEKEWICH: That is rather strong?—It is, my lord.

The heavens are above us?—Everything that can be put underground.

Cross-examination continuing, Witness stated that he was an admirer of the culvert system, but he had not seen it at work anywhere for electric traction purposes.

Sir RICHARD WEBSTER: That is the plaintiff's case, my lord.

Mr. BOUSFIELD: I have communicated with the Solicitor-General, and we do not propose to address your Lordship before calling evidence.

Sir RICHARD WEBSTER: I will now formally put in the license from the Postmaster-General, and the correspondence before action.

Mr. JUSTICE KEKEWICH: What is the point of this.

Sir RICHARD WEBSTER: We gave them notice before they constructed the tramway on this system that they would disturb the telephones and that they did it at their own risk. It is for that reason I wish to read this correspondence. The correspondence, which was between the Leeds Corporation and the Telephone Company, and which commenced on May 14, 1891, was then read. The gist of it was that the Telephone Company, while determined to protect their just rights, and advised by most eminent counsel that they were entitled to restrain the discharge of such powerful currents to earth in such a way as to interfere with their system, were most anxious to avoid any interference with the development of electric traction, whether in Leeds or elsewhere. In a letter dated November 27, 1891, the Telephone Company was referred to Mr. Graff-Baker, and the Highways Committee at the same time reminded the Telephone Company of the privileges they enjoyed in the borough by permission of the Corporation, and the Committee hoped that nothing would arise which would interfere with the good relations at present existing between the Company and the Corporation, or which would render it

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necessary for the Committee to review the terms upon which the Company used the highways within the district under the control of the Highways Authority. Sir Richard Webster then read a letter dated December 30, 1891, from Mr. Clarance Leighton, the defendant's solicitor :—" Owing to my absence from town yours of the 23rd only reached me this morning. Having regard to the intervention of Christmas and Bank Holiday, and to the fact that it had to be forwarded from Leeds to my client's London office, and thence to me, you will readily understand why you have received no answer before, but lest you should misinterpret my client's silence I wired you this morning as per enclosed copy. My client has received no representation from yours, and has therefore ignored none. It is true that he saw your letter to the Town Clerk, to whom he explained his views, as I am quite prepared to do to you now that you have addressed yourselves to Mr. Baker, but it is somewhat absurd for you to pose as anxious to avoid litigation when all you have done is to write two letters, one threatening action against the Leeds Corporation and the other threatening my client. As you appear to assume that Mr. Baker is wantonly hostile to your Company, I take this opportunity of stating once and for all that such is not the case. He has no desire to interfere with them in the least degree. On the contrary, he frequently makes use of the telephone, and is quite prepared to listen to anything you may have to say. On the other hand, I must point out that my client, as contractor to the Leeds Corporation, is making use of his franchise in a perfectly legal manner, in the manner expressly stipulated for by his contract, and in the only manner that has been found by experience practicable. If, as you state, your Company's telephones are disturbed, it can only be because their instruments are defective. They can be rendered, as you are well aware, perfectly proof against injury by all foreign currents of electricity, whether natural or artificial, at comparatively small expense by the adoption of the McCluer or other systems of metallic return. In the United States and elsewhere the telephone companies have adopted systems which enable them to carry on their business far more perfectly and extensively than your clients do in this country, and this with tramways similar to that of my client running through their midst. I fail to see upon what grounds you claim to ask my client to alter his system. You employ exceptionally delicate instruments ; it is open to you to protect them, and it is your duty to do so. It is a practical impossibility for us to alter our system ; so that if you are right, it means that Leeds must do without an electric railway. In conclusion, I need scarcely remind you that the Thomson-Houston Company has contested the point which you now raise over a score of times in the United States, and in every instance with success. I shall hope to call upon you to-morrow, as stated in my telegram."

Mr. GEORGE WOOD was then called and examined by Mr. DUNHAM, and stated that he was a superintendent of the Corporation Waterworks at Leeds. He was familiar with the position of all the water mains in the Roundhay district. The pipes were cast iron, spigot and socket, joined together by molten lead. In the Roundhay district the diameter of the pipes varied from 6in. to 3in. On July 12th he made an inspection of the water-supply pipes at some of the houses in the Roundhay district. In every case the return wire from the telephone was connected to the service pipes leading to the mains in the streets. The wire was twisted round the pipes about three or four times, and then soldered fast.

Mr. WILLIAM HENRY PREECE, examined by Mr. BOUSFIELD, stated that with regard to telegraph instruments, the earth return had been invariably used for some 50 years past. In practice it had been found that they did not get any serious disturbances, either by tramways or by electric light currents. At Leeds, for instance, they did not find that the telegraphs there were disturbed by the tramway The Post Office had a clause inserted to protect them in Leeds. They had no necessity to enforce it (for telephonic work). The invariable practice in the Post Office was to adopt the metallic return. Fifteen years since he went into the matter, and came to the conclusion that the only possible way of making a telephone work satisfactorily and clearly was to use a metallic return. The Telephone Company had never suggested that the telegraphs were a nuisance, although he knew, as a matter of fact, that they disturbed the telephone wires. The telephone was, without exception, the most sensitive and the most beautifully delicate instrument in the world ; there was nothing to compare with it. There was no more delicate instrument for picking up and indicating stray vibratory currents than the telephone. Cross talk was common. It did not make serious interruption or annoyance in telephonic communication. One got used to it, especially in London. All disturbances were avoided as long as the metallic circuit was complete. Her Majesty's Post Office had between 30 and 40 exchanges. The total telephones worked on the exchange system was 5,382 all over the country. He saw no difficulty whatever in working a telephone system which consisted partly of earth returns and partly of metallic returns. There being disturbances down at Leeds, he had the whole of Leeds carefully surveyed and examined, and he went himself to see how far the tramway interfered with the Post Office wires. He did not think it would be a serious matter to double the Roundhay subscribers' wires.

Mr. JUSTICE KEKEWICH : I should like to know that I understand it. I gather from this map and from what I have heard that the particular district with which we are dealing is what may be called a suburb of Leeds—that is to say, far away from the place that was mentioned just now, the Great Northern Hotel, in the centre of Leeds, and it is not densely populated ; at any rate, there is not a great number of houses. Supposing those conditions were changed, as they might very well be, and you had a great many houses there, side by side in rows and squares. and so on, each of which required the telephone, and you had to supply double metallic returns for every house, then it would come to a very serious matter indeed, and if it is right there it is right in a great many other places too.

Mr. BOUSFIELD (to the Witness): You think it is the right thing to do everywhere ?—I do, undoubtedly.

Witness, in continuation, said that he was prepared to say, generally from his experience of disturbances, that in towns they were chiefly due to electro-magnetic induction. On comparatively short lines electrostatic induction would be absolutely unappreciable. With regard to the suggested doubling back of the subscribers' wires and bringing them to earth near the exchange, it would tend very much to diminish the disturbance. It would remove entirely the disturbance due to electro-magnetic induction over the part duplicated, but it would not interfere in any way with any earth disturbance—that would remain the same. Lord Kelvin had suggested that there would be electrostatic induction still left even on a short circuit. He (witness) did not think from his experiments it was possible to get electrostatic effects on wires of less than 20 or 30 miles. Examined with regard to the distance at which a disturbance might be felt, Witness stated that he had recently been making some very interesting experiments down in South Wales to endeavour to communicate between the shore and the lighthouse, three miles off, on Fleet Holms, and it was very essential to find out where earth conduction came in, and where ether induction came in. In these experiments it was shown unmistakeably that the earth was affected to a distance of two miles around the circuit on which he was experimenting, and it was only when they got beyond two miles that they got into effects of induction. An alternating current of eight amperes at 20 or 30 volts was used. The effects observed between the wires under the Gray's Inn-road and the telephone showing them that they could read a message through a distance of 80ft. had led him on to the inquiry. He doubted whether the doubling of the tramway wires would do away with disturbance of the telephone in Leeds, because one of the essences of a metallic circuit was the power to twist the circuit so as always to maintain the average distance between the inducing wire and the induced wire the same. They could not do that with a double wire for tramway traction. He did not think a complete cure could be secured in any other way than by a complete metallic telephone circuit. It was a complete cure, and a recognised complete cure, and a most effective cure, and he did not see why they should go in any other direction. Apart from the tramways, his view about the telephone as an instrument for practical purposes in the absence of that complete metallic circuit was that it was an ineffective and incomplete apparatus. The use of an earth return for telephones was not really in the long run the most economical from a monetary point of view—quite the reverse. He thought himself that if they improved their service by duplicating the telephone wires they increased their business, and the increased business paid for the increased cost of duplicating the wires.

Sir RICHARD WEBSTER : I am aware that you are a master of expression, but you are the apostle and high priest of duplicate wires for telephones ?—I am.

You have enunciated it for the last twelve or fifteen years ?—I have.

And have used very strong language about it ?—Frequently.

Still, a very large number of people, unfortunately, will not adopt your religion ?—Unfortunately they will not.

The following table was then directed to be put upon the notes :—

LIST OF POST-OFFICE TELEPHONE EXCHANGES.

	No. of subscribers.		No. of subscribers.
Newcastle-on-Tyne	612	Workington	11
Sunderland	40	Liverpool	13
West Hartlepool	29	Cardiff	84
Middlesborough	33	Newport	49
Stockton	19	Swansea	6
North Shields	17	Talywain	10
South Shields	10	Pontypool	6
Tyne Dock	12	Barry Dock	8
Jarrow	3	Tonypandy	6
Blyth	2	Britton Ferry	3
Blaydon	1	Aberdare	2
Durham	1	Merthyr	1
Hull	163	Ebbwvale	1
Leicester	105	Falmouth	4
Nottingham	8	Cork	12
Hinckley	7	Limerick	4
Loughborough	4	Waterford	7
Manchester	12	London Paris	20

Telephones in use at Reuter's offices	4,691
" " Government offices	691
Total	5,382 on March 31, 1892.

The above total includes private lines and exchange circuits.

After having gone over the table, Witness stated that he understood that the National Telephone Company had something like 40,000 or 50,000 subscribers. He knew that the Telephone Company were now paying £45,000 a year to the Government as royalties. He had not considered the question of the best way of constructing a tramway so as to avoid disturbing neighbours.

Sir RICHARD WEBSTER: Did you not establish at Plymouth an exchange on the double wire system and compete for commercial business ?—We established it at the wish of the Plymouth people, and we maintained it as long as they wanted us to maintain it.

Were the Telephone Company misguided enough to come down and compete with you ?—They compete everywhere ; they are a commercial company, we are not.

And the misguided Plymouthians actually preferred the National Telephone Company to you ?—The misguided people did.

And they succeeded in obtaining on the single wire system—this wretched system—a very large number of subscribers, so large a number that in the proper management of your department you shut up your

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exchange?—Very nearly so; but you must remember that we are not a competing business company—we are simply the Government.

There you were trying to compete?—No.

If you could have made it pay you would have kept it open?—Well, we might.

In continuation of his cross-examination, Witness admitted that notwithstanding his powerful preaching all the telephonic business of the country other than the Post Office had been carried on on the single wire system up to the present. They had had interference by electric currents from the South London Railway and Deptford. These seriously disturbed his telephone circuits; he did not remember whether they affected his telegraph circuits. The disturbance from the Holyhead electric lighting disturbed the telegraph messages on the North Western. In Leeds itself they had had the presence in the telegraph circuits of small currents. He had no doubt that they came from the tramways. He transacted very large portions of his business, and not unfrequently communicated with a number of subscribers on the National Telephone system in London. He had talked successfully on many occasions, but with difficulty. He did not think that to put the telephone system underground was a matter of enormous difficulty. The Post Office found that it was cheaper to put wires underground when they reached a certain number. He did not think that an overhead wire was any better when it was carrying a tramway current than when it was carrying a telephone current. It was equally objectionable in either case. With reference to the question of the difference of expense of overhead and underground wires, the Local Authorities at Wandsworth had tried to get the Post Office to put their wires underground, and the Post Office resisted it and produced figures showing that it cost ten times more to put them underground than overground, but that was one wire. In the case of one wire the difference of expenditure was quite 10 to 1, but where they came to 30 or 40 wires the tables were turned.

Re-examined by Mr. BOUSFIELD, Witness stated that at Plymouth they did not go into the usual arts of commercial competition. The shutting up of the exchange at Plymouth was in no way due to any failure in the efficiency of the system.

Mr. BOUSFIELD: Can you give me a reason any more than you have done why in Plymouth the population all seem to prefer the National Exchange system to yours?—One cannot predicate the mind of the commercial public. It is probably a question of rental more than efficiency.

Mr. JUSTICE KEKEWICH: Do you think it is inconvenient to have underground wires as part of the system, and overhead for another part?—There is no inconvenience at all.

Mr. JAMES SWINBURNE, examined by Mr. BOUSFIELD, stated that he had been called in to examine the defendant's tramway at Leeds, and had gone into the effect which it had upon the use of the telephone in Leeds. He had made careful experiments on the subject in conjunction with Dr. Abdank. The tramway at Leeds struck him as being a very good specimen, and well constructed in every way. He could not find any faults in it. He should not think that the contacts between the trolley and the wire and the wheels and the rail—that was to say, the variation of those contacts—had any substantial effect in disturbing the telephones in Leeds. He was of opinion that the collecting of the current when running was a difficult thing anyhow, and if from two overhead conductors, it was a very much more difficult thing; in addition to that, the double overhead system produced no end of complications. Having regard to the existence of the double overhead conductor system, and the necessities of corners, witness did not think that it was a practicable system to apply in a place like Leeds. Witness was next examined on the various suggestions made by plaintiff Company's witnesses as to how a double overhead conductor system might be worked; he did not think them practicable. As to the Vevey system, that presented more difficulties than the double-conductor system. The Buda Pesth inch and a-quarter slot would never be allowed in a town like Leeds. With regard to his tests at Leeds, he tried the experiment of using a complete metallic telephone circuit, of which two sides were along the tramway, and the third side was straight across country, and the disturbance was practically the same. Then he tried using the double metallic circuit round the two sides, the circuit being tested occasionally, and it was quite clear that if they used a proper metallic system, then, though the tramway wire was close to the telephone at the very worst part of the whole system, the telephone line was quite perfect as regards disturbance. From the result of these experiments he came to the conclusion that there might be some mischief caused by conduction, but it was practically swamped by the mischief caused by induction. He had made an examination of the different instruments which were said to be affected by the trams. He heard disturbances to some extent on a fair number of the telephones. He did not find any of them that he had any difficulty in speaking through, and he did not find that the people at the other end had any difficulty in speaking to him. The cars were in full swing. They went to the telephone office. They gave every facility, and they allowed him practically to call up any subscriber. He called them up one after the other as if he belonged to the Telephone Exchange, and asked them if they had any complaint, and they said no generally. Some had little complaints about the instruments. Then he nearly always put the question: "Are you disturbed by the tramway?" And their answers varied. Sometimes they said "Yes, there is a disturbance," but the general answer was, it was not so bad as it used to be. He asked them all whether they were ever stopped from speaking entirely, and he understood not. The apparent diminution of the disturbance in Leeds was probably due, not to a diminution of the disturbance, but to the people getting more accustomed to it. These experiments were made on May 9, 1892. He thought, if anything, that London disturbances were worse than those at Leeds.

It was then decided to send an independent expert down to Leeds to examine as to the alleged disturbances, and the Court adjourned until January 12, 1893.

Windsor Town Council v. Windsor and Eton Electric Lighting Company.

At the Windsor Town Hall on Monday last the Borough magistrates were engaged in hearing a summons issued on behalf of the Town Council of Windsor against the Windsor and Eton Electric Lighting Company for unlawful proceedings, thus described:—"On the 5th, 6th, 7th, 8th, and 9th of December, 1892, at the parishes of New Windsor and Clewer, within the Urban Sanitary District of the said Borough of New Windsor, (they) did unlawfully displace, take up, and injure the pavement stones and materials of certain streets and highways within the said district, called respectively Peascod-street, High-street, and Thames-street, without the consent of the Mayor, Aldermen, and Burgesses of the said Borough, acting by the Council, being the Urban Sanitary Authority of the District."

Mr. G. H. LONG, town clerk, in supporting the summons, stated that the Company had obtained in 1890 a Provisional Order, the 7th section of which provided that "the undertakers within a period of six months after the commencement of this Order, and before exercising any of the powers by this Order conferred on them in relation to the execution of works, shall show to the satisfaction of the Board of Trade that they are in a position fully and efficiently to discharge the duties and obligations imposed upon them by this Order throughout the area of supply." Until, therefore, the Company had satisfied the Board of Trade that they were in this position, the Order gave them no authority to do anything whatever in the town, and as the Board of Trade had not yet sanctioned their proceeding with the work, they had broken the law. This they admitted, and it remained to be seen whether they could show any reasonable excuse for going on with the work without such authority. The present proceedings were taken under the 149th section of the Public Health Act, 1875, which provided that all streets repairable by the inhabitants at large within any urban districts, and the pavements in such districts, should vest in and be under the control of the urban authority; and that any person who wilfully took up the pavements without authority should be liable to a penalty of £5, and a further fine of 5s. for every square foot of pavement displaced. Assuming that the Company had power under an Order to break up streets, notice must first be given to the highway authority of their intention to do so, and plans must be furnished showing the line of the mains and the distributing wires, and their depth and position. But in this instance nothing of that kind had been done. The object of these provisions was to safeguard the public against accidents, but in this case some accidents had occurred. In consequence of the Company's action in breaking up the streets under such circumstances, the Town Council had resolved that the town clerk should be instructed to proceed against them under the Act mentioned; but they also resolved that he should be instructed to ask only for a moderate penalty.

Mr. T. V. DAVISON, the borough surveyor, in examination by Mr. LONG, said he had measured the pavement disturbed by the Company on the dates given, and found the total superficial area to be 4,711sq. ft. He had received no notice from anyone before the stones were removed; all he had received was a plan, which was sent to him two months ago, simply showing the three streets and the direction of the wires, but not giving the depths or position. No plan had been received of the present work.

Mr. LONG observed that the Company had applied to the Town Council for permission to lay their mains, and the Council, on learning from the Board of Trade that the Company had not complied with the Provisional Order, passed a resoution deciding not to consent to the Company going on with the work.

Mr. DAVISON further stated that notice had been given to the Town Council, the Postmaster-General, and the Gas and Water Companies, as required by the Order, but no notice with plans, as required three days before by the Public Health Act.

Mr. SEVENOAKES, on behalf of the defendant Company, declared that Mr. Davison had received proper notice with plans, and while admitting that the Company had disturbed the streets without the sanction of the local authority, and that technically they had not satisfied the Board of Trade that they were in the actual possession of sufficient capital to carry out the work over the whole area, he observed that he knew of no other company in the whole country that had been able to comply with that requirement But the Board of Trade had power reserved to withhold the revocation of an Order if they were satisfied that the Company were doing their best to carry it out. In this instance the work that had been done had been done with the full knowledge of the local authority, who had been consulted by himself individually, and by the Directors, and who had received several assurances that the company would do everything in their power to carry out the Order. The Board of Trade had shown extreme willingness to assist the Company. The Company had received the verbal sanction of the Board of Trade, and these various circumstances to some extent justified the action of the Company. He further claimed that, so far from the town being injured by what had been done, it would benefit, inasmuch as the pavement, when replaced by the contractors, would be in a better condition than when it was disturbed; and, further, that a large number of men had received employment who would otherwise have been idle. Under all these circumstances he asked the Bench to take a lenient view of the matter, and to be satisfied with inflicting a nominal penalty.

A number of letters between the various parties were put in and read, and in the end the Bench delivered a written decision, viz.:—"The magistrates are necessarily obliged to convict the defendants, as they have admitted having committed an offence The only question is the amount of penalty to be imposed. It is evident that the object of compelling persons to give notice to the highway authority, and requiring that the breaking up of the street shall be done under the superintendence and control of the surveyor, is to provide that means shall be taken to protect the public

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against accident. This was not done in this case. The amount of the penalty to which the defendants are liable, in addition to the fixed penalty of £5, is 5s. per square foot, amounting to £1,175. We are unanimous in imposing a fine of £2 as a fixed penalty, and in addition, a further penalty of £9. 16s., being at the rate of ½d. per square foot. We regret that the Town Council did not itself take action to prevent the breaking up of the streets instead of throwing the onus of a very unpleasant duty upon the magistrates."

The fine was at once paid, together with the costs.

Muirhead v. Caledonian Telephone Company (Limited).

In the Court of Session at Edinburgh, on Thursday last week, Lord Stormouth Darling had on his roll for trial an action brought by Mr. Andrew Erskine Muirhead against the Caledonian Telephone Company (Limited) for reduction of an agreement said to have been entered into between the pursuer and the defenders in December, 1891, and January, 1892. The pursuer in his condescendence said he was a telephone engineer, and that by the introduction of French telephones at the expiry of certain English patents in 1890 and 1891, he had developed a considerable business, for the carrying on of which the Caledonian Company was ultimately formed, with a capital of £50,000 in £1 shares, 10,000 shares of which had been taken up and 10s. paid per share. The pursuer was appointed Managing Director, and had a salary of £300 and 10 per cent. commission on net profits. In respect of his valuation of his stock, &c., he claimed £2,084. On account of this amount the defenders had paid him £400, and gave him 1,600 shares (10s. paid), valued at £800. The defenders admitted the accuracy of items £1,033 and £150, and the payment to account of the shares, but believed no further money was due, though they were willing to have the accounts adjusted on the action coming before the Court. The counsel asked for a short adjournment, as there was some hope of an arrangement being come to, In the result it was stated that the case had been settled, and his lordship was asked to discharge further proof, assoilzie the defenders, and find neither party entitled to expenses. Part of the arrangement, which was otherwise financial to a small extent, was that the whole of the charges made against the Directors were unreservedly withdrawn.

CORRESPONDENCE.

THE COST OF ELECTRIC SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although it was not my intention on entering the discussion on the above subject, to claim the suggestion of the sliding scale price for electricity, based on the *maximum demanded*, yet it may be historically interesting to note that I as manager of the Brighton Electric Light Company (then a branch of the Hammond Electric Light Company) drew up and used a contract form in the spring of 1885, from which I extract the following sentence relating to the charge:—"The undersigned hereby agree with the Brighton Electric Light Company to pay them at the rate of one halfpenny per hour per lamp (but in the event of the average daily consumption during the quarter being less than three hours per day, the charge shall be one penny per light per hour), as determined by the meter supplied by the Company." This was modified later in the same year, to the effect that the charge per unit consumed would be one shilling, if over ten were used, per lamp installed, and 1s. 4d. if less than ten were used.

Although there is an obvious flaw in the above scale, and it now seems very badly expressed, yet it will be evident that the suggestion of a price dependent on the number of hours the demand was used, belongs to the ever-electrically-active town of Brighton, and to the good old days when electricity was sold at 1s. 4d. per unit.

As the Brighton Corporation propose from January 1, 1893, to charge for the electricity consumed on the sliding scale basis of 7d. per unit for the first two hours per day the demand has been used (as shown by the yearly consumption), and half-price, or 3½d. afterwards, it is evident that I, as their adviser, after some considerable experience, have not arrived at the same conclusion as Mr. Holmes, of Liverpool, about the difficulty of getting people to understand the sliding scale; or believe that it has any material limiting effect on the number of lamps installed; for under the new tariff I fully expect a considerable increase in that number, owing to the obvious advantage to business houses in being able to get the electric light in their sitting-rooms, when the shop lamps are turned out, at the ridiculously low price of 3½d.

The method of determining the demand will be to install near the meter in every house a thermal type of maximum recording ammeter (as suggested by Prof. Kennedy), which will be read and set back to zero by the Meter Inspector once every month in the two winter quarters; the mean of these six maxima will be taken as the "demand" from which the number of hours per day the lamps have been used, is calculated.

In conclusion, I may add that the result of the present year's supply of electricity from the Corporation's works has been to show that out of a total expenditure of 7d. per unit sold, 5d. was the cost of having the plant in readiness to supply, and only 2d. the cost of producing the unit; thus bearing out Dr. Hopkinson's contention that a uniform charge per unit, without reference to the maximum demand, is financially unsound.—Yours, &c., ARTHUR WRIGHT.

26, Park-crescent, Brighton,
December 21, 1892.

EARTHING THE MIDDLE WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There are some points in Mr. Mavor's letter (see *The Electrician*, December 9th, p. 170) which I would ask your permission to comment upon. In his second paragraph, if I understand it rightly, he speaks of experience with earthing as if it had produced bad results in practice. I can but assume that he refers to installations accidentally earthed; the experience with wilfully earthed installations with two wires in this country being very limited. The only ones that I have acquaintance with on land with double wiring are those which I carried out several years ago, and which are now working in the same condition—the *Scotsman* Office in Edinburgh, with about 350 lights, being one, and Storey Bros. and Co.'s installation, Lancaster, being another large one; this latter has several detached buildings with one system of mains, and resembles strongly a town supply. In neither of these installations has anything occurred which could show that the earthing principle has introduced any detrimental effects; on the contrary, many advantages were derived. Judging from the following extract from an article by Von Ph. Seubel, which you published in your issue of 11th November last, it would appear that earthing the middle wire was the absolute cure of the troubles which Mr. Mavor describes as having taken place in America:—"It was only after careful discussions between a number of the officers of the Edison General and the Edison Illumination Companies of New York, that the third wires were put to earth at all the distributing centres, and in the central stations themselves. For three years I was occupied in the construction and maintenance of the underground network of the New York Edison Stations, and can state that before we put the middle wire to earth, we had very frequent troubles, which, in most cases, were due to electrolysis; in fact, not a week passed without a number of disturbances in the network, some very serious and some trifling. From the time, however, we put the middle conductor to earth the network remained perfect and absolutely free from faults for more than three months, and it seemed as if the previously existing strong tendency to electrolytic action had disappeared. Such disturbances as did take place at very long intervals of time were much smaller in extent than had formerly been the case, and it was abundanently evident to us that in addition to other advantages which were obtained by this earthing of the middle wire, it was an indisputable fact that it practically freed the network from all faults, whilst no corresponding disadvantages were observed. No complaints from the Telephone Company ever came to hand to my knowledge, notwithstanding that I was in daily active communication with the officers of the Company."

With regard to Mr. Mavor's comments on the benefit of insurance rules, I see only how they have confirmed old ideas, and how much they have retarded progress. This, in particular, I have been made to feel keenly in my early attempts at earthing and latterly in the introduction of concentric wiring. British engineers and electricians are not the people to establish bad work, proof of which we have in every other

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industry, all of which have been left to the skill and experience of the parties interested in the subject and unhampered by rules from insurance companies.—Yours, &c.,

J. D. F. Andrews.

41 and 42, Parliament-street, London, S.W.,
December 15, 1892.

P.S.—I delayed this letter waiting the sanction of the proprietors of the *Scotsman* and of Messrs. Storey Bros. to publish the above given information.

THE EWING HIGH-FREQUENCY ALTERNATOR AND PARSONS STEAM TURBINE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of November 18th I find a description of Prof. Ewing's high-frequency alternator, which has pleased me chiefly because it conveyed to me the knowledge that he, and with him, no doubt, other scientific men, is to investigate the properties of high-frequency currents. With apparatus such as you describe, shortly a number of experimenters, more competent than myself, will be enabled to go over the ground as yet but imperfectly explored, which will undoubtedly result in the observation of novel facts and elimination of eventual errors.

I hope it will not be interpreted as my wishing to detract anything from Prof. Ewing's merit if I state the fact that for a considerable time past I have likewise thought of combining the identical steam turbine with a high-frequency alternator. *Anch' io sono pittore.* I had a number of designs with such turbines, and would have certainly carried them out had the turbines been here easily and cheaply obtainable, and had my attention not been drawn in a different direction. As to the combination, to which you give a rather complicated name, I consider it an excellent one. The advantages of using a high-speed turbine are especially great in connection with such alternators. When a belt is used to drive, one must resort to extraordinarily large diameters in order to obtain the necessary speed, and this increases the difficulties and cost of construction in an entirely unreasonable proportion. In the machine used in my recent experiments the weight of the active parts is less than 50lb., but there is an additional weight of over 100lb. in the supporting frame, which a very careful constructor would have probably made much heavier. When running at its maximum speed, and with a proper capacity in the armature circuit, 2½ H.P. can be performed. The large diameter (30in.), of course, has the advantage of affording better facility for radiation; but, on the other hand, it is impossible to work with a very small clearance.

I have observed with interest that Prof. Ewing has used a magnet with alternating poles. In my first trials I expected to obtain the best results with a machine of the Mordey type—that is, with one having pole projections of the same polarity. My idea was to energise the field up to the point of the maximum permeability of the iron and vary the induction around that point. But I found that with a very great number of pole projections such a machine would not give good results, although, with few projections, and with an armature without iron, as used by Mordey, the results obtained were excellent. Many experiences of similar nature made in the course of my study demonstrate that the ordinary rules for the magnetic circuit do not hold good with high-frequency currents. In ponderable matter magnetic permeability, and also specific inductive capacity, must undergo considerable change when the frequency is varied within wide limits. This would render very difficult the exact determination of the energy dissipated in iron cores by very rapid cycles of magnetisation, and of that in conductors and condensers by very quick reversals of current. Much valuable work remains to be done in these fields, in which it is so easy to observe novel phenomena, but so difficult to make quantitative determinations. The results of Prof. Ewing's systematical research will be awaited with great interest.

It is gratifying to note from his tests that the turbines are being rapidly improved. Though I am aware that the majority of engineers do not favour their adoption, I do not hesitate to say that I believe in their success. I think their principal uses, in no distant future, will be in connection with alternate-current motors, by means of which it is easy to obtain a constant, and in any desired ratio, reduced speed. There are objections to their employment for driving direct-current generators, as the commutators must be a source of some loss and trouble, on account of the very great speed; but with an alternator there is no objectionable feature whatever. No matter how much one may be opposed to the introduction of the turbine, he must have watched with surprise the development of this curious branch of industry, in which Mr. Parsons has been a pioneer, and everyone must wish him the success which his skill has deserved.—Yours, &c.,

Nikola Tesla.

AN INDUCTION COIL ON ALTERNATE-CURRENT SUPPLY MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As an illustration of the point raised by Dr. Fleming in his "Experiments on the Magnetic Behaviour of Transformers at the Moment of Connecting them to a Circuit," the following experiment may be of interest:—

An induction coil, capable of giving 1½in. sparks, was supplied with an alternating current at twelve volts from a transformer on a house-lighting circuit in the Metropolitan Electric Supply Company's district. The coil has one hundred turns in the primary and eight thousand in the secondary, and, therefore, acted as a one to eighty step-up transformer. The length of spark from its secondary coil was too short to measure, and but little alteration could be noticed in its behaviour towards a vacuum tube when its condenser was arranged in shunt to the primary. But when the same alternating current was supplied to the coil through the contact-breaker, and that was allowed to vibrate, then the full length of spark (one and a-half inches) again appeared abundantly.—Yours, &c.,

H. L. Jones.

LUMINOUS DISCHARGES IN EXHAUSTED TUBES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The suggestion in your Editorial Note of December 9th, as regards the objection to the use of the term "current" in referring to the luminous discharge observed in bulbs and tubes surrounded by a coil of wire, through which a Leyden jar is discharged, calls for a few remarks. Doubtless, the term "electric current" is not a happy one under any circumstances, but, as it is universally employed, it is necessary to put up with it. I fail to see, however, that it is more inapplicable to the discharge in the tubes than to cases in which it is usually employed, *e.g.*, the current in an electrolytic cell. As regards the necessity of a closed circuit, we know that when dealing with alternating currents it is not a requisite condition, as there is an undoubted current in the conductors joining an alternating dynamo to a condenser, or in the rods of a Hertz oscillator.

In the case of a spiral coil round a straight tube there is no trace of a return circuit, unless the faint luminous glow filling the whole tube act as such, which I think extremely improbable. I do not imagine, however, that a return is necessary. The magnetic induction is strongest near the wire, and its rate of change is large enough to produce an electric stress sufficient to break down the rarefied gas close to the wire, resulting in a molecular convection current parallel to the wire, which tends to charge one end of the tube positively and the other negatively. Immediately this stress is removed these charges reunite (this may partly account for the faint glow which pervades the whole tube, and which I have never seen entirely absent, though, when the spiral discharge is very bright, it is hardly noticeable). The discharge from the jars being oscillatory, there will be a swinging backwards and forwards of the molecules close to the wire, thus giving the luminous spiral, as, in this swinging, the molecules will probably be caused to "wriggle" by the violence of their collisions, and thus give out light-waves. To obtain a bright spiral it is necessary that the wire should be very close to the tube, and it is consequently

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advisable to use bare wire. The best results I have obtained hitherto have been with an exhausted tube 13cms. in length and 2cms. in diameter wound with a spiral of 4 turns, 2½cms. pitch, of bare copper wire No. 23 B.W.G. With this, by properly adjusting the spark gap, a very bright and clear spiral can be obtained. Lengthening the pitch of the spiral rapidly reduces the brilliancy of the discharge, though I have, with one of about double the above pitch, obtained very fair results. With a straight wire I have, up to the present, been unable to get any trace of a straight luminous band, although a faint luminosity is sometimes visible in the whole of the tube.—Yours, &c., E. C. RIMINGTON.

The Park, Norwood, S.E.

GILBERTIANA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Silvanus P. Thompson has seen fit to publish a letter in your columns as remarkable for its inaccuracy as for its bad taste, and I shall be obliged to you if you will afford me space to correct the former, the latter being his own affair.

Prof. Thompson appears injured because a hard-working and singularly erudite American is publishing a translation of "De Magnete," the only conceivable reason for this emotion being that such a publication will make more ridiculous than they are at present, the hitherto sterile pretensions of the Gilbert Club, about which such a fuss was made some years ago by Mr. Thompson. Since when did this abusive Professor possess an international copyright in "De Magnete"?

The following facts may be of interest. Last autumn Mr. Mottelay came to consult me as to the course he should adopt with regard to the richly annotated translation he had made of Gilbert's book. He was divided between two opinions. He hesitated to do what he thought might interfere with the vague intentions of the Gilbert Club, and he was very reluctant to allow injustice to be done to the "De Magnete," a result he feared would inevitably follow, owing to what he considered Prof. Thompson's surprising want of knowledge on the subject.

I strongly advised him to publish, urging his absolute right to do so; the folly of allowing the great labour he had devoted to the subject to be wasted; the apparently doubtful, and, in any case, the limited issue of the Gilbert Club programme; and, taking his statement for granted, the imperfect character of the translation, if it ever were published. Mr. Mottelay decided to follow my advice, and Prof. Thompson may, therefore, look to me as being primarily responsible in the matter.

The reputation of Messrs. J. Wiley and Sons needs no defence at my hands against the scurrilous attack of Prof. Thompson. They rank as high as any publishers and gentlemen in the world. It is true that they published American editions of Ruskin's works; but it is also true that they exhausted every possible means to pay a royalty on these works, and only abandoned the attempt when, after several years, Mr. Ruskin refused to negotiate. Prof. Thompson may learn more of the standing of Messrs. Wiley and Sons if he ventures to attend the Electrical Congress at Chicago next year.—Yours, &c., JAMES DREDGE.

London, December 20, 1892.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am indeed very sorry that my friend, Prof. S. P. Thompson, deemed it advisable to give publicity to the letter which appeared in your issue of 9th inst.

Prof. Thompson is often referred to in my class of experimental physics as an authority on methods of winding electromagnets, on measuring the number of magnetic lines that thread through a given circuit, and, I may add, on dynamo-electric machinery in general; but I am sorry to say that his letter has led me to conclude that he sometimes allows his pen to run in advance of his knowledge. In a man with any pretensions to science, this is hardly pardonable.

If Prof. Thompson had known the negotiations that took place between Messrs. Wiley and Sons and Ruskin's publishers, if he had known the offers made by the great New York firm years before any copyright law was concluded, he would never, I feel sure, have committed himself to so *gratuitously* injurious a statement as that put forward in his letter about Mr. Mottelay's translation of Gilbert's "De Magnete," and his prospective American publishers.

May I say, Sir, that several of my pupils and electrical friends—interested in the great work of Dr. Gilbert—have frequently asked me, during the past three years, what is or what may be the probable period of incubation of Gilbert's great work. Doubtless Prof. Thompson has carefully diagnosed the case, and will, with his usual courtesy, enable me to give a satisfactory answer to my class when we meet after the Christmas holidays.—Yours, &c.,

Tooting College, Dec. 20th. M. F. O'REILLY, D.Sc.Lond.

[If we are rightly informed, Mr. Ruskin's works were reprinted in anything but a high-class fashion, in direct opposition to his wishes; and if we understand Mr. Ruskin's views on such matters, the offer of money in condonation of this act would add additional insult to the injury.—Ed. *E.*]

PROF. AYRTON'S MAGNESIUM CELL AND HIS EXPERIMENTS ON THE MIGRATION OF GOLD THROUGH MERCURY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On my return from the Continent to-day, I read Prof. Ayrton's reply to my letter published in *The Electrician* of December 9th, and if you will allow me, I shall now add a few further remarks. Prof. Ayrton agrees with me that the high E.M.F. of the magnesium-mercury cell can neither be explained by the chemical combination of the two metals nor by a thermo-electric effect of the usual kind, but is probably due to the interposition of some foreign substance between the magnesium and mercury. Whether this foreign substance be moisture or acid, as suggested by me, or magnesium oxide as supposed by Prof. Ayrton, is not very material, so long as it is conceded that it partakes of the nature of a compound body and an electrolyte, since there is nothing remarkable that a cell, consisting of two metals and an electrolyte, should show such a high E.M.F. electrometrically.

The formation of a thin film of oxide, or more probably hydroxide on the surface of the magnesium wire appears to me very plausible, inasmuch as I observed the very same thing many years ago with aluminium wire (*Nature*, Vol. XXVI., p. 245). When a freshly-scraped aluminium wire was brought into contact with mercury, and the resistance measured from time to time, it was observed that a gradual increase took place, which sometimes almost rose to infinity. The same was observed without mercury, when two aluminium wires were twisted together, but then oxidation proceeded much more slowly. If mercury is boiled with aluminium in vacuo, and then exposed to the air, it soon becomes covered with a growth of greyish-white alumina, which in reflected light shows a blue colour, evidently due to finely divided metal uniformly distributed in the substance.

With reference to the supposed electrical transference of gold through mercury, I mentioned only one cause in my former communication which would tend to convey gold to the bottom of the tube, viz., the circulation in consequence of inequalities of temperature; but it is quite obvious that when gold is placed on the top of mercury it will also descend, on account of its higher specific gravity. If, however, the gold is introduced at the lower end, and mechanical disturbances and changes of temperature are avoided, it will probably take an extremely long time before it reaches the uppermost strata. To substantiate this I need only recall the well-known experiment on the very slow upward diffusion of copper sulphate in water.

I remember having seen tall glass cylinders containing concentrated copper sulphate solution at the bottom, and colourless water above, which had been standing in a suitable

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locality for over a year. During the quickening of the mercury surface by the electric current mentioned by Prof. Ayrton, such violent disturbances take place that it is not at all surprising the gold should be rapidly distributed throughout the mercury.—Yours, &c., EUG. OBACH.

Woolwich, December 17, 1892.

P.S.—I just see in the last number of *Nature* that Prof. Erdmann, of Berlin, has also noticed the formation of hydrate of alumina on amalgamated aluminium. My own observations were made 20 years ago, and the hydrate then formed I still have in my possession; even now it shows the bluish colour quite distinctly.

THE RUSH OF CURRENT ON CLOSING THE PRIMARY OF A TRANSFORMER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have followed with much interest the series of experiments with transformers which Dr. Fleming describes in the current number of *The Electrician*. There is one point, however, in regard to which I have not been able to arrive at any degree of clearness. Why does Dr. Fleming assume that the rush of current, which he *alleges* takes place occasionally on "making" the primary circuit of the transformer, is due to a persistent magnetic condition of the core? Surely, nothing would have been easier than to test the magnetism of the core on each occasion that the current was switched on; but I do not gather that Dr. Fleming did this. Is it not equally, or more, probable that the alleged phenomenon was due to a condenser effect? This could easily be ascertained by earthing both coils of the transformer when out of connection with the mains, and if it turn out to be the case a simple appliance for earthing the coils of the transformer when disconnected would prevent the rush.

I have ventured to use the word "alleged" in this connection, as, though a certain slight difference of spark is no doubt occasionally observed, practical experience seems to show that the "rush" is never sufficiently formidable to give rise to any danger of collapse, and that transformers are daily connected with and disconnected from the mains without the occurrence of any mishap.—Yours, &c.,

8, Featherstone-buildings. R. N. LUCAS.
Dec. 20, 1892.

ELECTRICITY SUPPLY AT IPSWICH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We thank you for the second of your notes in your last issue. May we ask you, however, to be good enough to correct therein the statement that "Messrs. Laurence and Scott carry on an electrical supply business at Ipswich."

We disposed of this business over six months ago, expecting that the Ipswich Electricity Supply Company (Limited), would carry it on and develop it, but we regret that the Company has not so far fulfilled these expectations, and, owing to the announcement of the sale of its plant, we wish it to be clearly understood that the Company is in no way under our management.—Yours, &c., LAURENCE, SCOTT AND CO. (LIMITED),
W. B. Sisling, Secretary.

Gothic Works, Norwich, Dec. 20, 1892.

WOODHOUSE AND RAWSON UNITED (LIMITED).

The annual general meeting of the shareholders of this Company was held yesterday at the City Terminus Hotel, when there was a large assemblage of the shareholders. Sir Rawson W. Rawson occupied the chair.

The SECRETARY having read the notice calling the meeting,

The CHAIRMAN stated that the desire of the Directors was that the shareholders should be given the fullest information on all matters concerning the Company and should be placed in a position correctly to estimate the position and prospects of the Company, and form a judgment as to the wisest course now to be pursued. At considerable length he analysed the losses which had taken place during the past year, in order to show the causes from which they had arisen, and to demonstrate to them that these causes were exceptional and would not recur. The first of these, as shown in the profit and loss account, was that on lamp settlement and action £14,472. Their Company was prevented by the result of the action of the Edison and Swan Company from manufacturing or selling incandescent lamps in the United Kingdom, and as the result of this injunction they were prevented from utilising their valuable lamp patent, which had made the reputation of the Woodhouse and Rawson incandescent lamp. Subsequent to that action the Company, under the best legal advice, entered into an arrangement with the British Electric Light Company to work under the licence which that Company had obtained from the Edison-Swan Company. Owing, however, to a technical legal point, they found themselves subsequently in a position in which there was no alternative but to give up all attempt to contiuue the lamp manufacture, or to run the risk of incurring heavy damages at the suit of the Edison-Swan Company. By these means they were deprived of one of the principal expected sources of industrial profit, and in order to settle the action of the Edison-Swan Company they had to incur the large loss mentioned, the major portion of which was due to the necessary writing down of the stock and plant in that department. They retained their lamp plant and expected in next November, whenever the patents of the Edison and Swan Company expired, to resume the manufacture, with the advantage of the reputation which they had already established for their incandescent lamps. The next item was loss at Kidsgrove, amounting to £17,000 odd. The loss had been on contracts taken over from the vendors, and on work taken by them while the vendors were in the service of the Company. The losses were also due to debts which were incurred by the failure of the vendors' firm. In the matter of the Kidsgrove purchase, the Directors considered themselves justified in relying to a great extent on the judgment of their then business manager. Under the present management all the contracts undertaken, with a very few exceptions, had been profitable. A large amount of business had been taken up and successfully carried out, and a still larger amount, reaching a total of nearly £50,000, had been offered them during the last few months, which they could have undertaken if they had had the necessary capital. The third item on which he would remark was loss on trading and depreciation, amounting to £37,000. As far as they could make out, nearly £30,000 of this might be stated to be depreciation, and not actual trading losses. A portion of the loss was due partly to agencies which had since been closed as unprofitable, and the initial expense in the formation of new branches, several of which had only been in operation for the last four or five months, and were now beginning to pay their way. Among the most promising he would specially refer to Johannesburg, Sydney, and Paris. A great deal of the loss on trading was due to the working of their Cadby Hall Factory, which since their lamp business had to be temporarily closed, could not possibly be carried on with a profit. These works they proposed almost entirely to close after Christmas for a while, transferring their manufactures to Manchester and Kidsgrove works. By these means standing charges which had amounted to as much as £6,000 a year, would be converted into an annual profit of £500 or £600, which would be increased to a very considerable amount as soon as they were able to resume their lamp manufacture. The depreciation of stock, plant, and tools represented 25 per cent. off the cost price to the Company, which the Directors had thought wise to have written off. The sum of £5,650, which constituted the next item for depreciation on patents, was the proportion they had decided to write off each year from the amount at which their patents stood in their books. As they took no credit for new patents, they were satisfied that due provision was made for securing that the value of their patents was not unduly estimated. During the last year they added over 20 patents of more or less value to their list, most of which had been acquired at a mere nominal cost. It was only in cases where the invention, if realised, would be worth a large sum to the Company, such as £20,000 or £30,000, that they thought of spending anything but a few pounds or, at the outside, a few hundred pounds on developing it. One exception to this rule he might mention—namely, the Epstein patents. In that case it had been sufficiently shown to their experts, after a trial of more than two years, that this accumulator patent of Mr. Epstein was destined to prove one of the most valuable electrical inventions of the day. As to the criticism why the Woodhouse and Rawson Company undertook the business of promoting other electrical companies, the answer was clear. Among the patents which were brought to them were some involving necessarily so vast an outlay that it would be impossible, if it were expedient, for their Company to undertake the manufacture itself. At the same time, some of these patents were of very great value. Having now gone through the several losses shown in the balance-sheet, he might point out that they had depended not so much upon loss in trade as upon depreciation of stock, which they could not help, and the depreciation of securities, which they could not help, and which was not certain. He then referred to a special report of the auditors, as alluded to in their certificate to the accounts, and said that the necessity for this report arose from the fact that they were obliged to present their report and balance-sheet to the shareholders before the end of the year, and that, owing to the confusion caused in their accountant's department by a change of staff that was necessary, the required information and vouchers could not earlier be laid before the auditors. As the best compromise that could be effected, therefore, the Board determined to request the auditors to give such certificate as they were able to do with the materials laid before them, and to qualify their certificate in a report, which should be laid before the shareholders. Several of these questions, which were open at the date of the auditors' signature, on the 12th instant, had since been cleared up. He then read the report of the auditors, and gave further explanations required to clear up those which remain. With reference to the vouchers which still remained to be produced, the Board had no doubt that they would shortly be forthcoming. The amount was not large. The question of repayment of the guarantee fund was one upon which it was due to the shareholders that he should enter with some detail. The paragraph in the original prospectus was founded upon a clause in the agreement of this Company with the vendor Company, Woodhouse and Rawson (Limited). Having read the clause he said two interpreta-

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tions were possible of it. The first which was urged upon them by the vendor Company, was that if at any time during the three years they made sufficient profits to pay a dividend of 15 per cent. for three years the fund would at once be free from any obligation, and could not afterwards be drawn upon to make up the deficiency. The other view, which was taken by the Directors of this Company, and which he would assume for the present purpose to be the correct one, was that they were at liberty to make up from the guarantee fund the amount due to complete the 15 per cent. dividend if the profits available fell short of that amount. At that time last year, when the question came up for discussion, the prospects of the Company were extremely promising. In the first place they had secured the valuable concession of electric lighting of the Champs Elysées, in Paris, half the capital for the working of which concession had already been obtained by them in France, and, but for the extreme depression which prevailed in the Money Market in this country, there should have been (and the Directors foresaw) no difficulty whatever in providing the other moiety of the necessary capital. The profit to this Company should have been not less than £40,000 if that concession had been worked by them, but, unfortunately, they were unable to find the necessary share capital in this country, and one opportunity for making a profit was lost. Secondly, they had in their hands at that time the valuable Oncken and Epstein patents, both of which they anticipated being able to realise in the course of the present year. The Oncken patents they did realise, though at a very much reduced price, and owing to the comparatively small amount of capital subscribed in that Company they were obliged to take their profit, reduced as it was, in shares. That profit, as was stated in the report, did not show in last year's balance-sheet, as the Oncken Company was only brought out after the close of the financial year. The Epstein Company they had preferred to postpone bringing out. In addition to these three sources of what should have been very handsome profits, there stood to the credit of the Company a reserve of £43,000, represented by the investments now standing to their credit. It seemed, therefore, sufficiently clear that there was no reasonable probability of the profits of the Company from one or more of the four above-mentioned sources proving insufficient to pay the 15 per cent. dividend, and what the Directors could not but view with considerable anxiety was the obligation under which they lay of having in great probability to find £75,000 in cash to repay the vendor Company on the 1st of July in the current year. Of course, had the £75,000 remained intact in the bank from the first commencement of the Company, no difficulty could have arisen ; but inasmuch as the Company had, under the powers conferred upon it by the agreement with the vendor Company as mentioned, availed themselves of the right mentioned in the prospectus to employ this capital in the business, the fund was no longer in existence, and they were confronted by the alarming obligation to provide it by July 1st. Under such circumstances, they came, after a most careful and anxious consideration, to the conclusion, which he felt sure they would agree was the correct one, that if they could persuade the vendor Company to accept a considerable portion of the sum to be repaid in Debenture stock of this Company instead of in cash, that would be taking the best course in the interest of this Company. This, after much negotiation, they succeeded in arranging, and compromised the claim of the vendor Company in the month of January last by a payment of £12,000 in cash, and £51,000 in Debenture stock, and a special meeting of the shareholders authorised the Directors to carry out this arrangement. With regard to finance, the present position of the Company was this: it had cut down its expenses by a very large amount, and with the reductions which it contemplated carrying out before the end of this month, it would have got rid of all the sources of loss. In the industrial portion of the business the incomings would then at once be more than equal to the outgoings, and, they had every hope, would bring in during the year a very fair profit ; but for this purpose it was necessary to buy off the debts that they had incurred during the past, and to provide an adequate working capital for the loss. To enable the Company to buy in cheap markets, and to maintain its credit, the Directors estimated that the sum required was £60,000, and they proposed to raise this amount by mortgaging their free investments, amounting to over £70,000, and the stock-in-trade and merchandise, which amounted, at the date of the balance-sheet, to nearly £100,000. This would not interfere with the existing debentures and Debenture stock, as the proceeds would be chiefly used to pay off existing liabilities, nearly the whole of which was at present secured upon securities of different kinds, and more especially to pay off the amount that they had borrowed upon their uncalled capital, and thus save the necessity of making a call at the prsent time. The rate of interest to be paid was a high one, namely, 10 per cent. per annum, but it was only a temporary loan for a short period (one year), and as it would be issued *pro rata* to the shareholders and debenture-holders of the Company, they would have the benefit of this high rate. The balance would enable them to undertake profitable contracts which were offered to them at home, and which, as the business manager, Mr. Stutchbury, would presently inform them, were ready to their hands to the extent of £30,000 to £40,000, as soon as they had capital to undertake them. The loan would be charged as a specific charge upon the stock and merchandise in hand, two trustees being appointed. By this method the Company would obtain time to realise the investments and patents that it had in hand to recoup itself for the loss of the previous year. He concluded by moving the adoption of the report.

Lieut.-General Sir JOHN STOKES seconded the motion.

Mr. SQUIRE said he did not think the Directors were at all likely to be able to raise more capital until a good deal more was known about the actual position of the Company, and he would move, but not at all in a spirit of hostility, an amendment that the report should not be adopted, and that a committee of investigation should be appointed. In the first year of its existence the Company made a magnificent profit—at least on paper. It paid a dividend of 15 per cent on the ordinary shares, £30,000 was carried to reserve fund, and £16,000 carried forward. The shareholders were induced by the apparent great prosperity of the Company to part with the sum originally lodged with the Company as guarantee for the dividend of 15 per cent. for three years. In the second year of the Company's existence things were not nearly so rosy, and there was just sufficient to pay the dividend of 15 per cent. on the ordinary shares. The picture on the present occasion was very greatly changed, and instead of earning handsome profits, or even ordinary profits, they now showed a loss of £129,000. It was very difficult to offer any explanations to account for such a sudden change ; but he had noticed before that new industrial companies had a particular knack of being exceedingly prosperous at the commencement, and of then collapsing. This was particularly the case when the whole of the shares at the beginning had not been planted on the public. For the first year or two the profits might be made to look almost anything they liked ; but, of course, this could not be continued. The guaranteed fund of £75,000 was one of the main inducements to investors to put their money into the concern, and that being so he thought that the fund should have been sacred for the purpose for which it was originally intended. He himself voted against the proposal that was made for parting with it, but he preached to deaf ears, and the matter was carried through. They now knew what the position of the Company was. He would like to know who the people were who lodged the £75,000 in question.

Mr. SAMUEL POPE, Q.C. (one of the Directors), stated that £60,000 of the amount was in the business now.

Mr. SQUIRE replied that originally the amount was not secured, whereas it was secured now, more or less. With regard to the balance-sheet, bad as it showed the position of the Company to be, he believed it was really a good deal worse. He was himself a chemical engineer, and had been connected with a good many companies. Glancing down the assets, he saw a good many that were of an extremely doubtful character. For example, what was the value of the goodwill of a business which was losing at the rate of £2,500 per week? Then, £73,000 was put down for patents; and as a patentee himself, and an adviser on patents, he knew them to be doubtful property. In fact, a patent was good to-day and bad to-morrow, as some new invention might wipe it out of existence. He, therefore, thought that all patents ought to be written down with the utmost possible speed. He saw that one of their valuable patents had landed them in a lawsuit which had cost them about £14,000. Sundry investments figured for £102,000 altogether, but he shrewdly suspected that if they were to endeavour to realise that item it would not fetch half the sum shown. They were unquoted securities, and probably to a large extent unsaleable. (A voice: Like our shares.) He could not understand himself how it was that the Stock Exchange had persistently refused to quote the shares of Woodhouse and Rawson United, and stockbrokers to whom he had spoken on the subject said there must be some reason for it. He thought that in any case the £73,000 put down as the value of the patents was considerably in excess of their practical value. The Kidsgrove investment had been most unfortunate. Apart from their agencies, their manufacturing works were scattered all over the country, whereas he considered that they ought to be concentrated as soon as possible under one roof. He was certainly not so sanguine as to their prospects as the Directors were, and if they were going to rely on working off the interests which they held in other undertakings, he thought they would be disappointed. He was convinced that the public would not look at any industrial undertaking.

Mr. SAMUEL BACON suggested that the amendment should be altered, and that a committee of shareholders should be appointed, the meeting standing adjourned for three months, so as to afford the opportunity for making up the accounts for the six months which had since elapsed.

Mr. SQUIRE said he would accept this modification, and he would propose the amendment in the terms suggested.

Mr. BACON said that he would second the proposal. He desired that the affairs of the Company should be thoroughly investigated. The balance-sheet had been sprung upon him by surprise. Since its issue a committee of some of the largest shareholders had been going into the accounts, but he did not think they could have obtained all the information that was necessary. When the trading results of the past six months were known they would be able to see whether the affairs of the Company had improved, and what the real position of matters was. The Company had had £600,000 of the public's money, and he could not tell how this sum could have been possibly wasted in the last two or three years. If the proposal of the Directors was carried, this would be something like the position of things: they would have secured creditors to the extent of £22,000, a mortgage on their freehold of £23,500, and debenture stock and bonds to the extent of £164,000, while they would have shares to the extent of £427,000. Now they had a proposal for raising £60,000 on movable stock, but he believed if these powers were given to the Directors, as suggested, the shareholders would never get a penny out of the concern.

Mr. W. GRIFFITH supported the amendment, and said it appeared to him that the Directors themselves had lost faith in the undertaking. He considered that their securities were of the most worthless description, and while their profits were *nil* their expenses were enormous.

Mr. LOCKWOOD also strongly supported the amendment. He said he thought it very possible that the Company had never really earned the dividends that it had paid, and he thought that they would have to call upon the auditors to satisfy them that they had been earned. The Company had brought out a great many companies, but how many could be pointed to as paying interest at the present day. What were they worth in the market now? Many persons had been reduced to poverty by the Company.

Mr. POPE said he was thoroughly ashamed of the balance-sheet. So far as he was concerned, he was in the hands of the shareholders ; but, while he would be glad to hide his head, he would not run away from a

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concern because it happened to be in a disastrous condition. If they would undertake to raise the Debenture stock mentioned, he would put £2,000 into it on any security. The Directors could not object in the least to what had been said by the shareholders, and he could not imagine any of them feeling the least objection to the appointment of the proposed committee. The Company, however, wanted money to meet its present liabilities, and if the money was not found from some source or another, the creditors would wind it up. The shareholders must therefore understand that although it might be extremely advisable to have a committee to enquire into matters before any scheme was adopted, yet some money must be found, or the whole concern would pass out of their hands into the hands of a Receiver. The result of that would be that the concern would be shipwrecked and any prospects that there might be of bringing the Company round and realising its assets would be destroyed. His only objection to the appointment of the committee in the manner proposed was, that the result of their investigations would not be known for three months; and within that time the concern would be shipwrecked, as there was no money to pay their creditors.

Lieut.-General Sir J. STOKES endorsed the remarks of Mr. Pope, and said there was no doubt that the Directors desired nothing better than a thorough examination of their acts. The delay of such an investigation as was now proposed would, however, be fatal to the existence of the Company, as money must be found within a few days to keep things going.

Mr. F. L. RAWSON (Managing Director) said that he held over £30,000 in the shares of the Company, and he had also been the largest shareholder in the other companies. He was bound to give them the best of his abilities, and he could receive nothing until 15 per cent was paid on the ordinary share capital. Unless the thing went right, he got nothing. He agreed with Mr. Pope, that no exception could be taken to what the shareholders had said. The other committee which had been alluded to came to the same conclusion as the Board—that it was necessary to find a certain amount of money immediately to prevent the creditors from stepping in. He would do his utmost to work for the shareholders for nothing, until their affairs had been placed in a proper condition. As Managing Director he must take the responsibility of the position, but there were certain events which mitigated the blame which one had to carry. He attended to what was called the financial portion of the business—the buying and selling, the investigating and the developing of patents; but the industrial portion of the business had been caried on by others, although he must be held nominally responsible for the results. They had been deceived as to the Kidsgrove business. The industrial portion of the business had not had the management which it should have had; and when they found out the mistake that had been made in this direction they appointed the best man they could, and he had been conducting the business energetically, and cutting off losses very deeply. With reference to the industrial portion of the business it would pay its way and make a profit. The ordinary shareholders could not expect to make anything at all except by the particular department which he looked after—the new inventions, patents, &c.—but in the past few years they had made very large sums from this source. There was no reason why, in about two years' time, they should not be able to do so again. The electrical business was advancing rapidly, and what they had to do was to carry on their business quietly, realise the shares they held, pay back any temporary loan they might now make from the proceeds, and wait for better times. The only reason they could find out why the Stock Exchange had refused them a quotation was that the old Woodhouse and Rawson Company (Limited) was not wound up, and that the purchase by this Company was not completed, whereas, in the opinion of the Directors, by the arrangement they made, they had thought that it was completed. They only approached the Committee once for a quotation. It had been stated that the call that was made shortly after the last meeting was not referred to at the meeting, but the fact was that the point was put on a slip of paper and handed to the Chairman to mention, but it was overlooked. He got up himself with the intention of mentioning it, but as the meeting rather "sat upon him," he sat down.

Mr. WHATELEY (a member of the Committee referred to) said that the conclusion which they arrived at, shortly, was that it would be positively suicidal to allow the Company to be wound up now; but that if it were not to be wound up, they must each and all of them find some money for it. He believed that about 10 per cent. of their holdings would do all that was required.

Mr. STUTCHBURY (the Manager) said he desired to impress upon them his honest opinion that there was no need for a scare, and they certainly knew the worst. He had found to his surprise that the loss on the trading—the real industrial trading—had not averaged more than £17,000 a year since they started. That might appear a large amount to some; but as a business man, and one connected for many years in engineering business, he regarded it more as so much money sunk with a view of building up their business. With a large lock-up of stock and investments they were at the present moment short of available funds; but apart from that he had no hesitation in saying that their position to-day was better than it had ever been. Their industrial business was surely but slowly gaining ground, and their reputation for good, sound, honest work was second to none. They were every day remedying the defects they had suffered from. In the last six or seven months he had effected savings amounting to £7,000 a year, and he could see his way to making a reduction in the coming year of a further £4,500

Lieut.-General STOKES observed that, as the Director who devoted most time to the industrial branch of the business, he could fully endorse what their Manager had said.

Mr. SQUIRE, after some further discussion, proposed the following:—

"*That a committee of consultation, consisting of five of the principal shareholders, with power to add to their number, be appointed to confer with the Directors as to the present position and future prospects of the Company, and to report to the shareholders at the earliest possible date, and also that the balance-sheet and statement of accounts from August 1 to December 31, 1892, be prepared under the supervision of the Committee, and submitted to a special meeting to be held as early as possible; further, that the consideration of the adoption of the report be deferred until the report of the Committee be received.*"

Mr. BACON said he would second the motion.

Mr. POPE again pointed out the necessity of further powers being given to the Directors to raise money, as their creditors would be all coming upon them insisting upon being paid.

The resolution, as proposed by Mr. Squire, was then put to the meeting, and agreed to, and a committee was appointed, consisting of Messrs. Squire, Whateley, Pilling, Bacon, W. Griffith, and General Fife.

After some further discussion relative to the amount which the Directors should be empowered to raise pending the report of the committee,

The CHAIRMAN proposed the following resolution:—

"*That the Directors be authorised to raise a sum not exceeding £20,000 on the security of the floating assets of the Company, and that for this purpose the limit of the borrowing powers conferred on the Directors under the Articles of Association be increased from £250,000 to £265,000.*"

Lieut.-General Sir J. STOKES seconded the resolution, which was adopted.

The Directors and auditors were re-elected by other resolutions; and the proceedings, which lasted four hours, terminated with a vote of thanks to the Chairman and the Board.

TRADE NOTES AND NOTICES.

TENDERS INVITED.—The Town Hall and Parks Committee of the Burnley Town Council invite tenders for the supply and fixing of fittings for the electric light for the Town Hall, Burnley. Tenders must be addressed to the Chairman of the Committee on or before Wednesday, January 18th. Further particulars are given in our advertisement columns.

TENDERS ACCEPTED.—At the meeting of the London County Council on Tuesday, the Asylums Committee reported that they had considered the tenders for the second contract for the electric lighting (wiring, &c.) of Claybury Asylum. The lowest tender was that of Messrs. Appleton, Burbey, and Williamson, Queen Victoria-street, for £6,074, which they proposed should be accepted, subject to a supplemental estimate of £5,500 being submitted by the Finance Committee. The Committee had to point out that the sum of £17,500, authorised by the Council to be expended for the installation of the electric light, would not be sufficient to cover the whole cost of the work. The original estimate did not include the lighting of the mansion-house, since determined upon at an estimated cost of £1,500, nor certain necessary additional lights in the various workshops at an estimated cost of £600. The contract of Messrs. Latimer Clark, Muirhead, and Co. for the engines, dynamos, &c. (already entered into), amounted to £15,130, and with the above-mentioned tender of £6,074 would make a total sum of £21,204, or about £3,700 in excess of the £17,500 authorised. The excess was partly due to the extra lighting above-mentioned, and the remainder to the fact that all contracts were now proving to be higher than the estimates. A further sum of £1,800 was also required to cover commission to architect, salaries of clerks of works, and any contingencies. This would increase the first estimate by £5,500. The recommendation of the Committee was agreed to. The list of tenders sent in appeared in *The Electrician* of the 9th inst.

——— Messrs. Reed, Blight, and Co., have secured the contract for lighting Arundel Castle, Sussex, for the Duke of Norfolk. Mr. A. L. Phillips is the consulting engineer.

MESSRS. W. T. GOOLDEN AND CO.—This firm write us that, owing to the large extension in their electric mining and manufacturing business, they have decided to transfer their installation and fittings branch, from January 1, 1893, to their late manager. Mr. W. E. Townsend, of the firm of Messrs. Townsend and McIntyre, of 19, Brook-street, W., informs us that they have opened a showroom, at that address, for electric light and other fittings, and in order to carry on the installation business taken over from Messrs. Goolden and Co.

NEWTON ELECTRICAL ENGINEERING WORKS.—The well-known Taunton dynamo and other electrical apparatus are well illustrated in a catalogue which has been issued by this firm. The various sizes of dynamos, and the output which they will give at various speeds, are clearly set out in tables.

MACHINERY, TOOLS AND ENGINEERS' STORES.—Mr. George Hatch has issued a very useful price list of engineers' tools, bolts and nuts, machine tools and contractors' stores. We notice a large variety of drilling machines and shaping machines for both light and heavy work. The contents are excellently illustrated and contain very full descriptions, including, in many cases, weights, measurements and descriptive details. A considerable number of tools for special trades are to be found in this high-class catalogue.

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MESSRS. JOHN SHAW AND CO.—Price lists Nos. 1 and 2 relating to the manufactures of this firm are to hand, and include illustrations and prices of a large variety of spigot and faucet pipes, turned and bored pipes and connections, manhole covers, surface boxes, &c.

MESSRS. LISTER AND CO.—This firm send us their latest illustrated list of milling machines, which is accompanied by some useful notes on the working of the machines, a table of speeds, pitches, &c.

MESSRS. SMITH AND GRACE.—This firm have just issued a price list of their new patent independent grip shaft couplings for which advantages are claimed that it is in one piece, that no keys are required, and that there are no projections.

A DIRECTORY OF CONTRACTORS.—A useful Directory of Contractors for public works is issued by the proprietors of the *Contractors' Chronicle*, an old-established journal, giving weekly the latest particulars of open contracts, results of tenders, and similar information. The Directory contains a mass of information which will be found of service to electric light supply makers and dealers, machinery builders, &c.

CALENDARS FOR 1893.—Sir Joseph Causton and Sons send us a useful hanging calendar of handsome design. —— Messrs. Badoureau and Jones, electrotypers, send us a calendar illustrating the process of boxwood block making, stereotyping, electrotyping, &c.——The Western Electrical Company forward a calendar, consisting of a well-executed photograph of their stand at the Crystal Palace Exhibition, with the calendar in the mount of the photograph. The idea is a good one.——Messrs. Minter Bros. issue a neat hanging calendar, with a thermometer attached.

SHIP LIGHTING.—Two new vessels are being built for the Cunard Company, to be called the "Campania" and the "Lucania," and Messrs. Siemens Brothers and Co. are completing an extensive installation of the electric light upon each vessel. Four sets of generating plant are supplied to each steamer, consisting of Siemens' dynamos, coupled direct to Belliss engines, and capable of supplying 1,350 16-c.p. lamps, including 8 large groups of 8 lights each, for cargo working, and a powerful search-light. The switchboard consists of 13 sections, so arranged as to be capable of connecting up any of the four dynamos installed. The supervision of this important installation has been undertaken by Dr. J. T. Bottomley, F.R.S.

PERSONAL.—We are requested to state that the only connection between the firm of Messrs. Smeeton and Page and the General Electric Company is that of customer and dealer.

AWARDS.—Messrs. John Davis and Son have been awarded two gold, three silver, and one bronze medal for their exhibits at the Kimberley Exhibition.

——— Messrs. Mather and Platt (Limited) have received four gold medals for their exhibits at the South African and International Exhibition– one for dynamos for electric lighting and the electrical transmission of power, another for electric lighting plant, a third for incandescent lighting plant, and a fourth for motors.

THE BRUSH COMPANY.—*Money* understands that negotiations are pending between the Brush Electric Light Company and the South-Eastern Railway Company, concerning the acquisition by the latter of the extensive works of the former in Belvedere-road, Lambeth.

MESSRS. POOLE AND WHITE (LIMITED).—A statement of affairs has been issued in reference to the winding-up of this concern. The gross liabilities as to creditors are returned at £23,293, against which £10,104 is expected to rank for dividend. As regards contributories, the total deficiency is £16,082. Referring to *The Electrician*, it will be seen that the Company was registered in February, 1890, to carry on the business established by Messrs. T. G. Poole and W. White, at Nos. 58 and 59, Bread street, E.C. The business was afterwards extended, and premises have from time to time been taken at King's-road, Camden-Town, N.W.; No. 10, Glasshouse-street, W.; and 27, Arcade-chambers, Manchester. The nominal capital is £20,000, divided in 3,400 ordinary and 600 deferred shares of £5 each. On July 22, 1892, Mr. W. J. Kelly was appointed receiver for the debenture holders, and the assets of the Company are at present being dealt with by him. There are 172 creditors, 201 debtors, and 40 contributories. Mr. C. J. Stewart, official receiver and provisional liquidator, concludes his observations on the winding-up with the following remarks:—"It may be noted that the whole of the assets have been put beyond the reach of the ordinary creditors within the last twelve months, except in the case of one 'fully-secured' creditor, whose mortgage for £1,000 is stated to have been given in 1890." The first meeting of creditors was held at the Inns of Court Hotel, W.C., yesterday (Thursday), when the Official Receiver presided. Mr. Tryon dealt at some length with the working of the Company from its incorporation, and his own interests in the concern, and complained that he had been misled as to the state of some of the accounts, and that he had done all he possibly could in the interests of the firm and the creditors and shareholders. Mr. Poole said that the concern had largely suffered from want of ready money. Mr. Street (representing the International Okonite Company, Limited, and Messrs. Bullers, Limited) proposed that Mr. E. Wylie, of Bloomsbury-mansions, W.C., be appointed liquidator, which was unanimously agreed to. It was also decided that a committee of investigation be appointed with a view to reconstruction. Mr. Street put forward the names of Messrs. Thorp, Vaughan-Stevens, Stedall, and Tryon, who were appointed. This left one nomination to make, which the Official Receiver suggested should be made at the meeting of shareholders, a proposal which received unanimous support.

MR. RANKIN KENNEDY.—The first dividend in the estate of Mr. Rankin Kennedy, late of the Carntyre Electric Works, will be paid at Messrs. Dunlop and Murray's, 82, West Regent-street, Glasgow, on and after the 27th prox.

POLYTECHNIC.—The next term of the Polytechnic School of Engineering in Regent-street will start on Monday, January 16th, and special facilities are offered to students in the course of Electrical, Civil, Marine, and Colonial Engineering.

THE CHRISTMAS POSTAL ARRANGEMENTS.—There is to be no delivery in London or the suburbs on Christmas Day. The arrangements will be as on the ordinary Sunday, and the Postmaster-General has issued a circular detailing special arrangements for Boxing Day, December 26th, in reference to letters, telegrams, parcel post, and express delivery.

BRIDGEND.—The Local Board have decided to apply for a Provisional Order at once, and will purchase lands and commence the construction of works for lighting the town with electricity.

BRISTOL.—At the last meeting of the Council the arrangement entered into with Messrs. W. H. Allen and Co. to execute the work previously undertaken by Messrs. Woodhouse and Rawson United (Limited), for the supply and erection of condensers, pumps, steam, and other pipes, was confirmed, and a resolution was adopted adding to the area of electric supply a district not included in the original Bristol Order of 1883.

BROMLEY (KENT).—The Clerk, at the last meeting of the Local Board, stated that the support offered to the electric lighting scheme was disappointing, and it was decided to make another effort to obtain subscribers.

BUCKINGHAM.—Extensive alterations are being made in the Buckingham Central Station by Messrs. Parr and Gillies, who have now taken over the working. A new central station, with a capacity of 1,500 8-c.p. lamps, is nearly completed.

CANTERBURY.—The Town Clerk states, in reference to the costs of transferring the Provisional Order to a local company, that the Company consider the cost of the transfer (about £410) excessive.

CHELSEA.—At the last meeting of the Vestry the clerk read a communication sent to the Board of Trade by the agents of the St. Luke's, Chelsea, Electric Lighting Company, and a member of the Vestry (Mr. Brass) suggested that it would be better for the Local Authority to deal with the electric lighting itself rather than pass it over to a private company.

CHRISTIANIA (NORWAY).—A company has been formed here to construct electric tramways in the city, six kilometres in length, at a cost of £2,300.

COURT OF COMMON COUNCIL (LONDON).—At the last meeting of the Council the report of the General Purposes Committee in reference to the payment of £607 odd for current supplied to the Mansion House by the City of London Electric Light Company, was read. Mr. Morton, M.P., asked whether the cost of the electric light was heavier than gas. The answer was, that in this case the cost was about double that of gas, but that as a set-off the decorations were in a better condition than they had ever been before.

DUBLIN.—In consequence of the malicious extinguishing of the electric light, to which we referred in our last issue, it was decided at a meeting of the Corporation, held on Monday last, to vigorously apply the section of the Electric Lighting Act of 1882, which renders any person guilty of tampering or injuring any electric line or work to a penalty of penal servitude not exceeding seven years, or with imprisonment with hard labour for any term not exceeding two years.

EALING.—The Local Board have agreed to the Electric Lighting Committee's recommendation that Messrs. Bramwell and Harris be invited to report upon a scheme for lighting the district, the report to be sent in by Jan. 21st next.

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EDINBURGH.—Seven members appointed by the Town Council to visit the various centres of electric lighting activity south of the Tweed, are visiting London, Bournemouth, Cambridge, Bradford and Newcastle. The deputation includes the Lord Provost.

EDISON-SWAN WORKS.—In connection with the large works at Ponder's End, an application was made before the Licensing Committee for a licence for stage plays and for music and dancing, to be set apart by the Edison and Swan Company for the benefit of their employees. It was stated that the works employ about 750 persons. The licence was granted.

FLEETWOOD.—Mr. T. L. Miller, of Liverpool, has been appointed by the Fleetwood Commissioners to advise them upon the various tenders received for the electric lighting of the town.

HECKMONDWIKE.—Mr. S. Wood, Chairman of the Electric Lighting Committee, presented to the Local Board on Monday a report as to the proposed lighting of the town by electricity. The Committee recommend that the Board apply to the Board of Trade for permission to erect the necessary plant, &c., and to the Local Government Board for their sanction to supply the necessary capital to enable them to carry out the scheme, according to which a saving of £472 a year over the present charges for lighting is anticipated. The recommendation to the Committee was carried by a majority of one vote.

ILFORD.—The Local Board have decided to appoint an expert to advise them on the matter of introducing the electric light into Ilford.

IPSWICH.—The lighting plant of the Ipswich Electricity Supply Company (Limited) was disposed of on Monday by Messrs. Garrard, Turner and Son. We understand that the entire stock was purchased by Mr. Atthill (representing Messrs. Laurence, Scott, and Co.), Mr. Edey, Mr. Percy Huddleston, Messrs. Parr and Gillies, and the proprietors of the *East Anglian Daily Times*. The sale was stopped as soon as the amount necessary to satisfy the execution had been reached. The *East Anglian Daily Times*, in its issue of Saturday last, blames the Corporation for the part it has played in bringing about the failure of the Ipswich Electric Lighting Company, and mourns the return to gas lighting in terms which show that the electric light was thoroughly appreciated in Ipswich.

NANTWICH.—It has been decided by the Local Board to take the necessary steps to obtain powers under the Electric Lighting Act.

NEWPORT (MON.).—It has been decided to invite Prof. Robinson to Newport to advise the County Council on the subject of the electric lighting of the district, and to prepare a report, at a fee of fifty guineas.

NORTH BRIERLEY.—The Local Board has accepted the offer of Messrs. Waterhouse and Edmundson to defray half the cost and pay one halfpenny per hour for each lamp in an installation to be erected by that firm, with a recommendation that all poles and apparatus be removed at the request of the Board.

PAISLEY.—An endeavour is to be made to obtain an extension of time for carrying out the provisions of the Electric Lighting Order by the Town Council.

ST. AUSTELL.—At the last meeting of the Local Board it was decided to place a powerful electric lamp over the Fountain in George-street, St. Austell, the work to be done by Messrs. Veale and Co. (Limited), whose application for the renewal of their electric lighting licence for two years was also granted.

SUNDERLAND.—The Town Council have now decided to obtain the assistance of an expert to advise them in the selection of the best scheme for lighting the town by electricity. The Council will retain the Provisional Order obtained by them in 1890, and they have consulted with two electric light companies as to the terms for laying down plant and for running the same for a number of years; but too high a percentage of profit has been asked. The amount to be expended on preliminaries is not to exceed £200.

TAUNTON.—At a special meeting of the Town Council it was resolved to memorialise the Board of Trade for a Provisional Order for lighting the town and suburbs by electricity.

COMPANIES' MEETINGS & REPORTS.

The Electric Construction Corporation (Limited).

The fourth general meeting of this Corporation was held at Cannon-street Hotel, on the 16th inst., Sir Daniel Cooper, Bart., K.C.M.G., presiding.

The SECRETARY (Mr. W. Samson) read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: Three months ago I very reluctantly, at the entreaty of my colleagues, took the position of Chairman of this Corporation, and from the day I have held office until now my best endeavours have been to re-establish the credit of the Corporation. I and my colleagues have stuck manfully to the ship, and have within a few weeks obtained for it a position it has never held since the day it commenced work. Since my election as Chairman the time for the Corporation has been a critical one, but the Directors, individually and collectively, have found money and credit so as to enable us to meet all demands, but to do this they have had to incur responsibilities which I do not think any other Board of Directors would have done; but their faith in the soundness of the Corporation, if well and carefully managed, is such that they felt themselves secure, and they also felt sure that the shareholders would appreciate their efforts. The Corporation when it started had to make its name, like all new companies, and had to obtain work at times under onerous conditions. The profits earned, therefore, should not be gauged as they would be for an old and established company. I may instance the works at Manchester-square, near Rathbone-place; the Overhead Railway at Liverpool; the Works at Oxford; and the South Staffordshire Tramways. These important orders have to a great extent given the Corporation a footing and a name in the trade, and are a guarantee for future orders, of which we have now, according to what Mr. Parker says, from £60,000 to £70,000 in view. When the name of the Corporation is established it will enable it to obtain contracts on more profitable terms. The experience, too, of the last three years, will enable the Board to manage and guide the business more firmly and economically. The shareholders, as a body, have not supported the Corporation as they ought to have done in the issue of the preference capital, and the Directors have had to find the means among themselves to carry on the Company, and, therefore, from their practical knowledge are convinced that it would be folly to declare a dividend. They now ask you to contribute towards the £100,000 Second Mortgage Debentures, and let the Directors have the satisfaction of seeing you help the Corporation in the way they themselves have done. Mr. Duncan has issued a circular from a sick bed, and I have no doubt that his notions are none of the brightest or strongest. I may instance his remarks about the Electrical Power Storage, which was taken by this Corporation at a large price. From the day it was taken over to the day it was leased to the present Company the turnover gradually dwindled, and if it had continued to be conducted by the Electric Construction Corporation, it would have vanished by this time; whereas, managed separately, it has regained in 12 months its old output and is still advancing, and this Corporation is receiving a sum of £9,000 a year as a minimum; and as it holds the bulk of the shares in the undertaking, it practically receives all that is made by the Electric Power Storage Company. A Mr. Dunnill, the holder of a few shares, has also issued a circular, which I hope that the shareholders will treat respectfully, but I trust that they will not be led away into a scare, and so destroy absolutely their property by statements that can be easily and conclusively answered. The present Directors, as I have said before, have done a great deal in a very short time to put the Company on a firm footing, and they hope with new blood to do much more during the year to concentrate the resources of the Company, and also to confine it to its legitimate work; but whilst they are doing this they must not be harassed by the shareholders themselves, through a Committee of Investigation, which would only have a most disastrous effect upon the credit and business of the Corporation, already seriously injured by the attacks of hostile shareholders. At the same time there is no desire on the part of the Directors to withhold any information which they can properly give to the shareholders. The shareholders appoint the auditors of the Company, Messrs Broads, Patteson and Co., who are most able, most painstaking, and most independent, and would not pass any transaction that was not strictly correct. I am informed by our legal adviser that Mr. Dunnill's resolution is out of order, and cannot be moved; but nevertheless it may not be out of place for me to state the conclusion the Directors have arrived at respecting it. In the first place, let me say that I myself hold as large an interest in the Corporation as the whole of the shareholders whose proxies Mr. Dunnill has obtained. I merely mention this to show that the Board have a very substantial interest in the property of the Corporation. The Directors have carefully considered the proposal for the appointment of a Committee in the resolution embodied in Mr. Dunnill's circular, and came to the conclusion that there were very grave objections to a Committee. The Directors of the Board, as now constituted, have nothing whatever to conceal; and, if they considered only their own feelings, would welcome the appointment of a committee, but they are perfectly satisfied that the appointment of this committee would be exceedingly detrimental to the interests of the Corporation. Of this I may just give you an example. A foreign contract which they had good hopes of securing has gone past the Corporation, on the statement by the gentleman who had its disposal, that the rumours prevalent respecting the Corporation, and suggestions of its inability to carry out the contract if they got it, had deterred him from offering it to the Corporation. The final settlement of a contract which the Corporation had hoped it had secured is now being suspended, waiting the result of this meeting, probably to see whether the Directors held the confidence of the shareholders, and the Corporation is in a position to carry out the contract. But altogether apart from these considerations, the Directors cannot see that the appointment of a committee or its report, could carry the weight with the shareholders of the examination into the affairs of the Corporation which has just been made by the Electric and General Investment Company. That company was not a shareholder of the Construction Corporation, and had no interest in its affairs. When a loan to the Company was proposed, it, as the report states, caused an exhaustive examination to be made of the books and accounts, and it had a report by an expert upon the works. The result is that they have agreed to provide £50,000, which, I may tell you, is absolutely necessary to carry on

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the business of the Corporation. Surely these facts ought to carry more weight with the shareholders than the reports of ten committees. For these reasons the Directors have come to the conclusion that they must resist as most prejudicial, I will not say fatal, to the Corporation, the carrying of any such resolution as is indicated in Mr. Dunnill's circular. At the same time they must regard the passing of such a resolution as a vote of want of confidence in themselves. Gentlemen, I hope I have sufficiently impressed you with the gravity of the issue as affecting the future of the Corporation. As I am suffering from a severe cold, the Vice-Chairman will now explain to you the figures of the balance-sheet, with which he, from his active participation lately in the affairs of the Company, is better able to do than I am. I beg now to move:—

"*That the report of the Directors, and the accounts annexed thereto, be, and the same are, hereby adopted.*"

Mr. J. IRVING COURTENAY (Vice-Chairman): I respond with pleasure to the call of the Chairman (Sir Daniel Cooper), who has so gallantly come to the assistance of the Corporation under the trying circumstances with which you are all more or less acquainted. I feel bound to state that this Corporation owes a deep debt of gratitude for the splendid financial support given it by Sir Daniel Cooper, who has been loyally aided by the present Directors. I now propose to go through the profit and loss account and balance-sheet, and offer such explanations as may seem necessary. Taking the profit and loss account first, the head office expenses, viz., £7,870 3s. 1d., are less than they were last year by £3,553 4s., which I think you will agree is a substantial reduction, and the Directors intend to still further reduce these expenses. The amounts under the head of "Special Expenses" are very heavy, but the bulk of them may be deemed to be exceptional, and not likely to occur again; for instance, the chief amount in the allowances on contracts arose in the final settlement of accounts, in regard to one contract—namely, that with the Metropolitan Electric Supply Company, Limited. There were questions of vibration and other legal questions involved, and in the opinion of those who know the question best, the arrangement come to was a beneficial one for both parties interested. We are indebted for this friendly arrangement to the kind offices of Sir Henry Mance and Sir John Pender. Another amount is for commission paid to the British Electro-Chemical Agency (one of the subsidiary companies) in consideration of a licence for some of their patents which were essential for the proper working of patents which were sold by this Corporation to the Phosphorus Company (Limited). The Electric Construction Corporation has a very considerable interest in the Electro-Chemical Agency. The last item of these "special expenses" is for outlay in connection with the Crystal Palace Exhibition. The Corporation is bound to make a good display at Electrical Exhibitions, but following years benefit by the foundations thus laid for new business. The maintenance of patents has been a heavy account in the past year, owing to the costs incurred in the important case known as the "Lane-Fox Distribution Patent," which resulted in a judgment against Mr. Lane-Fox. This again is an expenditure the benefit of which will be felt in the future. We consider that some of the items under the head of "Special Expenses" might very fairly be chargeable to capital—at anyrate, not wholly charged against the revenue of one year; but I assume you will approve of the Board's action in writing off all these charges at once which has the effect of very greatly strengthening the balance-sheet. Turning now to the balance-sheet, you will observe an item of £6,470 for difference between par value of shares sold and amount realised, which we have deducted from the reserve account set apart for this purpose; and this is a convenient opportunity for me to call your attention to the principle the Board has adopted, with the approval of the auditors, which is, not to attempt to value the shares we hold in subsidiary companies at any other figure than their par value, but to create a large reserve fund as against them, so that when the shares are realised, should there be any deficiency, there will be an ample reserve to meet it. The reserve is independent of the £18,000 reserve for general purposes, and £10,000 for bad and doubtful debts. The amount of shares held by the Corporation has been the subject of comment, but you will remember that a large proportion of these shares were acquired in payment for various patents sold or licensed by the Corporation. We should, of course, have preferred to get cash, but that was not possible. It became necessary to develop and work the numerous patents owned by the Corporation, in some way or other and on the best terms we could get, and this remark applies also to the provisional orders. For legal and other reasons separate companies had to be formed, and we hope that, in future, these subsidiary companies will be a source of considerable income, the Corporation keeping itself to pushing and developing its manufacturing and contracting business, so far as practicable, upon cash terms only. You will have noted that there is a sum in cash, £3,115. 15s. 9d., at the London and General Bank (Limited), which is now in liquidation, of which £3,000 is on a joint deposit account on behalf of one of the subsidiary companies, as a guarantee fund in connection with patents sold to them. No official statement of the prospects of this liquidation has yet been made, but we are assured that no loss will accrue so far as this deposit is concerned. As stated in the report, the Directors do not propose that any dividend be paid on the ordinary shares for the past year, but recommend that the dividend, at the rate of 7 per cent. per annum, be paid on the preference shares to September 30th last, that £30,000 be placed to a suspense account, and that the balance of £26,862. 1s. 5d. be carried forward. The Directors believe this to be the sound course for men of business to take under existing circumstances, and that the shareholders will approve the policy. The Directors will use every effort to realise some of the shares, and to make the balance of profit and loss account available for dividend purposes as soon as possible; and though the fixed charges are somewhat heavy, I see no reason, with strict economy, both at Bushbury and head office, why a satisfactory dividend should not be regularly earned in the future. I now come to the work done at our Bushbury Works. The past year has been a very heavy one at the works. We have turned out an increase in the amount of work in our ordinary business, and have also put down a system of continuous current high-pressure distribution of electricity for Oxford, and during the Exhibition at the Crystal Palace we delivered by the same system about 500-H.P. over a mile into the Crystal Palace from the station. The Oxford installation, Mr. Parker says, has proved to be thoroughly efficient and reliable, and it will stand among the first of the installations in this country in the future as a means of supplying energy for lighting and power. We have also carried out the contract for the Liverpool Overhead Railway Company, or very nearly so, putting down the whole of their power in the electrical portion of the engineering, carriages, and all necessaries for running the line. This line of railroad is expected to be in running order about the end of the year. We have manufactured and installed seven and a-half miles of an overhead system of tramways for the South Staffordshire Tramways Company (Limited), which is now shortly to be opened for traffic. This work has been highly praised by the Board of Trade Inspector. These contracts have many novel features, and being the first of their kind do not admit of the profit that is to be made when regular business is established, but we may look forward to these being the pioneer enterprises of future great business in this class of work. The works are now thoroughly equipped, and their capacity can be largely extended with great advantage to the Corporation, as the additional charges upon additional business would be very much less in proportion. Mr. Parker tells us he knows of a substantial amount of work in different directions, which he expects will be entrusted to this Corporation to execute. The value of these contracts must not be gauged by the precise cash returns, but must be regarded rather as contained in the valuable advertisement from such important works as the Liverpool Overhead Railroad and the South Staffordshire Tramways. We have in the past year worked out in our laboratory several inventions for the more economical production of zinc, chlorine and alkalies; to carry some of these into practical effect the Directors have founded the Electro-Alkali Company. These inventions promise success in our laboratories, and I hope that Mr. Parker may in a short time be able to report that their commercial application is equally successful. The Alkali patents were in the first instance transferred with other patents to the Electro-Chemical Agency, but when as the result of full experiments, Mr. Parker arrived at the opinion that the alkali patents promised to be of great value, it was considered best to put them into a separate company, and they were bought back for preferred shares in the Alkali Company from the Chemical Agency, and they are now the property of the Alkali Company, in which the Electrical Construction Corporation has a very large interest. The Chairman has already dealt with the remarks of Mr. W. W. Duncan about the Electrical Power Storage Company, which are in some important particulars incorrect. The net profit when the Electrical Power Storage business was worked by the Electrical Construction Corporation, was never what Mr. Duncan states it was, nor are the annual costs of administration what he states; they are really about half the amount, because a portion of the account is for seventeen months' working, and a large sum is included for carriage, &c., which does not belong to administration account. I explained the figures to Mr. Duncan last autumn, when he remarked that my explanation had knocked the bottom out of his criticisms. He has thought fit to repeat them, but the reasons for his whole attack are obvious. Experience has shown that it is practically impossible to run successfully two businesses together which differ so much as do the storage battery and dynamo manufacturing business. The result is that, whereas the business had so seriously fallen off when it was worked by the Electrical Construction Corporation that it had nearly reached the point where no profit could be earned at all, we have, since it has been worked separately, nearly doubled the output, and are still increasing it. I think the shareholders would wish to hear further details from Mr. Parker of the important works I have alluded to, and later on I will ask him to address you. I now come to the important paragraph in the report dealing with the general financial position of the Corporation. I may state at the outset that the problem of how additional capital could be raised, on terms which would be satisfactory to the shareholders, presented some difficulties on account of the many interests which had to be protected. There are the First Mortgage Debenture Issues, at present of £150,000, then there are some preference shares, then come the ordinary shares, and finally there are the founders', whose rights have had to be safeguarded. I am glad, however, to be able to assure you that the scheme which the Electric and General Investment Company (Limited), after a very close study of the whole of the question (with the assistance of the most competent legal advice), has devised for us is one which protects and preserves the rights of all existing interests, and in this connection it is right, perhaps, to tell you that we have had an advantage in dealing with the Electric and General Investment Company (Limited) which we should probably not have had if the arrangements had been made with others, by reason of the fact that the Electric and General Investment Company have a special knowledge of this class of industrial undertakings, and they have, therefore, been better able to appreciate the great potentiality for future work which this Corporation possesses. The problem was, as to how £100,000 additional capital could be raised on terms which, while they are sufficiently attractive, are not unduly onerous to the Corporation, and the result is, I feel bound to say, to the satisfaction of your Board. We are raising £100,000 of new capital at a rate of interest of 6 per cent. per annum, which is no higher than the rate of interest paid upon your First Mortgage Debentures, and the scheme provides for this money to be repaid within a comparatively short period. Of course, it will be obvious to everyone that the money could not be raised on such exceedingly advantageous terms without offering a bonus, and the form in which this is done is satisfactory both from the point of view of the future of the Corporation, and also from that of the shareholders, who have the first right to subscribe the money. The bonus I speak of is given

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in the form of an income bond which is attached to each debenture, and is of a corresponding amount, *i.e.*, the subscriber of every £10 Second Mortgage Debenture receives a bonus bond of £10 free of all liability, and this income bond will commence to carry interest from the date on which the debenture is drawn and paid off at par. The rate of interest will be determined for each year by the dividend paid on the ordinary shares of the Corporation for each preceding year. It is, perhaps, desirable that I should explain the procedure a little more fully by giving you an example. Assuming that at the end of next year debentures to the amount of, say £4,000 are paid off, then the income bonds to the amount of £4,000, corresponding to the debentures which had been drawn, will commence to carry interest, and they will receive interest for the year 1894 at the same rate as the dividend that may be paid upon the ordinary shares for the year 1893. I have no hesitation in saying that, in my opinion, these debentures with income bonds constitute an exceedingly profitable investment, but I hope to be able to convince you that the terms are not unduly onerous to the Corporation, because the Board feel that the new capital will of itself produce the amount which is required to pay the interest thereon and to redeem them; and if this expectation is realised, it will be seen that the Corporation will obtain the benefit of this increased earning power at the cost of merely the interest paid upon the income bonds On the other hand, the shareholders who subscribe for those debentures will make an exceedingly good thing, especially those whose bonds are drawn at an early date, because they will receive their principal back with 6 per cent. interest, and will at once rank with the ordinary shareholders for dividend without cost to themselves. This explanation of the scheme will, I think, make it clear to every shareholder that if he wants to secure the full benefit of the arrangement for himself he can do so by taking up his proportionate allotment. It is a great satisfaction to the Directors that the Board has been strengthened by the addition of the Right Hon. David Plunket and Mr. James W. Barclay, both of whom occupy so leading a position in the City of London, and with whose assistance the economies that must be effected in various directions, will be judiciously and effectively carried out, and we feel confident that, with the support of the shareholders, the Corporation can be made to take the first rank among the English, electrical properties of this country.

Mr. THOMAS PARKER supplemented the Vice-Chairman's remarks by a brief description of the various works in which the Corporation has been engaged. Amongst these, the most important have been the overhead railway at Liverpool—the largest practical effort in electrical railway work yet attempted—the South Staffordshire tramways, and the lighting of the City of Oxford.

Mr. H. P. DUNNILL (Ironbridge, Salop), who had given notice of a resolution to appoint a committee of seven shareholders to investigate the affairs of the Corporation, was informed by the Chairman that the resolution could not be put because the notice had been received 24 hours too late.

Mr. DUNNILL then moved the following amendment to the motion before the meeting:—

"*That the accounts be not adopted, that the Directors be requested to amend the same by giving all the particulars of all the shares in subsidiary companies, licences granted, and patents sold, and the amounts receivable in each case, and from whom, and that this meeting be adjourned to enable this to be done, and that fresh accounts be delivered to every shareholder seven days before the adjourned meeting.*"

He did not wish to say a word against the manufacturing business. If the Directors had employed the shareholders' money in legitimate work of that kind there would have been a good result; but it had been spent in exploiting companies and in paying promotion charges, and he thought that it was now necessary that a thorough investigation of their position should be made by independent shareholders.

Mr. W. U. COOK seconded the amendment, observing that it seemed ridiculous that they should have such a large capital and make so poor a return.

Mr. BEACHCROFT, representing a large holding in the Corporation, urged the shareholders not to pass the amendment, which, he said, was tantamount to a vote of censure on the Directors. There was all the more necessity, he maintained, for not taking such a step because the Corporation was approaching a period of successful operations.

Mr. HERRING explained the conditions under which the Electric and General Investment Company (Limited) has agreed to issue £100,000, additional capital for the further development of the business. He expressed his belief that the success of the Corporation in the future was certain with good management and greater economy.

Mr. DIBLEY, in reply to Mr. Millington, said that he would retire from the Board of Directors with the greatest pleasure if anything wrong could be proved against him.

After some remarks by Mr. HANCOCK with regard to the relations of the Electrical Power Storage Company and the Electric Construction Corporation,

Dr. DRYSDALE urged Mr. Dunnill to withdraw his amendment, adding that he had the greatest confidence in the Board, and that he was perhaps one of the few shareholders who had taken the trouble to see the works of the Corporation at Wolverhampton, which he described as being in every way excellent.

After some further discussion the Chairman put the amendment, which was lost by a large majority, only five voting for the amendment.

Mr. DUNNILL demanded a poll, but on being informed by the solicitor to the Corporation of the superior strength of the Board in the matter of proxies, agreed not to put the shareholders to the trouble of voting.

The original motion was then agreed to.

The CHAIRMAN proposed, and Mr. COURTENAY seconded, the re-election of the retiring Directors, Mr. James Pender and John B. Verity.

The motion was carried unanimously.

The auditors, Messrs. Broads, Patteson and Co., were, on the motion of Dr. Drysdale, seconded by a shareholder, unanimously reappointed.

Dr. DRYSDALE next proposed a vote of confidence in the Directors.

A SHAREHOLDER seconded the resolution, which was agreed to *nem. con.*

The CHAIRMAN returned thanks, and expressed the hope that at the next meeting he might have a more prosperous condition of affairs to report.

The proceedings then ended.

Crompton Electric Supply Company of Australia (Limited).

The third annual general meeting of the shareholders of the Crompton Electric Supply Company of Australia (Limited) was held at the registered offices of the Company, Mansion House-buildings, on Monday last, Mr. J. F. Albright presiding.

The SECRETARY (Mr. Francis Reeves) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen—You will infer from the notice that this meeting was convened because it is our duty to meet you before the end of this year, and we had hoped to be in a position to lay the accounts before you up to May 31, 1892, but unfortunately these have been delayed, and we have been expecting to receive them by almost every mail. I might, perhaps, explain that one of the chief reasons why the accounts and report from the other side have been delayed is that we ourselves in London have been in the past very stringent in endeavouring to see that the accounts were very satisfactory, so as to protect you interests, and we insisted on our auditors in Sydney going thoroughly into certain points, and the result, so far as this year's accounts are concerned, has been that the auditors have been extremely strict in respect to the right method of stock-taking. I have little doubt in my own mind that one of the other reasons is the one mentioned in one of our most recent mails from Sydney. One of our managers, Mr. Whiffen, has been unfortunately ill. I hope you will receive that as a sufficient explanation of the difficulty we have been placed in with regard to meeting you with the accounts. Speaking of Mr. Whiffen's illness brings me to another point with respect to our business, which I should like to comment upon. Seven or eight months ago we had the question of supplementing the management in Sydney brought very strongly before our notice, largely on account of the fact of Mr. Whiffen's ill health. This matter has received our most careful attention, and certainly my co-Directors have spared no pains—and I myself have done the best I could—to select the gentlemen we have sent out to Sydney to assist the management. We believe we have obtained an extremely suitable gentleman in Mr. R. H. Buchanan. About a fortnight ago we received a cable saying that he had arrived there, and we trust that he is now getting established in his position, and that we shall ere long receive the full benefit of his assistance. As most of you are well aware, business in the Australian Colonies for some time past has not been in a very flourishing condition. Any of you who have read the reports of other trading concerns connected with the Colonies will have seen this fact prominently dwelt upon; but although we anticipate that the accounts which we are now waiting for will also show to some extent this falling off in business, we are pleased to be able to report to you that our more recent advices give us considerable encouragement in regard to the revival of business—at any rate of the particular branch in which we are interested. There is another question which, as your Directors, we wish to bring before you. It has been very evident to us for some time past that the subscribed capital of the Company is insufficient to deal thoroughly and profitably with the whole of the business which the Company might have handled advantageously. Considerable contracts are lost for want of capital, and of course, as you all know, the business which is insufficiently strong in a financial direction cannot buy so cheaply or so well as if it had sufficient capital. Having carefully considered this question, the Directors have decided that the best way of supplementing the capital would be by the issue of debenture bonds, making a first charge on the Company's assets, and bearing interest at the rate of 7 per cent. per annum. These they propose to offer to the shareholders for subscription next month, giving the shareholders the first option of subscribing for them. It is, of course, almost needless for me to point out that if any shareholders wish to take up any more Ten per Cent. Preference Shares, which are the basis of our present capital, they can take that course. Further, with regard to this question of additional capital, we have felt the absolute necessity of increasing it, and we also feel that it is probable that it will not be such an issue as is likely to be taken up by any of the outside public. Therefore, we have to rely almost entirely on ourselves and personal friends of the shareholders for support in this matter. Whatever we may be able to do as Directors by getting personal support outside the present body of shareholders, I am not prepared at the present moment to forecast; but we wish it to be distinctly understood that the existing shareholders have this Debenture issue offered to them first, and it is only in the event of our not receiving sufficient support from them that we should attempt to get it subscribed for by people outside. So far, I have dealt with the question of the delay of the accounts, the supplemental management, and the issue of fresh capital. I now come to, perhaps, a rather pleasanter duty, so far as I am concerned, namely, to introduce to your notice Mr. Trotter, who is one of the Committee of Management in Sydney, and fortunately, I may say, for this Company, he has been able to come over to England on his own private business, and we are, therefore, in a position to receive the benefit of his visit by getting his advice in a way which we could not otherwise have done. Before

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putting the resolution to the meeting, I would ask that gentleman to give you the benefit of the same information as he has given his colleagues.

Mr. TROTTER expressed the great pleasure he experienced in meeting the shareholders and to explain to them some of the work which had been successfully carried out by the Company. In the first place, he might say, as a shareholder, that he had the greatest faith in the future of their enterprise. Referring to the delay in receiving the accounts, he said that the auditors were puzzled to know what was meant by the points alluded to by the Chairman, and this, with other circumstances, led to greater delay in sending home the accounts. They must also remember that the distances in Australia were very great, and one of the reasons for the postponement was that a portion of the stock was some 1,500 miles from Sydney, viz, at Broken Hill, where, unfortunately, a great strike broke out which further increased the difficulty of delivering the accounts in time in London. He believed that Mr. Buchanan would be of great service to the Company. With regard to the business done in the past, he referred with satisfaction to the contracts carried out at Broken Hill Works, at the *Daily Telegraph* office, which is entirely lighted by electricity, and elsewhere. The installations had all proved satisfactory, and it would be gratifying to the shareholders to know that whatever work had been done by the Crompton Electric Supply Company, its name stood first for electrical work in the Australian Colonies. As to present and future work, they had taken the contract for lighting Perth, in Western Australia. They had in view also the lighting of Sydney, and were trying to get a Bill through Parliament for that purpose. It had already passed the second reading, but it took a long time to get a Bill through. As to the question of capital, this was a difficulty which he had seen for some time. The amount in the first instance was not sufficient, it being only about £13,000. The Broken Hill contract alone amounted to £3,000, or practically a quarter of the whole and if they were to do the class of work which they would be called on to perform they must increase the sinews of war. There were, of course, various schemes in sight within the scope of the Company, and it would be advantageous during the passing of their Bill through Parliament to have established a central station. But they did not see their way to do it. He mentioned this to show that, in numerous instances, if they had had the money they could have done better. He said again, unhesitatingly, that, as a shareholder and a member of the Committee, and with the help of Mr. Buchanan, he had every faith in the future of the Company.

Mr. T. R. TUFNELL agreed with Mr. Trotter in the soundness of the Company's property and its future possibilities. He hoped also that they might obtain the increase of capital asked. With regard to the question of the accounts he thought that the state of things was very unsatisfactory. Indeed, in this respect they seemed to go from bad to worse. This was the third annual meeting of the Company. On the first occasion they were told that the accounts would come forward, but in an imperfect state, so that they could be submitted to the shareholders for approval. Still, sufficient was shown to satisfy the Directors that they would be justified in declaring an interim dividend, which was accordingly declared. But now they were met with a bald statement that the accounts had not come forward, and therefore the meeting was to be adjourned, and in the notice calling the meeting there was no hint of a dividend. There was complete silence, although their financial year ended last May, and although the meeting was held two months later than previously, the Directors were not now in a position to tell the shareholders whether they had made a profit or loss by the last year's transaction. Mr. Trotter had told them of the extensive contracts which the Company had made, and it must be satisfactory to the shareholders to know that these contracts had been carried out satisfactorily ; but that gentleman had not pointed out what return had been realised by those contracts. At the last meeting he ventured to suggest that the difficulty in regard to the accounts might be obviated if the managers were requested to send home a transcript of the entries in their books month by month, as was done in other companies. Their auditors, although he had not the pleasure of knowing them except in connection with this Company, appeared to be most efficient accountants, and there would be no difficulty in satisfying these gentlemen as to the futility of their objections, if they had any, to comply with the orders of the Board on any question. He quite approved of sending out Mr. Buchanan, who seemed to be a most suitable person for the performance of the duties which would devolve upon him.

Mr. TROTTER said that there were difficulties in connection with getting in the accounts this year which were not likely to occur again.

Mr. TUFNELL thought that at least the Directors might have obtained sufficient information to satisfy them whether they had made or lost by the last year's transactions.

The CHAIRMAN said he was not the least surprised at the criticism just made. He pleaded guilty—not in his own private capacity, but for the Company. Their Directors had done everything in their power to obtain the information which they required, and he would ask the shareholders to again be patient, and to rest assured that the Board would do everything in their power to get over the difficulty. He moved :

"*That the Directors' proposal to issue First Mortgage Seven per Cent. Bonds to an amount not exceeding £10,000 be, and the same is hereby, adopted.*"

Mr. W. G. WHIFFEN seconded the motion, which was carried unanimously.

The CHAIRMAN next moved :

"*That this meeting be adjourned* sine die *to await the arrival of the accounts.*"

Mr. C. F. TUFNELL seconded the motion, which was carried.

Mr. T. R. TUFNELL proposed a vote of thanks to the Chairman and to Mr. Trotter, and the proceedings ended.

Morecambe Electric Light and Power Company (Limited).

The second ordinary meeting of the shareholders of the above Company was held on the 13th inst. at Morecambe, Mr. W. B. Hodgson presiding.

The CHAIRMAN, in moving the adoption of the report and balance-sheet, said the duty was a pleasant one in view of the satisfactory result of the Company's first season's operations. Many difficulties had to be grappled with and overcome, but the various works had steadily progressed, and the installation increased and been perfected. The profit, £74. 9s. 11d., might seem small, but this was because of the greater cost in having to use the town gas instead of the "Dowson" gas, which they manufactured themselves, the plant for which could not be completed until October. The Chairman then gave a few particulars of the present financial position of the Company, from which it appeared that the amount expended on plant was £3,112, and the amount to pay £1,588, total £4,700 ; against which £2,870 had been subscribed in share capital, exclusive of the 760 shares accepted in lieu of cash, so that there remained a balance of £1,830 to be taken up in new shares. It would also be seen that debenture bonds for £1,000 had been issued, in order to partially make up for the deficiency in subscribed capital. He strongly impressed upon the shareholders the desirability of making an effort to subscribe for the £1,800 required among themselves, and thus increase their holding in what would ultimately prove a valuable property.

Mr. MABBOTT seconded the resolution, which was carried unanimously.

Mr. MABBOTT then moved that a dividend of 5 per cent. on the "called-up" paid share capital be declared, which was seconded by Mr. SCHOFIELD and adopted.

The Chairman of the Company, Mr. Morgan, having resigned his seat on the Board through inability to attend the meetings, Mr. Twyeroould was elected in his stead, and Messrs. W. Hollingworth and W. Wilson were also elected Directors. The auditor, Mr. J. Duff, was re-appointed.

It was decided that the accounts be made up in future to the end of December, and to hold the annual meetings in the first week of February each year, and after votes of thanks had been passed to the Chairman, the secretary, and the engineers, the meeting separated.

Woodhouse and Rawson United (Limited).

The following is the report for the year ended July 31, 1892, of the Directors of this Company. Contrary to our custom, we also give the balance-sheet issued by the Directors, and a print of the circular accompanying the report : —

The Directors express their regret that the favourable expectations which they entertained at the commencement of the year, and which they expressed in their last annual report, have not been realised. In common with almost all undertakings connected with electricity, your Company has felt severely the competition of the past year arising through the depression of trade, and this depression has told even more heavily on this Company, because, acting on the manifest and frequently-expressed desire of the shareholders that the industrial side of their operations should be developed, the Board has, within the last eighteen months, formed branches in the chief centres of electrical enterprise throughout England and the Colonies. Many of these, as, for example, Sydney and Johannesberg, after some initial losses incident to their formation, have developed into promising undertakings, but the benefits likely to be derived from them do not show in the last year's balance-sheet.

The result of these developments has been shown by the fact that whereas the turnover of the industrial portion of the Company's business was, in the first year, £72,258, that of the second year was £126,015, and that of the year just concluded £151,121. On the other hand, the financial portion of the business, which has been repeatedly stated to the shareholders to be the most profitable, has, owing to the financial depression, been almost entirely suspended during the past year.

In most of the Company's branches there has been a loss more or less serious, due to a large extent to the unfavourable period which succeeded their formation. Owing to the number of these branches the aggregate of such losses would in any case have proved large, but some are so considerable as to require special notice.

The failure of the arrangement for continuing the manufacture of incandescent lamps under the licence of the British Electric Lighting Company, obliged the Board during the past year to close down, at any rate for a time, a large portion of the Cadby Hall factory, which had been laid out for the purpose of this part of their business, and has also obliged them, as they are no longer at liberty to sell their lamps in the United Kingdom, to write down the value of their large stock by 75 per cent., the sale price of lamps abroad being only one-fourth of that realised in this country. Their valuable lamp plant has also depreciated largely from the same cause, as it cannot be utilised before the expiration of the Edison and Swan patent in November next. This has been one of the most serious blows to the progress of the Company, but one which may be retrieved when they recover at that date the right of using their valuable patents, which have gained for the Woodhouse and Rawson incandescent lamp an established reputation throughout the world.

The Board would point out another serious disappointment in the industrial department during the past year. When the Directors last met the shareholders they had obtained a valuable concession for lighting a large area of the richest part of Paris and had entered into an agreement whereby they had secured the co-operation of one of the strongest firms in France, who undertook to provide over one-half of the capital required. This would not only have provided a large profit by the sale of the concession, but would have furnished employment for the Company's works for some time to come. But owing to the insuperable difficulty experienced in raising the required balance of capital in this country, the advantages accruing to this Company by the concession were lost.

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The newly acquired Kidsgrove and Chiswick Works have also been the source of unexpected losses. In the latter case the Board have reduced expenses to a mere nominal amount. The loss on the Kidsgrove Works was mainly incurred in realising the assets and carrying out the contracts taken over from the vendors. These contracts are now finished, and the works have been placed under capable management; they require only a sufficiency of capital to enable them to carry on an important and profitable business. The remainder of the loss is largely due to the large amount written off for depreciation of stock, which had been increased in the expectation of a demand which, unfortunately, did not arise.

The union of Cadby Hall and Manchester under one management has proved most unsatisfactory; the Directors have, therefore, recently placed the works at Manchester under the separate management of tried and experienced officials of the Company, and are reducing the business at Cadby Hall Works to the execution of contracts in hand and actual orders, with a correspondingly large reduction of staff and standing charges.

Notwithstanding, however, the serious check received by their industrial department through the causes above mentioned, the Directors consider that the Company would have to a great extent recouped itself by the results of its financial enterprise, if the past year had presented any opportunity for launching an industrial company with a reasonable prospect of success. The Oncken Company, which their contract with the patentee obliged them to bring out by August 1st, yielded only shares as the profit of this Company, and these do not appear in the present balance-sheet.

The Epstein accumulator, which was introduced by this Company, has proved a complete success as the most efficient and economical on the market. The Epstein Electric Accumulator Company, in which this Company is so largely interested, has been manufacturing now on a commercial scale for the past six months, and the result of its operations has been to demonstrate that the Epstein accumulator has solved the difficulty of using accumulators for traction purposes. Owing, however, to the general financial position there has been no chance of realising the value of the Epstein patents, but it is expected that this Company will derive large profits from them in the future.

The Directors are glad to be able to state that the reputation of the Company is such that inventions of the most valuable description are constantly placed in the Company's hands for development, a share of the patents being given for their services in this respect, and without any money payment on their part

During the last twelve months the Board have given unceasing attention to the reduction of expenses, and they are glad to be able to state that their efforts have been successful. It is anticipated that a considerable further reduction will be effected within the next three months. The Directors have relinquished their fees since last January.

The Directors regret to say that Mr. Philip Rawson was ordered by his medical adviser to abstain from all business for a time, and resigned his seat on the Board in September last; Sir Edward Thornton also at a recent date requested the Directors to accept his resignation. Your Directors have not filled up the vacancies occasioned by these resignations, for they have felt that it was due to the shareholders that the appointment of Directors should be such as might commend itself not merely to the Directors themselves, but to the general body of shareholders.

The auditors, Messrs. Jackson, Pixley, Husey, Browning and Co., retire in accordance with the Articles of Association, and offer themselves for re-election.

WOODHOUSE AND RAWSON UNITED (LIMITED).

BALANCE SHEET, *July 31, 1892.*

Dr. LIABILITIES.

	£ s. d.	£ s. d.
Share Capital Authorised—		
60,000 ordinary shares of £5 each	300,000 0 0	
50,000 Preference shares of £5 each	250,000 0 0	
	£550,000 0 0	
Share Capital Issued—		
Ordinary shares of £5 each—		
37,514 of £3. 15s. called up	140,677 10 0	
17,683 fully-paid	88,415 0 0	
	229,092 10 0	
Preference Shares of £5 each—		
41,068 fully-paid	205,340 0 0	
	434,432 10 0	
Less due on calls	7,400 17 6	427,031 12 6
Debenture Stock, 5½% ... £118,187 0 0		
Less held as collateral security 19,625 0 0	98,562 0 0	
Mortgage Debenture Bonds, 6 per cent.	65,500 0 0	
	164,062 0 0	
Less outstanding	50 0 0	164,012 0 0
Pension fund		1,565 0 0
Bad debts, reserve		2,433 1 8
Sundry Creditors—		
Secured	22,006 7 8	
Unsecured	24,819 15 3	
Bills payable	12,488 5 8	59,314 8 7
		£654,356 2 9

Cr. ASSETS.

	£ s. d.	£ s. d.
Freehold premises: Cadby Hall, London, Union Foundry, Kidsgrove	69,309 12 3	
Less Mortgages thereon	23,500 0 0	45,809 12 3
Leasehold premises in London and elsewhere		2,528 15 7
Plant, machinery and tools at Cadby Hall, *less* depreciation; Chiswick, Kidsgrove, and Manchester, per valuation		37,554 2 1
Stock (finished and unfinished) and merchandise at works, depôts, warehouses and branches, per valuation	99,553 8 4	
Goods in transit	1,379 17 10	
Expenditure on contracts in hand	22,186 13 3	123,119 19 5
Sundry investments		101,847 5 0
Furniture and fittings		2,742 19 3
Sundry debtors	73,278 12 4	
Bills receivable	323 14 6	73,602 6 10
Goodwill		99,263 3 7
Moiety special expenditure on advertising, repayable by instalments		5,669 0 2
Patents, patent rights, &c.		73,450 18 1
Cash at bankers and in hand		2,033 16 8
Loss		86,734 3 10
		£654,356 2 9

PROFIT AND LOSS ACCOUNT *for the year ended July 31, 1892.*

Dr.

	£ s. d.	£ s. d.
Salaries	7,764 8 0	
Printing and stationery	1,030 13 3	
Postages and telegrams	886 18 2	
Legal expenses	1,300 8 6	
Travelling expenses	305 9 0	
Directors' fees £2,000 0 0		
Less amount waived 1,137 10 0	862 10 0	
Patent fees	862 8 1	
Rent, rates, insurance, &c.	2,660 6 9	
Royalties	1,954 2 10	
Bad debts £3,549 17 9		
Less reserve 2,600 0 0	949 17 9	
Bad debt reserve	1,773 15 10	20,350 18 2
Advertising	5,688 0 8	
Catalogues	761 12 0	
Exhibition expenses	1,766 5 1	8,215 17 9
Debenture interest		9,350 18 2
Loss on lamp settlement and action	14,472 11 3	
Loss at Kidsgrove	17,784 6 4	
Loss on trading and depreciation of stock, plant and tools	37,274 3 7	69,531 1 2
Depreciation on patents	5,650 1 4	
,, investments	26,012 10 0	31,662 11 4
		£139,111 6 7

Cr.

	£ s. d.	£ s. d.
Net profit at July 31, 1891	51,439 4 5	
Less appropriated to pay dividend	43,408 16 10	
	8,030 7 7	
Reserve fund	35,000 0 0	
Brought forward from last year		43,030 7 7
Interest on loans and investments		7,554 18 8
Balance of discount account		379 10 0
Premiums, transfer fees, &c.		1,412 6 6
Balance, *i.e.*, loss	129,764 11 5	
Less brought forward as above	43,030 7 7	86,734 3 10
		£139,111 6 7

We have examined the above profit and loss account and balance-sheet for the year ended July 31, 1892, but as we consider it desirable to refer to many of the items contained therein, we have made a special report to the shareholders, which report must be considered as part of this certificate.

JACKSON, PIXLEY, BROWNING, HUSEY and Co.,
Chartered Accountants, Auditors.

58, Coleman-street, London, E.C., December 12, 1892.

The following is a copy of the notice sent out with the report:—

"Notice is hereby given that the fourth ordinary general meeting of Woodhouse and Rawson United (Limited) will be held at the Cannon-

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street Hotel, Cannon-street, London, E.C., on Thursday, December 22, 1892, at 12 o'clock in the forenoon, for the purpose of transacting the ordinary business of the Company, and, if thought fit, extending the limit of the borrowing powers of the Directors under the Articles of Association to such sum as may be determined.

"The transfer books and register numbers of the Company willbe closed from Wednesday, the 14th, to Wednesday, the 28th December, both days inclusive.

"By order, A. L. FOLEY, Secretary.

"88, Queen Victoria-street, London, E.C.
"December 13, 1892."

Gulcher (New) Electric Light and Power Company (Limited).

The report of the Directors of this Company for the twelve months ended June 30th last, is brief, and chiefly consists of a lament over the loss of £6,000 for the financial year. This is partially ascribed to depression of trade, and otherwise to "some contracts of an unfortunate character" entered into by the Company. The auditor's endorsement to the accounts which accompany the report is as follows: —

"I have examined the accounts of the Company, and the above balance-sheet, so far as the English accounts are concerned, correctly sets out the position of the Company on June 30, 1892. Vouchers for the items N. Z. stores and book debts, £2,932. 11s., have not been produced, and for these items I have been obliged to accept estimates furnished by the Chairman. —RUSSELL DAY, Auditor."

Yorkshire House-to-House Electricity Company (Limited).

The following report of the Directors to June 30th last is to be presented to the ordinary general meeting of the Company to be held on Wednesday next at the Great Northern Hotel, Leeds, at 2:30 :—

A freehold estate in Whitehall Road, Leeds, immediately behind the Great Northern Railway Station Hotel, containing upwards of an acre, admirably adapted for the Company's purposes, and having the advantage of a river frontage, has been purchased. The property includes several workshops and other buildings which are not at present required by the Company, and from which a rental is being derived. The erection of works has been vigorously pushed forward, but it has been found impossible to complete them as soon as was expected, and it will probably be early in the coming year before they are in operation. Underground culverts, about 10,000 yards in length, for the reception of distributing cables, have been laid, and the drawing in of the cables is now in rapid progress. An arrangement was made with the Highways Committee of the Leeds County Council for the necessary trenching to be undertaken by their staff, by whom the work has been admirably and expeditiously done.

The applications for supply of current already received are sufficiently numerous to lead the Directors to anticipate a successful business for the Company.

The whole of the present Directors having been appointed under Article 77, their appointment will require confirmation by the shareholders. The retiring Directors, Mr. Grosvenor Talbot and Mr. Robert William Eddison, being eligible, offer themselves for re-election. Mr. John Gordon, junior, offers himself for election by the Company as auditor.

NEW COMPANIES, STATUTORY RETURNS, &c.

ASKWITH AND CO. (LIMITED).—This Company was registered on the 13th inst., with a capital of £20,000 in £1 shares, to acquire, develop, and turn to account certain grants in Africa and elsewhere, and to carry on the business of an electric company in all or any of its branches, including that of electricians, electrical and mechanical engineers, electrical contractors, suppliers of electricity for the purposes of light, heat motive power, or otherwise, and manufacturers of and dealers in all apparatus or things required for, or capable of being used in connection with, the generation, distribution, supply, accumulation and employment of electricity.

HOCKET (LIMITED).—This Company was registered on the 15th inst., with a capital of £10,000 in £1 shares. The objects are—to adopt and carry into effect an agreement dated December 15, 1892, between Percival Everitt on the one part and Herbert H. Preece (on behalf of the Company) of the other part, and to carry on the business of electrical engineers, machinists, iron and brass founders, &c.

MEASURES BROTHERS (LIMITED).—This Company was registered on the 19th inst., with a capital of £100,000, in £100 shares, to acquire, take over as a going concern, and carry on the business of girder makers, iron and brass founders, bridge builders, mechanical and electrical engineers, machine and engineering tool makers, &c., carried on under the style or firm of "Measures Brothers," at 57, Southwark-street, London, S.E.

TAVY IRON AND ENGINEERING WORKS (LIMITED).—This Company was registered on the 19th inst., with a capital of £10,000, in £5 shares, to carry on the business (*inter alia*) of electrical and mechanical engineers, electricians, contractors for the supply of electric light, heat, and motive power and manufacturers of, and dealers in cables, wires, lines, dynamos, accumulators, meters, generators, fittings, brackets, lamps, globes, posts, insulators, and all things and apparatus necessary for, or capable of being used in connection with, the generation, distribution, supply, accumulation, and employment of electricity.

ELECTRIC CLOCK COMPANY (LIMITED).—The statutory return of this Company, made up to Oct. 27, 1892, was filed on the next day. Only 7 ordinary shares of a capital of £1,200, divided into 1,170 ordinary and 30 founders' shares, have been taken up, and no calls made, the original signatories being the only shareholders. No agreements, contracts, or registered office, have been filed.

ELECTRIC CYCLE SYNDICATE (LIMITED).—The statutory return of this Company, made up to Aug. 13th, was filed on Dec. 3rd ; 1,921 shares of £1 each, out of a total of 3,000, have been taken up. Upon 921 of these 10s. per share has been called, resulting in the payment of £380. 10s., and leaving £80 in arrears. In accordance with an agreement, dated April 25, 1892, Villeroy C. Doubleday has been allotted 1,000 shares of £1 each, each considered as fully paid.

ELECTRIC LAMP COMPANY (LIMITED).—The statutory return of this Company, made up to Nov. 10, 1892, has been filed. 2,797, out of a total of 4,000 shares of £1 each, on 107 of which the full amount has been called, resulting in the payment of £50, and leaving £57 unpaid. The remaining 2,690 shares have been issued as fully paid, in accordance with an agreement dated June 30, 1892, with Thomas P. C. Crampton, of 12, Swinton-street, Gray's-inn, London, W.C., and Albert Essinger, of 26, Thavies Inn, Holborn, W.C., by which they sold inventions of improvements in electric arc lamps, and also for an improved form of carbon, patents for which had been, or were about to be, granted in Great Britain, France, Austria, Italy, Spain, Belgium, Germany, and the United States of America, for £3,000, in £1 shares.

ELECTRICAL COMPANY (LIMITED).—The statutory return of the above-named Company, made up to Nov. 25, 1892, has been filed. The whole capital of £15,000, in 3,000 shares of £5 each, has been taken up, and £1 called and paid on each share. In addition to this, these shares were issued with £3 considered as paid upon each, in accordance with an agreement, dated July 25, 1892, with Key's Electric Company (Limited) and Frederick T. Eggers, its general manager and liquidator, by which that Company sold its business for £9,000, payable as above.

KENSINGTON COURT ELECTRIC LIGHTING COMPANY (LIMITED).—A meeting of this Company (in voluntary liquidation) is to be held at 1, Great George-street, Westminster, on January 19, 1893, at 5 p.m., to receive an account of the winding up.

CITY NOTES, &c.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—Notice is given that the coupons on this Company's Four per Cent. Mortgage Debentures to bearer, due on the 1st prox., will be paid on and after the 2nd prox., at Parr's Banking Company and the Alliance Bank, Bartholomew-lane, E.C. The coupons must be left at the bank three clear days for examination. The warrants in payment of the interest of the registered debentures will be sent out on the 31st inst., and the register will be closed from the 27th to the 31st inst. inclusive.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—Notice is given in our advertisement columns that the coupons on this Company's second issue of Five per Cent. Debentures, due 31st inst., will be paid on and after that date at Parr's Banking Company and the Alliance Bank, Bartholomew-lane, London, E.C. Coupons must be left at the above bank three clear days for examination.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended December 18th were £918, as against £788 for the corresponding period of last year, being an increase of £130. The total receipts for half-year amount to £20,657, against £18,586 in the corresponding period of 1891, being an increase of £2,071.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).—It will be seen by our advertisement columns that the share register of this Company will be closed from the 7th to the 14th January prox., both days inclusive.

ELMORE'S FRENCH PATENT COPPER DEPOSITING COMPANY (LTD.).—We understand that the 10 per cent. dividend warrants on the preference share capital for the six months ending 1st ult. have been posted.

GENERAL ELECTRIC COMPANY.—The General Electric Company (Edison-Thomson-Houston Company) has just declared its semi-annual dividend of 3 per cent. on its Preferred Stock ; this is payable January 2, 1893.

HUMPHREYS (LIMITED).—A dividend of 7 per cent. on the Preference and 10 per cent. on the Ordinary stock of this Company has been declared, and £5,000 has been carried to the reserve account. The Directors' report states that this, the first year's trading, has been of a most satisfactory description.

SCOTTISH HOUSE TO HOUSE ELECTRICITY COMPANY (LIMITED).—This Company are inviting capital.

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PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—The Stock Exchange Committee have been requested to allow £100,000 Four per Cent. Guranteed Debentures to be quoted in the Official List.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The coupons due 31st inst. on the debentures of this Company will be paid by Messrs. Barclay and Co., Lombard-street. Coupons should be left three clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Dec. 16, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £3,387.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended December 16th were £2,511, as compared with £2,544 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 14.	Price Wednesday, Dec. 21.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week ending Dec. 21.	
						£ s. d.		Highest.	Lowest.
			TELEGRAPHS						
£1,247,720	Stock	12/6	Anglo-American	49½ 50	49½ 50½	4 19 0	Jan., Apr., July, Oct.	49¾	..
£2,876,140	Stock	25/0	Do. Preferred	91 92	91 92	5 16 4	,, ,,	91½	91
£2,876,140	Stock	5/0	Do. Deferred	10⅜ 11⅛	10½ 10⅝	..	,, ,,	11	10⅝
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine xd	10⅞ 11¼	10⅞ 11¼	5 15 7	Mar., June, Oct., Dec.	11 1/16	10¾
£68,200	£100	5%	Do. 5 per Cent. Bonds	101 104	101 104	4 16 2	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	106 110	106 110	4 10 11	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock xd	178 182	175 180	3 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11⅛ 12⅜	11⅛ 12½	6 19 2	February and August	12¼	..
6,000	10	10%	Do. Preference 10%	17⅞ 18⅜	17⅜ 18⅜	5 8 1	,, ,,	..	..
12,931	5	1/7⅛	Direct Spanish (£4 paid)	2⅛ 3⅛	2⅛ 3⅛	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	,, ,,	..	..
60,710	20	3/6	Direct United States	11⅛ 11⅜	11⅛ 11⅜	6 3 4	Jan., Apr., July, Oct.	11 5/16	11 3/16
400,000	10	2/6	Eastern	14⅛ 14⅜	14⅜ 14⅝	4 7 5	,, ,,	14 13/16	14⅛
70,000	10	6%	Do. 6 per Cent. Preference	15⅜ 16⅛	15⅜ 16⅛	3 13 10	,, ,,	16	..
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109 112	109 112	3 11 5	May and November	110½	110
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	14½ 14¾	14⅜ 15	4 13 4	Jan., Apr., July, Oct.	14⅞	14⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	110½	110
£78,800	100	5%	Do. 5 p. c. (Austin. Gov. Sub.) Debs. 1900	107 110	104 107	4 13 6	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor Deb., 1900	104 107	103 106	4 14 4	,, ,,	104½	103¼
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	109 112	103 106	3 15 6	February & August	..	..
180,227	10	1/9	Globe Telegraph and Trust	9⅜ 10	9⅜ 10	4 15 0	Jan., Apr., July, Oct.	10	9½
180,042	10	6%	Do. 6 per Cent. Preference	14⅞ 15½	14⅞ 15½	3 19 4	,, ,,	15 1/16	15
150,000	10	5/0	Great Northern	19¼ 19¾	19¼ 19¾	4 6 1	Jan., April, and July	..	..
£990,000	100	5%	Do. 5 per Cent. Debentures, 1883	104 107	104 107	4 13 6	March & September	105	..
17,000	25	12/6	Indo-European	44 45	44 46	5 8 8	May and November	45⅝	44¾
88,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	,, ,,	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108 111	108 1 1	5 8 1	March & September	..	..
10,502	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October	..	..
3,380	£100 Cert.	30 0	Submarine Cables Trust 6%	116 120	116 120	5 0 0	,, ,,	..	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July	..	..
£271,400	100	6%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	10¾	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	104 108	104 108	7 8 2	June and December	..	..
88,321	10	6d.	West India and Panama	1½ 1½	1⅜ 1⅝	..	,, ,,	1¼	..
84,866	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10 10½	5 14 3	May and November	..	..
1,866	10	6%	Do. 6 per Cent. 2nd Pref	8 9	8 9	6 13 4	,, ,,	..	..
£30,000	100	5%	Do. 5 per Cent. Debentures, 19 7	..	105 108	4 12 7	June and December	..	..
94,242	15	3/0	Western and Brazilian	7 7½	7 7½	6 0 0	,, ,,	..	..
33,125	7½	3 0	Do 5 per Cent. Cumulative Preferred	5½ 5⅞	5½ 5⅝	6 10 4	,, ,,	5⅝	5⅜
33,125	7½	4/6	Do. 5 per Cent. Deferred	1¼ 1⅜	1⅜ 2	..	,, ,,	..	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106 109	106 109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106 109	106 109	5 10 1	,, ,,	..	..
$1,836,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
224,000	14/0	14d.	Consolidated Telephone Const. & Maintenance	1 3/16 1 5/16	1 3/16 1 5/16	7 16 5	May and November	..	..
220,000	£1	4⅜d.	Oriental (11s. paid)	1 3/16 1 5/16	1 3/16 1 5/16	7 18 2	Yearly	..	..
454,747	5	2/6	National xd	4⅜ 5⅛	4¾ 5	6 0 0	June and December	4 1/16	4 1/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref. xd	14¼ 15¼	14 15	4 0 0	,, ,,	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. xd	13¾ 14¼	13¾ 14¼	4 4 3	,, ,,	14	..
90,950	5	6¾d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid) xd	..	4¼ 4½	..	..	4 7/16	4½
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112 114	112 114	..	January and July	114	113⅜
48,000	£10	..	New Telephone, Limited (£4 paid)	4¾ 5	4⅜ 5	..	..	..	..
58,000	5	1/6	United River Plate	2½ 3	2¾ 3¼	..	January and July	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	,, ,,	..	..
			ELECTRICITY SUPPLY COMPANIES.						
80,152	£10	..	City of London Electric Lighting (fully paid)	10¼ 10⅜	10½ 10⅝	..	—	10⅝	..
20,000	£10	..	Do. 6 per Cent. Preference	5 5½	5 5½	10 18 2	..	5⅝	5½
19,900	£5	..	Electricity Supply Co. of Spain	..	..	..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..	5 5¼	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	..	..	..
8,332	£5	..	House to House Electric	2¼ 3¼	1⅝ 2⅝	..	—	—	—
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5¼	5 5½	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	5¼ 5½	6 6½	..	January and July	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	3 7/16 3 9/16	3 9/16 3 11/16	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 1/16 5 3/16	5 3/16 5 5/16	..	March	..	..
111,000	5	..	London Electric Supply	3/8 1/2	3/8 1/2	..	—	..	..
13,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	..	6	6
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	101 104	102 105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	—	—	..	..
18,680	£5	2/6	St. James' and Pall Mall	7¾ 8¼	7¾ 8¼	—	—	8 1/16	..
7,900	£5	7%	Do. 7% Preference	8¼ 8¾	8¼ 8⅜	4 0 0	—	8⅞	..
12,853	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 10 0	—	5¼	
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/6⅜	Brush Electrical Engineering	3 3¼	3 3¼	..	—		
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2⅛ 2⅜	5 1 1	—		
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July	5⅜	¼
12,189	5	..	Edison and Swan United	..	..	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid) xd	2¾ 3¼	1⅞ 2¼	..	..	..	..
45,000	10	12/0	Electric Construction	2½ 3	2½ 3	..	—	2⅞	2⅝
70,000	2	10/0	Elmore's Patent Copper Depositing	¾ 1	¾ 1	—	—	⅞	..
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	..	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21 22	21½ 22½	5 11 1	February & August	21⅞	21
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/9 4/3	3/9 4/3	..	..	..	..
78,849	5	4/2⅝	Swan United (£3. 10s. paid)	3 3¼	3 3½	10 0 0	May and November	3½	..
37,380	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July	45½	..
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103 106	103 106	4 14 4	January and July	..	..
—	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	½ ¾	..	..	—	..	..
—	£5	8%	Do. Preference (fully paid)	2½ 3	¾ 1¼	..	—	..	..
			RAILWAYS AND TRAMWAYS.						
£50,000	£10	..	City and South London Railway	3 4	..	..	—	..	
600,000	Stock	½%	Do. Stock	35 38	35 38	1 ..	—	37	—

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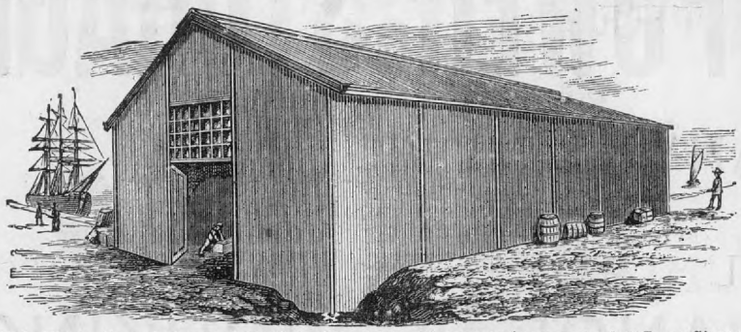

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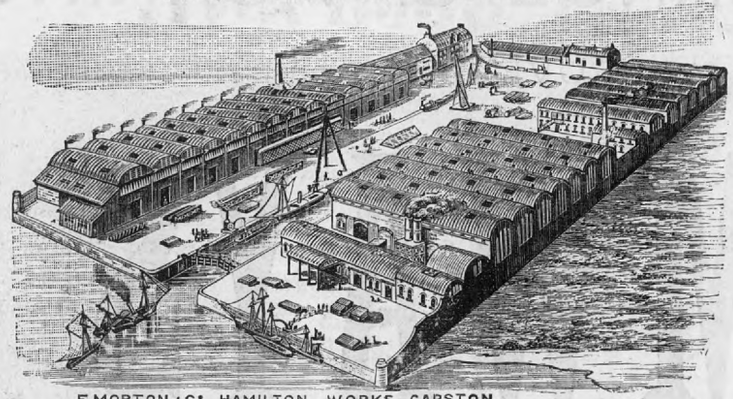

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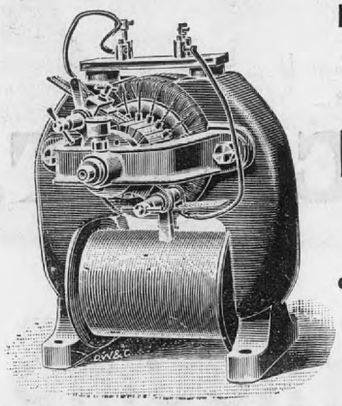

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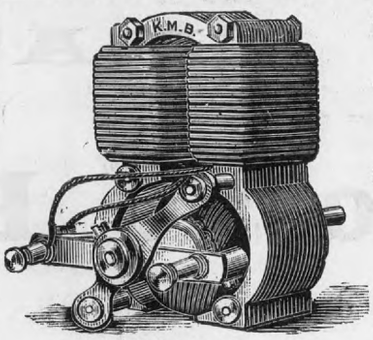

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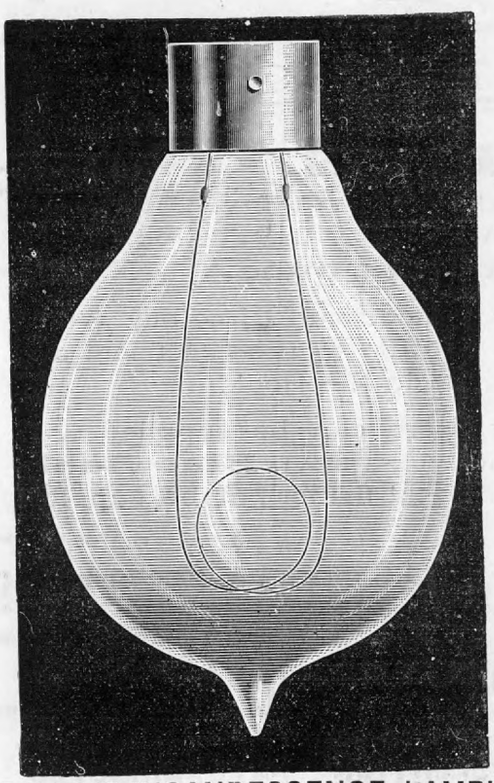

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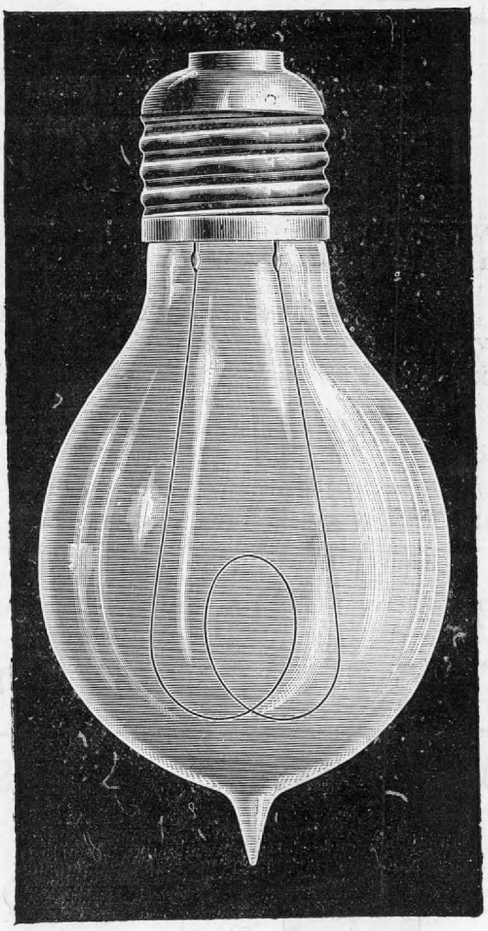

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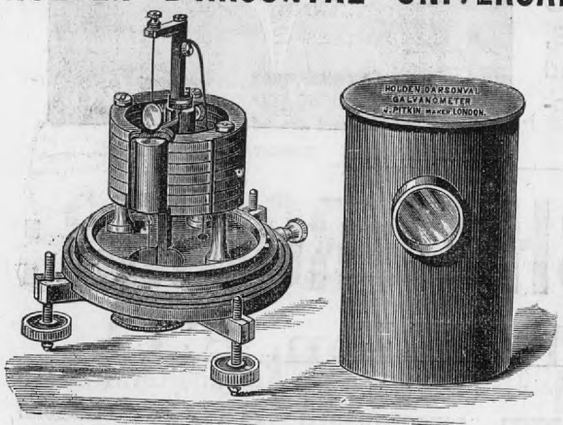

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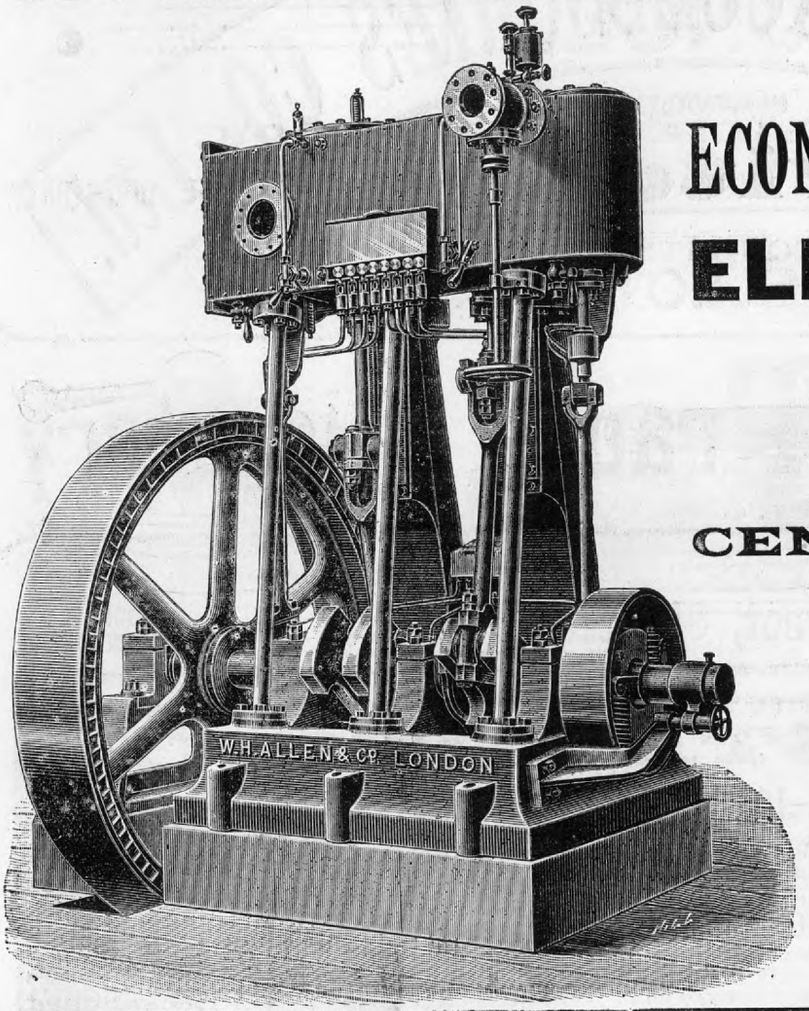

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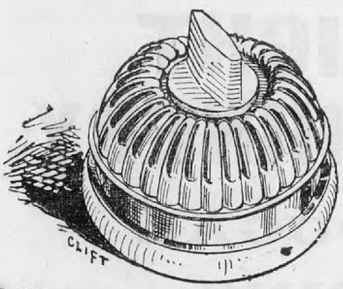

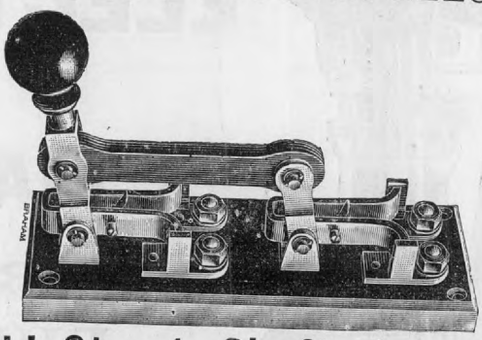

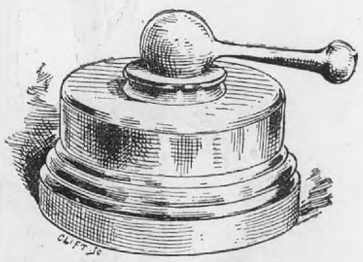

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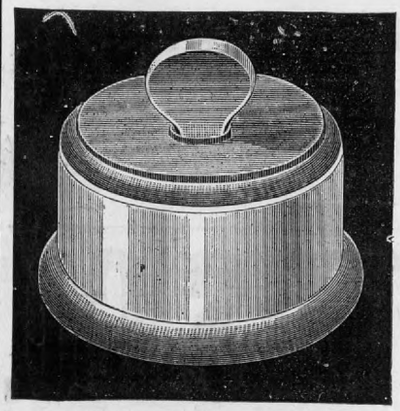

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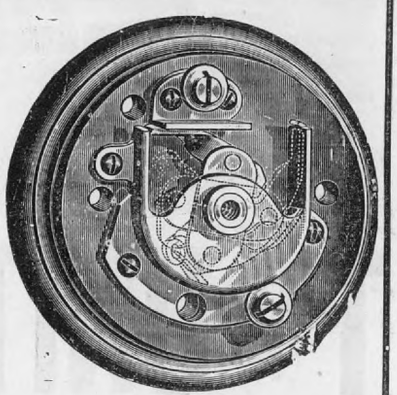

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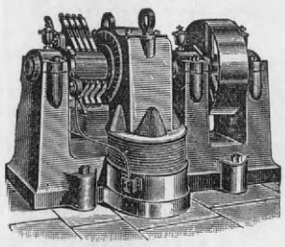

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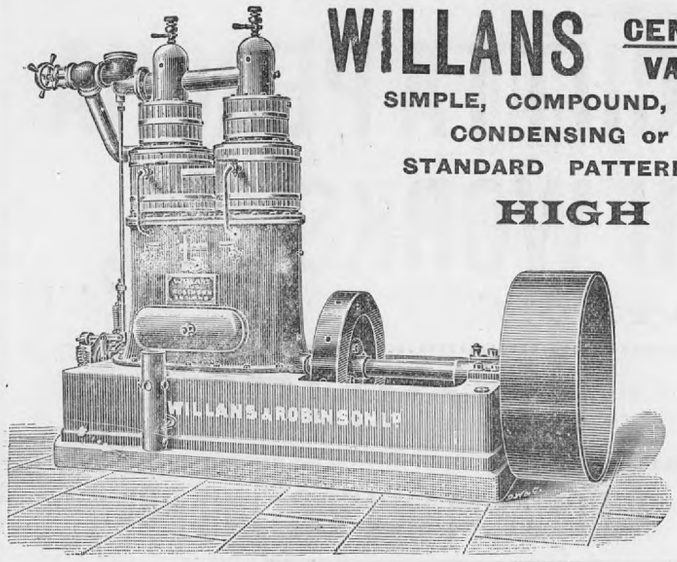

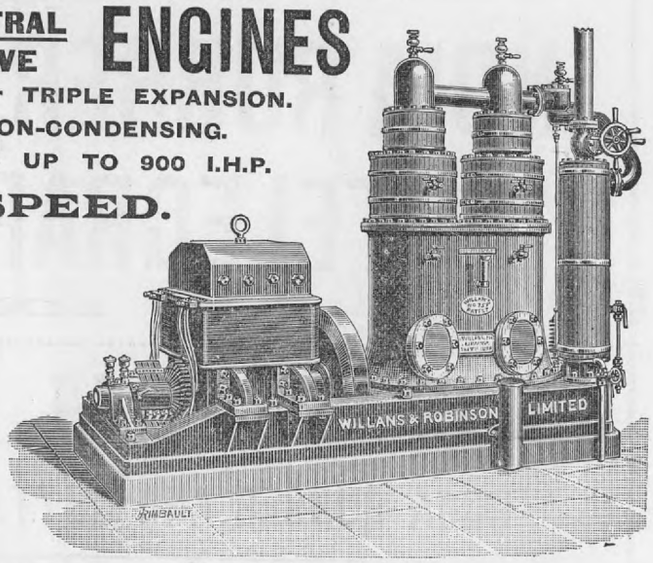

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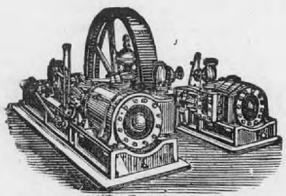

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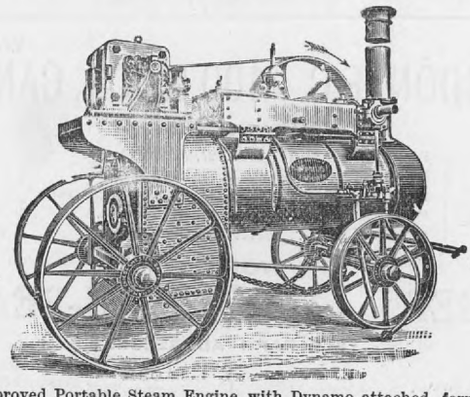

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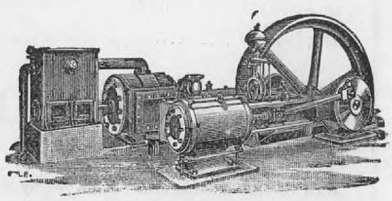

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No. 763.—Vol. XXX. FRIDAY, DECEMBER 30, 1892. PRICE FOURPENCE.
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NOTES.

What may perhaps be taken as the last attempt to overthrow the Edison lamp patent has just been defeated in the United States. After an unaccountable delay the Edison Company took proceedings, a few months back, against the makers of the well-known Sawyer-Mann lamp and obtained an injunction. Against this decision an appeal was immediately lodged, but without avail. The United States Circuit Court of Appeals held that the contention of the Westinghouse Company, the real defendants, that the General Electric Company, the real plaintiffs, were within the scope of the Anti-Trust law, had no bearing whatever upon the question at issue. The Appeal Court, however, in upholding the decision of the Court below, ordered the owners of the patent to supply lamps upon reasonable terms to electric lighting companies. The necessity for such a proviso, and several statements which have of late been current in the American technical press, would seem to point to a decided flaw in the patent law of the United States. The possession of a patent appears over there to carry with it an almost unlimited power of oppression.

The knotty problem of differential charges for electrical supply continues to be discussed in our Correspondence columns, and so far from finding a solution in the ingenious mechanical arrangements of the Scott meter, has thereby received at the hands of Prof. Garnett the addition of a delightful complication. In his letter this week Prof. Garnett suggests that instead of altering the rate of charge on the astronomical basis of sunset and a certain later hour in the evening, the rate should depend on the actual output of the station at any moment, and he arrives at the happy conclusion that the dials of the meters should register £. s. d. This irresistibly recalls the fact that the real object of electrical supply companies is not to provide electrical energy to the consumers, but dividends to their shareholders. The method of charging should, therefore, take into consideration the real value and cost of the dividend. The control of the station clock should then depend on the price of coal, of bread, of Consols, and of the company's shares, the rate of income tax, the bank rate, local rates, and the bimetallic ratio.

Although the discussion on earthing the middle wire, which has been aroused by the "Human Document" published in our issue of November 25, is not continued in our Correspondence column this week, we hope to print a further communication upon the subject, and to place before our readers rather more practical considerations than some of those which have already appeared. Meanwhile, the subject has been taken up in the columns of the *Review*, a contemporary devoted to insurance matters. On matters touching insurance, insurance experts should, of course, command attention; but we may be excused if we are less ready to accept than are they to offer their ideas on details of electrical engineering. Because the inventor of a system of concentric wiring has advocated earthing the middle wire, and with an obvious reason, amongst others perhaps, that owing to the large surface of his outer conductor external insulation would be very expensive, the *Review* jumps to the conclusion that concentric wiring involves earthing the middle wire. We are by no means prepared to advocate concentric wiring; it is still on its trial, and labours under two restrictions—patent rights and the necessity for special knowledge on the part of wiremen. It has received ample attention in these columns, and will doubtless make its way under the auspices of the two or three firms who hold patents for details. The subject of earthing the middle wire is of a much more important character. Those who are opposed to it are unfortunately the most reluctant to express their reasons, and talk with much vagueness—but, we must confess, with commendable caution—about corrosion and electrolysis, both of their own mains, and of gas and water pipes.

In describing the Holden hot-strip ammeter in *The Electrician*, Vol. XXIX., p. 589, we remarked that the available force in such an instrument is so great that mechanism might be introduced to correct the uneven division of the scale. In making this observation the question presented itself, why should a thermal ammeter exert more force than an ordinary electro-magnetic instrument? We did not allude to this apparent paradox at the time, but as the idea presented itself again in Mr. Arthur Wright's letter last week, we proposed the subject to Mr. E. T. Carter, who has attacked the problem in an article which will be found in another column. If a thermal ammeter jams, something will have to go, but the needle of a magnetic ammeter seems to enjoy sticking rather than otherwise. The mechanical work spent in an instrument of this kind is so small that attention is directed to force rather than energy, but it is here that the difficulty is concealed. A simple experiment might be arranged by taking

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two long wires, similar in every respect, and hanging, say, a pound weight on one of them, and an ounce on the other. Pass the same current through the two, heating them, and causing them to extend. Now cut off the current, and one wire in retracting would appear to do more work than the other. The explanation put forward by Mr. CARTER, viz., the alteration of specific heats by tension or compression, accounts for a good deal, but several points remain somewhat obscure. As Mr. CARTER concludes his article with a couple of questions, we will end our Note with a few more. Will these two wires assume the same temperature? By how much is the resistance, and therefore the C^2R, affected by the difference in the tensions? As the pound does work in falling, will this appear as heat in the wire? And, finally, does one wire really do more work than the other?

WE have just received from Professor MACFARLANE a copy of a very able paper, entitled "The Principles of the Algebra of Physics." It consists of a modified version of the science of quaternions, and presents several new features of interest. The paper is a long one, for quaternions are so little used that, whenever they are discussed, the principles on which they are based have to be explained from the commencement. It has been said that quaternions have been of very little service in discovering new relations in physics, however convenient they may be for expressing old facts in a compact form; and with the view of removing this reproach various mathematicians have from time to time endeavoured to simplify the very cumbersome system of notation introduced by HAMILTON and TAIT. The latest attempt in this direction is that of Professor MACFARLANE, and his chief innovation consists in using the ordinary trigonometrical functions, with extended meanings, to represent certain relations between the different quantities used in the directional calculus. The result, however, is to make the mathematics assume the appearance of spherical trigonometry, and, as the symbols of ordinary algebra can be handled much more easily than combinations of sines, cosines, and tangents, we much doubt whether this departure is really a step in advance.

THE extension caused in a bar of iron when placed in a magnetic field was first shown by JOULE, and has been measured by various experimenters, the expansion being rendered visible either by an arrangement of levers, or with the aid of a microscope. A simple and elegant method of making the observations has, however, been recently used by M. ALPHONSE BERGET, and is described in the *Comptes Rendus*. The method is due originally to FIZEAU, who employed it for measuring the expansion of crystals, and the present modification is to fix the iron bar firmly at one end, and arrange so that the other end presses together two glass surfaces, such as the plane surface of a black glass mirror and that of a plano-convex lens. The interference fringes formed, owing to the phenomena of "thin plates," are displaced when the bar is magnetised, and from the amount of displacement the expansion of the bar can be measured. The results are excellent, for with an iron bar only 5 centimetres long it has been possible to obtain a curve connecting the density of the lines of force in the bar with its extension. The curve obtained is similar in character to the saturation curve of iron, the extension of the bar approaching a limit as the induction density is increased. In this respect it entirely differs from the curves obtained by Mr. SHELFORD BIDWELL, who, in the course of an exhaustive research on this subject, showed that the extension of the iron attained a maximum value, and that further increase of the magnetising force caused the bar to shorten. He even showed that strong magnetic forces caused the iron to contract by about one-part in 150,000. The apparent inconsistency of these results and of those of M. BERGET does not in any way detract from the interest of his method. The apparatus seems suitable for lecture demonstrations, and is compact and portable.

MR. OLIVER HEAVISIDE commences in our present issue the fourth chapter of his present work, and leaving for the moment the rather difficult analytical treatment of the electromagnetic theory, he introduces the discussion of plane waves by at least two columns of most interesting plain prose. It may seem invidious thus to call attention to a particular article, but we do so because it is safe to assume that a considerable number of our readers occasionally pass over Mr. HEAVISIDE'S contributions, hastily assuming that they are always of a profoundly mathematical character.

Paris.—The central lighting station for the Champs Elysées district is about to come into operation.

Post Office Appointment.—Mr. H. J. Vase, Technical Officer, has been appointed Superintending Engineer, vice Mr. J. Gavey.

Canterbury.—It is announced that the Brush Company have accepted the terms upon which the Town Council are disposed to make over their Provisional Order.

Yarmouth.—The ratepayers of Yarmouth have met together and voted by an overwhelming majority that the Town Council do not proceed further with the proposed electric lighting scheme.

The Hazeltine Coated Carbon.—According to the *Electrical Engineer* of New York, Mr. C. W. Hazeltine, of St. Louis, Mo., has recently discovered that by coating carbons with copper, of about the same thickness as that usually employed, and then with a heavier coating of zinc, the carbons can be made to burn nearly twice as long as with merely the copper covering.

The Dissipation of a Static Charge.—In a recent number of *Wiedemann's Annalen* are described some experiments by Narr on the rate of dissipation of a hollow charged sphere at temperatures varying from 0°C. to 100°C. The rate of loss of charge was practically unaffected, only a 1-10th increase being noted, in spite of the convection currents set up by the heated sphere.

Nelson.—On Friday evening last the municipal central lighting station was inaugurated. Some 450 lights are already connected up. The generating station is at the Corporation Gasworks, and the steam pressure of 80lb. required for driving the engine is supplied by waste heat from the retort-house. The plant is capable of supplying 600 16-c.p. lamps. Insulated cables laid in iron pipes are used.

Australian Land Lines.—The Governments of Queensland and Western Australia are in communication with reference to a proposal to connect the telegraph system of Northern Queensland with Western Australia, so as to make communication

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complete round the Australian coast in case of an attack by a hostile fleet. The Queensland Government has agreed to carry the Queensland lines as far as Port Darwin.

Interurban Telephony.—The business men of Minneapolis and St. Paul will not rest easy now, says the *Western Electrician*, until they have telephonic communication with Chicago. It is estimated that the line will cost £12,000, and that an annual income of £3,000, or about £10 per day, will be required to cover interest, depreciation, working expenses, &c. The distance in a bee-line is about 350 miles.

Cable Interruptions :

Cable.	Date of Interruption.
Cayenne-Vizeu	September 24, 1892
St. Thomé-Loanda*	November 24, 1892
Penang-Medan	December 1, 1892
Senegal-Pernambuco	December 27, 1892

* Communication with South Africa is still maintained by the East Coast route.

The French Government and the Telephones.—Anyone wishing to obtain reliable statistics with regard to the result of the Government purchase of the telephone system of France cannot do better than digest the report on the subject published by the Directeur Général des Postes et Télégraphes. It is to be found in the July-August number of the *Annales Télégraphiques*, of which it takes up some 56 pages.

The Proposed Trans-African Land Line.—The following letter, signed L. Hirsch and Co., referring to the African Trans-continental Telegraph scheme, appeared in Friday's *Times* :—

Sir,—It having been brought to the notice of the Hon. C. J. Rhodes that a rumour has been circulated by the Havas Agency to the effect that the African Trans-continental Telegraph scheme has been abandoned, Mr. Rhodes requests us to-day, by telegraph from Marseilles, to emphatically deny this statement, and to affirm that operations are to be immediately commenced. Instructions have been already given for the requisite legal steps to be taken for incorporating the Company, and as soon as this is done subscribers will receive the letters of allotment.

Railway Telephones.—In connection with the recently threatened strike of the telegraph operators on the Jersey Central Railroad, it was, says the *Western Electrician*, announced that the Company had taken steps to protect itself, and, anticipating a "walk out," had placed long distance telephones in its stations by means of which, it was hoped, the business could be continued without the operators. Whether there was any foundation for this report cannot be stated positively, but certain it is that the differences between the men and the Company were soon settled, and there is reason to believe that the men did not secure the advance in their wages that was the principal point in dispute.

Hanley.—An inquiry was held at Hanley on Thursday last week by an inspector of the Local Government Board with regard to a proposal of the Town Council to adopt a system of electric lighting throughout the borough. The Town Clerk stated that on September 16th the Council accepted the tender of the Brush Company for £15,780, which included the whole plant, engines, and mains. Buildings would cost £8,000. Several large ratepayers supported the application of the Council, while the ex-Mayor and others opposed the scheme on the ground that the town was already overburdened with rates. It was also pointed out that trade throughout the district had never been in such a bad state.

The Lighting of Trolley Lines.—In a letter to the *Electrical Engineer* of New York, X. I. M. inquires why the electric tramway companies continue to illuminate their tracks at night by the arc between a defective trolley wheel and the wire. He has, he states, noticed at times melted metal drop from the trolley to the top of the car and the ground below. "If trolley poles were properly attended to when out of adjustment, and if eccentric or defective trolley wheels were removed when necessary and trued up or new ones substituted, it would make the poor, overworked motor beneath the car put on the seraphic smile supposed to be worn only by angels when having their photographs taken for a Sunday-school picture."

The Prizes of the Académie des Sciences.—On December 19th the Académie des Sciences held its annual general meeting. The Poncelet prize was awarded to Sir John Fowler and Sir Benjamin Baker; the Montyon prize was obtained by M. Raffard for his well-known elastic coupling and brake; the Gay prize was given to M. Moureaux for his magnetic survey of France. Amongst the prizes offered are the Vaillant (4,000fr., 1894) for "An investigation of the chemical and physical causes which determine the existence of the rotatory power of transparent bodies, especially from an experimental point of view." The Gaston Planté prize of 3,000fr., to be given to any Frenchman making an important electrical discovery or invention, will be awarded for the first time next year (1893).

Electric Traction and the Telephone.—The Port Defiance, Tacoma, and Edison Railway, says the *Scientific American*, has in operation an appliance designed to prevent delays when an accident happens to any of the cars along the line. The appliance is an ingenious telephone arrangement, so connected with the main office that the conductor can telephone what the trouble is and all the details, so that arrangements can be made at the office to avoid delay of other cars on the line. Along the line between Point Defiance and Edison a telephone wire is strung, and there are special poles, down which proper wires run to an average man's height from the ground. Each car carries a telephone instrument, which can be connected with the wires and communication with the main office obtained. After notice of a breakdown is received the remaining cars on either side of the break can be operated by office orders through the telephone, and thus kept running to time.

Copenhagen.—The central station at Copenhagen, which is a municipal concern, has, says our Scandinavian correspondent, found it expedient to bring about a 25 per cent. reduction in the price of electricity for lighting. The price now is 6 öre or four-fifths of a penny per 100 watt per hour ; *i.e.*, 8d. per Board of Trade Unit. From a financial point of view, there does not appear to be any great objection ; for instead of, as calculated, having an average load of 16,000 lamps all the year round, it is likely to be 17,000 lamps, and their average time of burning will probably be 500 and not 400 hours, which will raise the consumption from 352,000 kilowatt hours to 467,000 kilowatt hours. This consumption should, then, at the reduced rate, bring in almost exactly the same revenue as before. There will, of a necessity, be an increased expenditure for fuel and wages, and it is reckoned that the annual addition to the renewal and extension fund will have to be reduced.

Zürich.—The municipal central station at Zürich has recently come into operation. At first it was intended to have continuous-current for the arc lights, and alternate-current for the glow lamps, and to employ water-power (the falls of the Limmat) exclusively. The laying down of two separate sets of mains and generating plant was, however, found to be too expensive, and as the falls of the Limmat supplied a very variable amount of energy, it was finally decided to use auxiliary steam-power and to employ the alternate-current throughout. The central station is situated near the Town Waterworks. The plant comprises two 175-H.P. low-pressure turbines; one 300-H.P. compound steam engine ; two 30-H.P high-pressure turbines. Distribution is carried out on the transformer sub-station three-wire system. There are at present nine sub-stations. Some 3,200 16-c.p. lamps are connected to the mains, and 75 arc lights. The municipality imposes a fixed charge of 10fr. per annum per lamp installed, and charges at the rate of 6¼d. per Board of Trade unit for energy actually supplied.

The Thomson-Houston Electric Light Carbon Factory.—If the attitude towards electrical manufacturers disclosed in the following paragragh which appeared in *Electricity* of New York, on November 23rd, were usual in this country, fires would, perhaps, be more frequent and dividends less rare. The Thomson-Houston Carbon Company's factory at Fremont, Ohio, destroyed by fire in February last, is being rebuilt, the citizens having collected some $35,000 and given it to the Company as a bonus to keep the factory in Fremont, as it was understood the Directors were in favour of building elsewhere. The new plant will be much larger than that destroyed. The building will be 336ft. by 70, and will be of brick and iron, with a slate roof. The engine and boilers for the main factory have a capa-

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city of 300 H.P. There will also be a machine shop, the power for which will be supplied by a 150 H.P. engine. The retorts for the carbons are already finished, and work is being rapidly pushed on the baking ovens. It is expected that the factory will be in full operation by the beginning of the new year, when a force of from 300 to 400 hands will be employed, and the output of carbons will be about 3,000,000 a month.

Exports of Telegraphic Apparatus.—The statistics of our exports of telegraphic wires and apparatus connected therewith, as shown in the November Board of Trade returns, accentuate the very disappointing comparison shown in previous returns. The value of our exports in November was less than in the previous November, and very much less than in the November of 1890; and the total exports of the eleven months compare very unfavourably indeed with corresponding figures of the first eleven months of either last year or the year 1890. Below we give a statement of the exports for the first three quarters, and for the first two months of the last quarter of the present year, in comparison with the corresponding figures of 1891 and 1890 :—

	1890.	1891.	1892.
First Quarter	£324,670 ..	£653,081 ...	£96,079
Second Quarter	397,042 ...	331,449 ...	579,756
Third Quarter	210,280 ...	342,106 ...	124,605
Nine Months	931,992 ...	1,326,636 ...	800,440
October	335,064 ...	38,167 ...	31,198
November	246,378 ...	25,143 ...	39,993
Total Eleven M'ths...	£1,513,434 ...	£1,389,946 ...	£871,631

The Speed of American Electric Cars.—The St. Paul Council, says the *Western Electrician*, has passed an ordinance regulating the speed of electric cars. It prescribes limits for the centre of town, and directs that within these boundaries eight miles an hour shall not be exceeded. In the outside districts the cars may be run twelve miles an hour. The agitation of this matter has called attention to the statistics of street railway accidents. The St. Paul police reports show 31 accidents from electric cars during the past six months. The fire department has had frequent collisions with the cars. The speed of cars in other cities is tabulated as follows :—

City.	Centre.	Suburbs.
Cleveland, O.	4	12
Nashville	6	12 to 15
Cincinnati	8	—
St. Louis	8½	10
Louisville	9	12
Syracuse, N.Y.	6	—
Memphis	15	—
Washington, D. C.	9	—
New Orleans	6	—
Baltimore	7	16
Los Angeles	8	—
Sacramento	8	—
Denver	8	12
Portland, Ore.	8	—
Boston	8	12

The average speed allowed in these 15 cities is, it will be seen, 7·9 miles per hour.

The Boston Municipality and the West End Street Railway.—"An interesting controversy between the Boston City Council and the West End Street Railway Company has," says the *Western Electrician*, "been in progress for some time. The Boston aldermen ordered the Company to equip its cars with 'fenders.' The Company replied that it had had the matter under consideration for a long time, but had as yet been unable to decide upon any 'fender' submitted. The Council evidently considered this an evasive answer, and ordered immediate action. The Company thereupon agreed to accept any 'fender' which the Council might recommend. It suggested that a Commission be appointed to examine the 'fenders' submitted for consideration. The Company agreed to pay all expenses and abide by the decision of the Council. This proposition had the effect of silencing the aldermen and convincing the public that the Company was acting in good faith. It is not expected that the Council will accept the Company's proposition, as it is believed the city would be liable for damages should accidents follow the adoption of the 'fender' recommended by the city." Municipalities and companies are much the same all the world over. The former oscillate everywhere between over-sluggishness and drastic ordinances, the latter in all climes retain their characteristic penchant for winning, without in any way deserving it, a name for disinterested philanthropy.

Transmission of Power from the Coalfields.—A Paper was read by Mr. B. H. Thwaite at a recent meeting of the Manchester Association of Engineers, upon a bold scheme for generating power on a large scale by means of gas-engines in the South Yorkshire coal district. The details have been worked out with the assistance of Mr. J. Swinburne. The most interesting part consists of estimates for the plant by Mr. C. E. L. Brown, of Messrs. Brown, Boveri and Co., and by the Maschinen-Fabriken Oerlikon. The figures show that 10,000 H.P. can be delivered and sold in London with 7 per cent. profit for 1·34d. per supply unit. *Industries*, in comparing this scheme with the Niagara supply, says that putting a central station down in an English coalfield means economy, because there is already a market for the power. Putting down power plant to supply power at Niagara at a greater price than it can be produced, say at Pittsburgh, may be successful, but it would be still better to put down a station at Pittsburgh. In England we have better opportunities than in America, as we can put down power stations which can probably produce power more cheaply than it can be provided at Niagara, and, further, we need not wait in this country for towns to grow up to use it. All the English manufacturing towns are within electrical reach of possible coalfield stations. When any scheme like, for instance, the one at Niagara, is to be carried out, it should be carried out quickly. Few people realise the financial effect of loss of time in extensive constructional works. It should be remembered that the capital is often spent in large proportions at the beginning of an undertaking, and if several years lapse before the returns begin to come in compound interest must be allowed during the time of building. The omission of this consideration has brought about ruinous effects in some undertakings, such as docks and railways.

The Proposed Electric Railways.—The Clapham Junction and Paddington Railway Bill proposes the incorporation of a company, the promoters of which include the names of Baron Sudeley, the Hon. E. S. Churchill and Mr. D. F. Carmichael, with power to make a railway four miles one furlong in length, from near St. John's-hill, Wandsworth-road, to the Bishop's-road bridge of the Great Western Railway. The railway is to be constructed in two tunnels by means of compressed air, the tunnels are to be lined with iron or metal plates, and the traffic is to be worked by electricity or other motive power than steam. The capital of the Company is fixed at £1,050,000, in shares of £10 each, with power to borrow on mortgage £350,000. The period for the completion of the works is fixed at five years from the passing of the Act. There are special clauses following in the lines of recent legislation for the conveyance of the working classes over the line at certain times in the morning and evening, at the rate of 1d. per journey. Power is taken in the Bill to pay interest at the rate of 3 per cent. out of capital during construction.—The Edgware-road and Victoria Railway Bill provides for the incorporation of a company, including the names of Sir Frederick Johnstone and others, for the purpose of making a line four miles three furlongs six chains in length, from Edgware-road to Vauxhall-bridge-road at Victoria, with a subsidiary line one furlong four chains in length, from High-road, Kilburn, to Dyne-road. The mode of construction and the manner of working are to be similar to those of other proposed electric railways, and the capital of the Company is set at £1,200,000, in 120,000 shares of £10 each, with power to borrow on mortgage £400,000. The works are to be completed within five years from the passing of the Act, and provision is made for the conveyance of the working classes before seven in the morning or after six in the evening, except on Sundays, Christmas Day, and Good Friday, at fares not exceeding ½d. a mile.—The City and South London Railway Company have also deposited a Bill asking for an extension of time for the construction of the subway authorised by their Act of 1890.

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ELECTROMAGNETIC THEORY.—XLI.

BY OLIVER HEAVISIDE.

(*Continued from page 151.*)

§ 176. It has often been observed that the universe is in an unstable condition. Nothing is still. Nor can we keep motion, once produced, to a particular quantity of matter. It is diffused or otherwise transferred to other matter, either immediately or eventually. The same fact is observed in the moral and intellectual worlds as in the material, but this only concerns us so far as to say that it underlies the communication of knowledge to others when the spirit moves, even though the task be of a thankless nature.

The laws by which motions, or phenomena which ultimately depend upon motion, are transferred, naturally form an important subject of study by physicists. There are two extreme main views concerning the process. There is the theory of instantaneous action at a distance between different bodies without an intervening medium; and on the other hand there is the theory of propagation in time through and by means of an intervening medium. In the latter case the distant bodies do not really act upon one another, but only seem to do so. They really act on the medium directly, and between the two are actions between contiguous parts of the medium itself. But in the former case the idea of a medium does not enter at all. We may, however, somewhat modify the view so that action, though seemingly instantaneous and direct, does take place through an intervening medium, the speed of transmission being so great as to be beyond recognition. Thus, the two ideas of direct action, and through a yielding medium, may be somewhat harmonised, by being made extreme cases of one theory. For example, if we know that there *is* a yielding medium and a finite speed, but that in a certain case under examination the influence of the yielding is insensible, then we may practically assume the speed to be infinite. But although this comes to the same thing as action at a distance, we need not go further and do away with the medium altogether.

There is another way of regarding the matter. We may explain propagation in time through a medium by actions at a distance. But this is useless as an explanation, being at best merely the expression of a mathemat cal equivalence.

Now consider the transmission of sound. This consists, physically, of vibratory motions of matter, and is transmitted by waves in the air and in the bodies immersed in it. The speed through air is quite small, so small that it could not even escape the notice of the ancients, who were, on the whole, decidedly unscientific in their mental attitude towards natural phenomena. Suppose, however, that the speed of transmission of sound through air was a large multiple of what it is, so that the idea of a finite speed, or of speed at all, did not present itself. We should then have the main facts before us, that material bodies could vibrate according to certain laws, and that they could, moreover, set distant bodies vibrating. This would be the induction of vibrations, and it might be explained, in the absence of better knowledge, by means of action at a distance of matter upon matter, ultimately resolvable into some form of the inverse square law, not because there is anything essentially acoustical about it, but because of the properties of space. Furthermore, we should naturally be always associating sound with the bodies bounded by the air, but never with the air itself, which would not come into the theory. A deep-minded philosopher, who should explain matters in terms of an intervening medium, might not find his views be readily accepted, even though he pointed out independent evidence for the existence of his medium—physiological and mechanical—and that there was a harmony of essential properties entailed. Nothing short of actual proof of the finite speed of sound would convince the prejudiced.

Now, although there is undoubtedly great difference in detail between the transmission of sound and of electrical disturbances, yet there is sufficient resemblance broadly to make the above suppositional case analogous to what has actually happened in the science of electromagnetism. There were conductors and non-conductors, or insulators, and since the finite speed of propagation in the non-conducting space outside conductors was unknown, attention was almost entirely concentrated upon the conductors and a suppositional fluid which was supposed to reside upon or in them, and to move about upon or through them. And the influence on distant conductors was attributed to instantaneous action at a distance, ignoring an intermediate agency. Again, a very deep-minded philosopher elaborated a theory to explain these actions by the intermediate agency of a yielding medium transmitting at finite speed. But although in doing so he utilised the same medium for whose existence there was already independent evidence, viz., the luminiferous ether, and pointed out the consistency of the essential properties required in the two cases, and that his electromagnetic theory made even a far better theory of light than the old, yet his views did not spread very rapidly. The old views persisted in spite of the intrinsic probability of the new, and in spite of the large amount of evidence in support of the view that some medium outside conductors, and it may be also inside them as well, but not particularly conducting matter itself, was essentially concerned in the electrical phenomena. The value and validity of evidence varies according to the state of mind of the judge. To some who had seriously studied Maxwell's theory the evidence in its favour was overwhelming; others did not believe in it a bit. I am, nevertheless, inclined to think that it would have prevailed before very long, even had no direct evidence of the finite velocity been forthcoming. It was simply a question of time. But the experimental proof of the finite speed of transmission was forthcoming, and the very slow influence of theoretical reasoning on conservative minds was enforced by the common-sense appeal to facts. It is now as much a fact that electromagnetic waves are propagated outside conductors as that sound waves are propagated outside vibrating bodies. It is as legitimate a scientific inference that there is a medium to do it in one case as in the other, and there is independent evidence in favour of both media, air for sound and ether for electrical disturbances. It is also so excessively probable now that light vibrations are themselves nothing more than very rapid electromagnetic vibrations, that I think this view will fully prevail, even if the gap that exists between Hertzian and light vibrations is not filled up experimentally, through want of proper appliances—provided some quite new discovery of an unanticipated character is not made that will disprove the possibility of the assumed identity.

Now, the immediate question here is how to propagate a knowledge of the theory of electromagnetic waves. If we could assume the reader to have had a good mathematical training, that would greatly ease matters. On the other hand, it is hardly any use trying to do it for those who have no mathematical knowledge—least of all for those anti-mathematical attackers of the theory of the wave propagation of electrical disturbances who show plainly that they do not even know intelligibly what a wave means, and what is implied by its existence. But, between the two, I think it is possible to do a good deal in the way of propagation by means of a detailed exposition of the theory of plane waves, especially in dielectrics. By the use of plane waves, the mathematical complexity of waves in general in a great measure disappears, and common algebra may be largely substituted for the analysis which occurs in more advanced cases. Most of the essential properties and ideas may be assimilated by a thinking reader who is not advanced in his mathematics, and what is beyond him he can skip. Besides this, the treatment of plane waves is itself the best preliminary to more general cases.

The problems that present themselves by the artificial limitation to plane waves are often of an abstract nature. There are, however, some important exceptions; the most notable being that of propagation along straight wires, of which the theory is essentially that of plane waves, modified by the resistance of the wires. Before, however, proceeding to the details of plane waves, which will form the subject of this chapter (although it will be needless to altogether exclude connected matters), it will be desirable to prepare the mind by an outline of some general notions concerning electromagnetic waves, irrespective of their precise type.

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§ 177. Consider a non-conducting dielectric, to begin with. The two properties it possesses of supporting electric displacement and magnetic induction, which we symbolise by μ and c, the inductivity and permittivity, are, independently of our actual ignorance of their ultimate nature, so related that the speed of propagation v depends upon them in the way expressed by the equation $\mu c v^2 = 1$, or $v = (\mu c)^{-\frac{1}{2}}$. Thus, an increase either of the permittivity, or of the inductivity, lowers the speed of transmission. In transparent bodies we cannot materially alter the inductivity, but we can very considerably increase the permittivity, and so lower the speed. If on the other hand, we wish to have infinite speed, for some practical purpose of calculation, we may get it by assuming either $\mu = 0$ or else $c = 0$. In the latter case, for example, we destroy the power of supporting electric displacement, whilst preserving the magnetic induction. This is what is done in magnetic problems (the theory of coils, self and mutual induction) when we ignore the existence of electric displacement. On the other hand, in the theory of condensers connected up by inductionless resistances, and in the electrostatic theory of a submarine cable, it is the magnetic induction that is ignored, in a manner equivalent to supposing that $\mu = 0$. In either case we have infinite speed or apparent instantaneous action.

Now, consider some of the consequences of the property of propagation with finite speed. Let there be a source of disturbance at a point for simplicity. It may be either an electric source or a magnetic source. By an electric source we mean a cause which will, if it continue steadily acting, result in setting up a state of electric displacement, whilst a magnetic source steadily acting would result in a state of magnetic induction. In the former case there will be no magnetic induction along with the displacement, and in the latter case no displacement along with the induction. Now, if the speed of propagation were infinite in the former case of an electric source, by the non-existence of μ, the steady state would be set up instantly, and consequently all variations of the intensity of the source would be immediately and simultaneously accompanied by the appropriate corresponding distribution of displacement in the dielectric. Similarly, with a magnetic source, if the speed be infinite by the non-existence of c, all variations in the source will be simultaneously accompanied by the distribution of magnetic induction appropriate to the instantaneous strength of the source.

Now do away with the artificial assumption made, and let both μ and c be finite, and v therefore also finite. At the time t after starting a source, the extreme distance reached by the disturbance it produces is vt. That is to say, beyond the sphere of radius vt, whose centre is at the source, there is no disturbance, whilst within it there is. The wave-front is thus a spherical surface of radius vt, increasing uniformly with the time. Along with this continuous expansion of the range of action there are some other things to be considered. The mere spreading causes attenuation, or weakening of intensity as the disturbance travels away from the source. Besides this, the intensity of disturbance is not the same at a given distance in all directions from the source, and since the displacement and induction are vectors, their directions are not everywhere the same. They are distributed in the circuital manner, so that we have expanding rings or sheets of displacement or induction. Whether the source be of the electric or the magnetic kind, it produces both fluxes initially and when varying, and generally speaking to an equal degree as regards energy. This is a main characteristic of pure electromagnetic waves, a coexistence of the electric and magnetic fluxes with equal energies; and if the source be in a state of alternating variation this state of things continues. But if the source, after varying in any way, finally become steady, the generation of electromagnetic disturbances will speedily cease, and the production of a steady state will begin round the source—of displacement if the source be electric, and of induction if the source be magnetic—whilst the previously generated electromagnetic disturbances will pass away to a great distance. In the end, therefore, we have simply the steady state of the flux corresponding to the impressed force, whilst the electromagnetic disturbances are out of reach, still spreading out, however, and in doing so, leaving behind them the outside portion of the residual steady flux due to the source, which steady flux, however, requires an infinite time to become quite fully established.

We may take a specially simple case in illustration of the above general characteristics. Let the source of energy be contained within a small spherical portion of the dielectric, of radius a, and let it be of the simplest type, viz., a uniform distribution of impressed electric force within the sphere. We know by static considerations alone what the nature of the final displacement due to such a source is. It is a circuital distribution, out from the sphere on one half, and in on the other, connection being made through the sphere itself by a uniform distribution; being, in fact, of the same nature as the induction due to a spherical body uniformly magnetised in a medium of the same inductivity as its own. Now, we can describe the setting up of the final steady state due to the source, when it is suddenly started and kept constant later, thus:—At the first moment an electromagnetic wave is generated on the surface of the sphere, which immediately spreads both ways and becomes a spherical shell, whose outer boundary goes outward at speed v, whilst the inner boundary goes inward. At the time $t = a/v$, therefore, the disturbance fills the sphere of radius $2a$, the centre being just reached. The steady state then begins to form, commencing at the centre and expanding outwards thereafter at speed v. At the time $t = 2a/v$, therefore, we have the steady state fully formed within the sphere of radius a, whilst just outside it is an electromagnetic shell of depth $2a$. Up to this moment the impressed force has been continuously working—not, indeed, in all parts of the sphere it occupies, but in all parts passed by the front of the inward wave from the beginning until the centre was reached, and after that, in the parts not occupied by the already formed steady state. Consequently, at the moment $t = 2a/v$, when the steady state is fully formed throughout the region occupied by the impressed force, the latter ceases to work. It has wholly done its work. The amount done is twice the energy of the final complete steady state, say 2U. The rest of the work is done by the electromagnetic wave itself. For the subsequent course of events is that the fully-formed electromagnetic shell of depth $2a$ runs out to infinity, of course expanding on the way, and in doing so it leaves the steady state behind it. That is to say, it drops a part of its contents as it moves on, so that the steady state is always fully formed right up to the rear of the expanding shell during the whole of its passage to infinity. This shell is not a pure electromagnetic wave, with equal electric and magnetic energies. The magnetic energy is constant, of amount $\frac{1}{2}$U, on the whole journey, but the electric energy is in excess. The excess is employed in forming the steady state, so that when the shell has reached a great distance it becomes appreciably a pure electromagnetic wave, having the amount U of energy, half magnetic, half electric, with a slight excess in the latter, to be later left behind in forming the remainder of the steady state. The energy U of the shell is wholly wasted if the dielectric be unbounded, for there is nothing to stop the transference to an infinite distance.

If we wish to form the steady state without this waste of energy, we must bring the impressed force into action very gradually—infinitely slowly, in fact. In this way the energy wasted in the very weak electromagnetic waves generated will tend to become infinitely small, and the work done by the impressed force will tend to the value U, the energy of the steady state.

When the sphere of impressed force is not finite, but is infinitely small, so that it may be regarded as a special kind of point-source, we simplify matters considerably in some respects. For, by the above, the result is that the moment the source starts, say at full strength, the steady state also immediately begins to grow, so that at the time t it occupies the sphere of radius vt. Outside it there is no disturbance, but on its surface is an infinitely thin electromagnetic shell, which performs the same functions as the previous finite shell. That is, it lays down the steady state as it expands, and thus carries out to infinity in itself as much energy as it leaves behind.

Notice, however, this peculiarity, that if we had started with what appears at first sight to be the simpler problem, viz., a point-source, we should be quite unable to see and understand

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the functions of the electromagnetic shell on the extreme verge of the steady field. The reader may compare this case with that of the establishment of the steady state of displacement due to another kind of point-source, viz., electrification suddenly brought to rest at a point after previous motion at the speed of light, as discussed in § 55. There is a perfect similarity as respects the uniform growth of the steady state. But the nature of the bounding electromagnetic shell is not the same. In the case of electrification it belongs to the zero degree of spherical harmonics; in our present problem it is of the first degree.

If, after keeping on the impressed force at a point for, say, an interval τ, we suddenly remove it, this is equivalent to keeping it on, but with the addition of an impressed force which is the negative of the former. From this we see that the result of putting on the impressed force for an interval τ only is to generate a shell of depth $v\tau$, which runs out to infinity. Within this shell is the steady electric displacement due to the source appropriate to the instantaneous position of the shell. On its outer surface is an electromagnetic wave moving out to infinity, and generating or laying down the steady electric displacement as it goes, whilst on the inner surface is another wave running after the first, and undoing its effects. That is, it takes up the displacement laid down by the first wave, so that inside the inner wave (just as outside the outer) there is no disturbance.

(To be continued.)

ERRORS OF OBSERVATION IN THE THREE-VOLTMETER METHOD.

BY A. RUSSELL.

With the usual arrangement, let V, V_1, V_2, W and A be the true values of the volts, the watts and the amperes in the circuit. Then, whatever the law of the applied E.M.F.,

$$2\,V_2\frac{W}{A} = V^2 - V_1^2 - V_2^2 \quad \ldots \quad (1)$$

where V_1 is the potential difference at the ends of the inductive resistance. We shall discuss the error introduced into the calculated value of W by errors of observation in reading the voltmeters. The error introduced into W by the ammeter reading is obviously proportional to the error in the ammeter reading.

Let the observed readings of the voltmeters be $V + x\,V$, $V_1 + y\,V_1$, $V_2 + z\,V_2$, where x, y, and z may have any values between $\pm a$, $\pm b$, $\pm c$ respectively. Let W′ be the calculated value of the watts; then,

$$2\,(V_2 + zV_2)\frac{W'}{A} = V^2(1+x)^2 - V_1^2(1+y)^2 - V_2^2(1+z)^2 \quad (2)$$

$$= 2\,V_2\frac{W}{A} + (2x + x^2)\left(V_1^2 + V_2^2 + 2\,V_2\frac{W}{A}\right) - (2y + y^2)\,V_1^2 - (2z + z^2)\,V_2^2$$

$\therefore$ From (1)

$$(1+z)\frac{W'}{W} = 1 + 2x + x^2 + \frac{A}{2\,V_2\,W}\{V_1^2(2x - 2y + x^2 - y^2) + V_2^2(2x - 2z + x^2 - z^2)\};$$

$$\therefore \frac{W'}{W} = 1 + 2x - z + x^2 + z^2 + \frac{A}{2\,V_2\,W}\{V_1^2(2x - 2y + x^2 - y^2) + V_2^2(2x - 2z + x^2 + z^2)\} + \text{terms multiplied by } x\,y,\ x\,z,\ \&c. \quad \ldots \quad (3)$$

$$= 1 + 2x - z + \frac{A}{V_2\,W}\{V_1^2(x - y) + V_2^2(x - z)\} \quad \ldots \quad (4);$$

neglecting terms multiplied by small quantities of the second order. Now, in the measurement, V_1 and A are fixed, and we have to find the value of V_2, which makes $\frac{W' - W}{W}$ a minimum. This value in any particular observation depends upon the values of x, y and z, and can be found from (4). The most important error to consider, however, is the maximum possible error arising from errors of observation. This error is got by putting $x = a$, $y = -b$, and $z = -c$.

Then $$\frac{W' - W}{W} = 2a + c + \frac{A}{V_2\,W}\{V_1^2(a+b) + V_2^2(a+c)\}$$

$$= 2a + c + \frac{A}{V_2 W}(V_1\sqrt{a+b} - V_2\sqrt{a+c})^2 + \frac{2\,A\,V_1}{W}\sqrt{(a+b)(a+c)}.$$

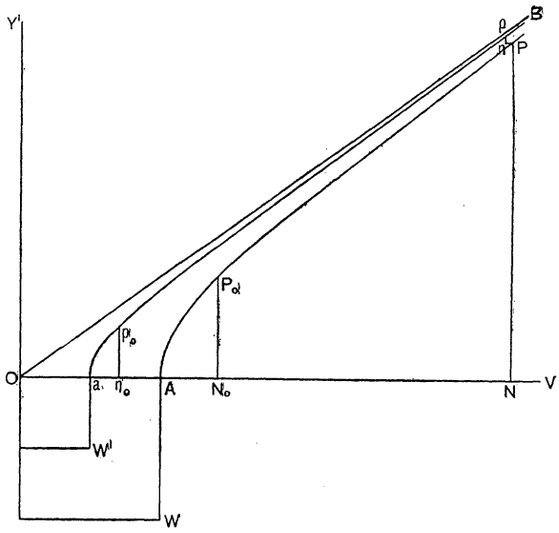

FIG. 1. Effect of Small Errors Pn and pn in determining the Value of the Area of O W.

The value of V_2 that makes this expression least is obviously

$$V_1\sqrt{\frac{a+b}{a+c}} \quad \ldots \quad (5).$$

In this case $$\frac{W' - W}{W} = 2a + c + 2\frac{A\,V_1}{W}\sqrt{(a+b)(a+c)} \quad \ldots \quad (6).$$

For example, suppose we are measuring the power consumed in a circuit in which $\frac{W}{AV_1}$—the power factor—is small, equal to 0·1 (say), and that we are using three exactly similar voltmeters which we can read to ± 0·1 per cent. Then the maximum error in W is 4·3 per cent., when V_2 is equal to V_1. If

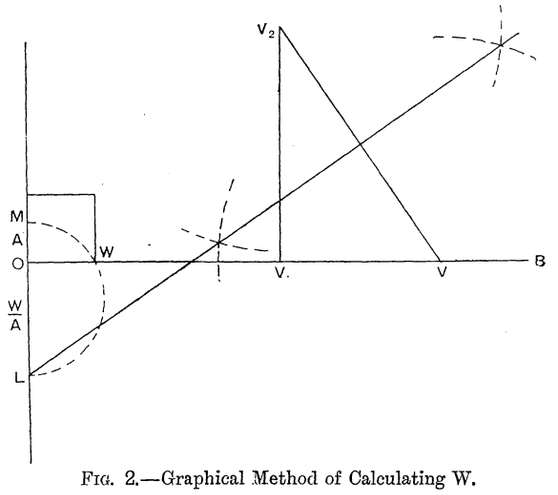

FIG. 2.—Graphical Method of Calculating W.

the voltmeters are not exactly similar instruments, a, b and c will not be all equal, and we see from (5) and (6) that the best arrangement is to use the most accurate voltmeter to measure V and the least accurate to measure V_1, and to make V_2 greater than V_1.

Again, from equation (3) we at once deduce that the mean value of W′/W

$$= 1 + \tfrac{1}{3}(a^2 + c^2) + \frac{A}{6V_2W}\{V_1^2(a^2 - b^2) + V_2^2(a^2 + c^2)\}$$

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As this mean is deduced from a very large number of observations, and as we only take a few observations in practice, it is better to give V_2 a value that makes the maximum possible error least than to give it the value that would make the error in the mean of a very large number of observations least. Hence, (5) and (6) can be taken as working formulæ.

It is instructive to consider the problem graphically. Let $V_2 = V_1 = V'$; then the fundamental formula may be written

$$V^2 - 2V'^2 = 2rW,$$

where r is the non-inductive resistance.

Suppose we regard V and V′ as variable and r W as constant, and plot out the points P which satisfy this relation; we get the curve A P_0 P (Fig. 1). This curve is the curve got by cutting a cone which has O V for its axis and O B for a generating line, by a plane parallel to its axis. In the figure $OA^2 = 2rW$ and the angle B O V is a little greater than 35deg. Now, from the arrangement of the voltmeters the least value of V′ is $\frac{1}{2}$ V; therefore, all the points lie further up the curve than P_0, where ON_0 is equal to 1·414.O A. We may imagine a large number of these curves to be drawn, each corresponding to a different value of W. In the figure we have drawn two such curves—one corresponding to W, the other to $\frac{1}{4}$ W. We see that the further P is up the curve, the more likelihood is there that small errors in the value of V and V′ will displace P on to the wrong curve. We deduce, as before, that V'^2/rW, or AV_2/W, should be as small as possible in order that the method may give accurate results.

The following graphical method of calculating W illustrates the difficulty of finding W correctly by the formula. Let O B and O L (Fig. 2) be two lines at right angles to one another. Measure off O V = V, O $V_1 = V_1$. From V_1 draw $V_1 V_2$ perpendicular to O B and equal to V_2. Join V_2 V, and bisect it at right angles by a line meeting O L in L. Then O L is equal to W/A. To get W, produce L O to M, making O M equal to A. On L M as diameter describe a semicircle, cutting O B in W. Then the square on O W measures the required watts. We see by this construction how errors in the measurement of V, V_1, or V_2, depress or elevate L, and thus increase or diminish the true value of the watts.

AN AMERICAN DIRECT-DRIVEN DYNAMO.

While the practice of coupling dynamos direct to high-speed engines is firmly established in this country and the rest of Europe, belt and rope driving are still popular in America. In this country rope driving appears to be adopted for the most part because the makers of the engines are unwilling or unable to run at sufficiently high speeds; in Germany, however, this difficulty is overcome simply by increasing the size of the dynamos. For ship-lighting purposes direct driving is now admitted to be imperative, even if only from considerations of space.

The General Electric Company of New York (under which title our readers will remember the Edison and Thomson-Houston interests have been amalgamated) have sent us particulars of generating plant which has been fitted on a steam-ship of the whaleback type, the "Pillsbury," (Fig. 2). A small room (Fig. 1), 8ft. square, was all that could be spared. This precluded the employment of a belt-connected plant, and a generating set of the Thomson-Houston International Company type was therefore adopted. The dynamo is of 150 lights capacity, and is directly coupled to a 15 H.P. engine, both having a

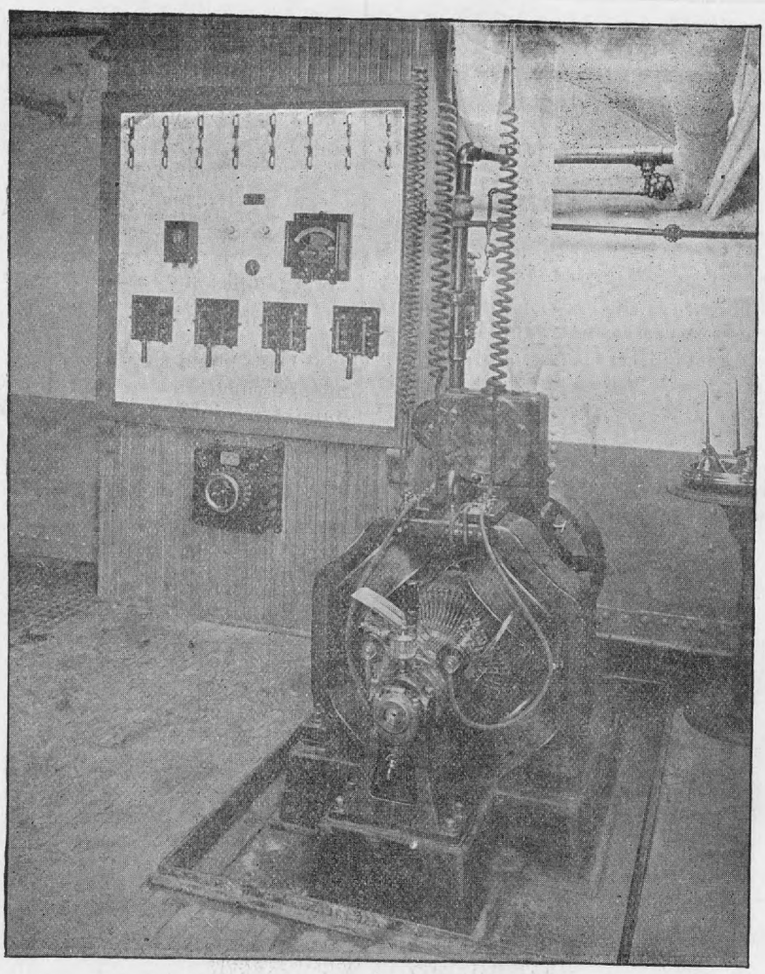

Fig. 1.—Thomson-Houston International Company's Direct-Driven Plant.

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common bed plate. We are informed that under careful tests the engines showed a very high economy. The generator is of the 4-pole type, compound wound, having an automatic regulation within 2 per cent. over the entire range from no load to full load. The commutators are cross connected, so that only two brushes, 90deg. apart, are used. The rheostat is of the iron frame type. The engine and dynamo are both provided with self-oiling bearings. Behind the engine, and attached to the wall, is a white marble switchboard. The dynamo room is in the after portion of the vessel, on the first lower deck. The vessel is wired in the usual manner for 150 lights. The plant on the sister whaleback, the "Washburn," is of a similar character.

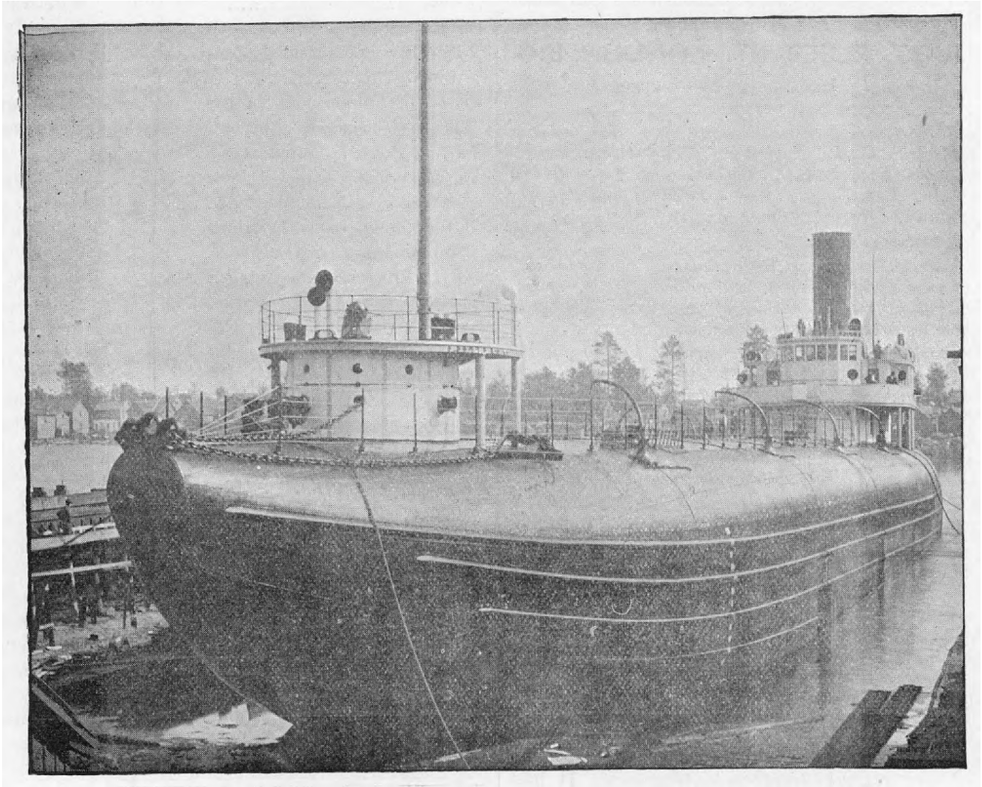
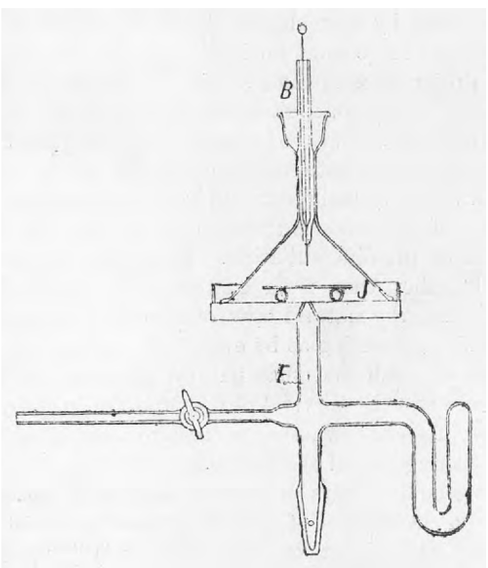


Fig. 2.—The Whale Back Steamer "Pillsbury."

ON THE METALLIC LAYERS OBTAINED BY DISINTEGRATION OF CATHODES.*

BY J. MOOSER.

The form of Geissler tube employed by the author is shown in the accompanying figure. B is the cathode, F is the anode. Between them, resting on glass tubes, is a plate of glass J, upon which the deposit takes place. It is permissible to assume that the metallic particles torn from the cathode follow the direction of the lines of force. If, therefore, B terminates in a small ball, and J is not too far off, it may be assumed that the trajectories of the metallic particles are rectilinear and equally divided in the space round the centre of the ball. It is thus easy to calculate the relative thickness of metal deposited on J when at different distances from the centre of B. To arrive at the relative thicknesses of metal the author compared the resistance of concentric rings of the metallic deposit which he obtained by laying the metallised surface of the plate J on a board provided with concentric grooves containing mercury.



Assuming that the deposited platinum had a density of 21, the author was able from the absolute resistance of a ring, and the weight of J, to deduce the absolute thickness and specific resistance of the deposit. The lowest figure obtained for the specic resistance of platinum deposited in hydrogen was 18 times that of pure platinum. When the deposit takes place in air its specific resistance may amount to 82 times that of platinum.

* Abstract *Wied. Ann.*, Vol. XLII.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, January 3rd.

ROYAL INSTITUTION.

3 p.m. Juvenile Lecture. "Astronomy," by Sir Robert Ball, F.R.S.

THURSDAY, January 5th.

ROYAL INSTITUTION.

3 p.m. Juvenile Lecture. "Astronomy," by Sir Robert Ball, F.R.S.

FRIDAY, January 6th.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Paper to be read:—"The Theta-Phi Diagram of the Thermo-dynamics of Steam," by J. Macfarlane Gray.

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The Electrician.

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EVOLUTION IN ELECTRICAL ENGINEERING.

Electrical engineering, the offspring of electrical science and of the engineering profession, has now attained the age of about sixteen years, and having acquired something more than a rudimentary education and training, the time has arrived when some beginnings of specialisation may be looked for. There is much to be said in favour of the view that a lad should not be encouraged, or, at all events, compelled, at too early an age, to choose a trade or profession. It appears that while in a less developed state of society competition was milder, and there was less hurry for a youth to begin the battle of life, yet selection of a vocation was more easy, and willing selection was made by mere boys. Many a young man to-day has to be forced into some business, caring little, and as likely as not a wrong start is made. We are reluctant, therefore, to urge that electrical engineering, which is now arriving at years of discretion, should be forced into any specialisation; it is jostled hotly enough between rash adventurers, greedy speculators and visionary theorists; and we will only glance at a few indications of separation into different branches, and consider the result of the differentiation. Borrowing this term from biological rather than from mathematical science, we are reminded that the natural laws of evolution must be obeyed by electrical engineering as by every other process of development, and we shall find that natural selection, the struggle for existence and the survival of the fittest must result in the production of species, whether we turn to the animal kingdom or to a dealer's stock of electric light switches.

In the good old days of one of the parents of electrical engineering, electricians of all kinds were physicists. The first commercial outlet for the commercially minded was telegraphy, and long after came the Gramme dynamo, the Jablochkoff lamp and the infancy of electric lighting, and theory began to diverge from practice, science from business; so, also every mechanical engineer was at one

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time a millwright, probably with nothing less than quarter-inches on his rule; nor was even this wanted when he designed an engine with the toe of his boot on the dusty floor of the pattern shop, filling in the details with a lump of chalk. We dare wager that a large number of electrical engineers have never had a lump of chalk in their pockets since they adopted the profession which they have honoured by their choice.

But a few years ago an electrical engineer was ready to turn his attention to any job short of making a submarine cable or an electropathic belt. The first sign of differentiation was the appearance of the man who had a capital arc lighter and who was too busy to build any other kind of dynamo, and of the chemist who made glow lamps. But most of those who threw their energies and capital into the business plunged after every job that presented itself. True, they often failed to make a profit, but what they did earn was in cash, and not in "ordinary shares." The enterprising gasfitter then began to turn his brackets and fittings upside down, and so a new branch of trade was created. Was it trade, by-the-bye, or profession? No matter, it paid pretty well. Another indication that evolution is doing its work is the existence, and the increasing number, of firms who undertake wiring, and who neither sell nor manufacture supplies and sundries; of dynamo makers who eschew the taking up of carpets and floors, and ruining pretty rooms with ugly switches, and uglier lampholders and shades; of cable makers who do not stock the wood casing so dear to insurance inspectors, and of dealers in everything who will undertake no responsibility after goods have crossed their counters. To these we might add managers of financial departments who repudiate responsibility for the industrial branches of their establishments, and a score of other specialists. And behind all, and yet ahead of all, is the man of science. The appearance and the development of distinct species is a clear sign of progress. We altogether combat the idea that any ironmonger can wire a house, and we consider that it is most reprehensible to encourage him to try his hand at it. But wiring, though it needs special knowledge, is a far less complex trade than that of plumbing, needing none of the dexterity necessary for wiping a joint, nor acquaintance with sanitary science or highly complicated hydraulic problems. Wiring is, no doubt, destined to take its place as a trade with gasfitting; but like gasfitting, may be taken up as a branch by important firms.

It would be well if in this process of evolution little more differentiation arose between the electrician and the electrical engineer, and between the man of science and the man of business. The hopeful products of our technical colleges, brimful of knowledge which has been denied to their seniors, cause much of the confusion which at present exists. The recent presidential address by Mr. Atkinson, the article in our columns last week by Mr. Cunynghame, and the leading article in the *Engineer*, which we reproduce in another column, treat of the shortcomings of technical education. If scientific men destined to remain, and content to be, scientific men need this training—and Prof. Schuster's address at Edinburgh last summer raises thereon more than a doubt—these young hopefuls may, if they can afford it, go straightway and be scientific men, and given the run of a workshop they may design and build magnificent dynamos; but if these do not pay, they are brilliant scientific experiments, not engineering. Engineering is a business, and the success of a business is very properly measured by its cash profits. Success in science is not so measured, or Galileo and Faraday would, indeed, have been sad failures. Science has, and science will ever continue to have, attractions that cannot be measured in money. But even in the business of engineering occasions arise, as was the case in the supply of dynamos to the Admiralty under its stringent specifications, where real skill is called for, and where it is not only worth while but necessary to design each size from the beginning; the result being to raise the whole level of design. That there was but little profit to the contractors in this particular venture is now of small importance. A little more distinction between science and business would lead to a better understanding of those results which are now called failures. To design a new dynamo for each new order is a temptation to every enterprising manufacturer, and to turn out a machine of high efficiency is the aim of many an ambitious engineer. To add a few inches to the length of a stock size of armature and to widen the field magnet may be unscientific; any fool can do it, but it pays. Niceties of design may have to be sacrificed in order to bring machines into a properly standardised set, but it is those who make the sacrifice who will succeed—as success is measured. It is fortunate that electrical engineering is throwing out so many branches, for specialisation will thus become compulsory, and the concentration of the energies of able minds on distinct departments will be better both for the development of the industry and the individuals of whom it is composed.

SPARKING AT COMMUTATORS.

BY F. M. WEYMOUTH.

(*Continued from page 212.*)

Our attention may now be directed to some certain points. We have spoken of disruptive sparks and arcs, of current, and electromotive force, or potential. Some effects in particular however, may be noted. When dealing with the formation of the arc, we mentioned the great heat as being due to the current. A high voltage with or without much current, produces on communication what is called a "shock," best made analogous perhaps to a vibration more or less terrific, according to its strength. But the current burns. A large current at a very low voltage will produce scarcely any "shock," but may produce great heat. This latter, however, depends on there being a resistance to its flow. A resistance being offered, the work done in overcoming it is the immediate source of the heat that will be manifested. If there be little or no resistance, there will likewise be little or no heat. Now there is always *some* heat with every kind of spark; but the point we wish to arrive at may be made more clear perhaps thus. Suppose an animal is to be killed by electricity. It may be put in a circuit with a high voltage and small current, say 20 amperes at 2,000 volts. On switching on the current, it is struck dead instantly by the "shock" due to the high potential; while the body subsequently will show no signs of burning, for it will not have offered sufficient resistance for the small current to take effect. On the other hand, if intense heat be desired to burn or melt any otherwise refractory substance, large currents are required. Thus we find in the case of electric smelting furnaces wherein the intensest heat is obtained by means of the arc, that extremely large currents of even 12,000 or 14,000 amperes are used: while there may be only an electromotive force of 30 to 60 volts. It should be noted here moreover, that the resistance that gives rise to the heat is not that due to the substance being acted upon, but to the arc itself; hence the comparative lowness of the electromotive force. Thus we observe that for great heat extremely large currents are supplied, at not necessarily a high potential; and so it is to the presence of *current* that heat is due in an arc, with all its concomitant effects, such as burning, melting, and volatilisation.

Now we have already dwelt on the destruction of the electrodes of an arc. This, however, is not the only source of expenditure in either material or energy. For it is supposed

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that a back electromotive force is set up in the arc, which impedes the flow of the normal main current. Hence, besides the energy necessary to overcome the resistance of the gas which is the product of the volatilisation of the carbon, energy is also spent in overpowering this back electromotive force. A complete theory of the arc would however appear to be wanting. But at the British Association meetings in Edinburgh this last summer, a Paper on the subject was read by Prof. Silvanus P. Thompson (see *The Electrician* for August 26th, p. 460), should any feel interested in knowing more. Further however, when considering the arc and its generation, we have observed that it is commenced by a disruptive spark, which may be of either our third or fifth orders, accompanied by great heat, due principally as we now find to the presence of the current: for a statical electric spark wherewith there is practically no current, does not cause much heat. A further point however to be noted, is the extremely small amount of time occupied by a disruptive spark. This is in fact infinitesimal; the time taken by so great a disruptive spark as a flash of lightning being at the most, only about the hundred thousandth part of a second.

We have now reached that stage in our progress, however, when we may bring the above to a practical bearing. Thus we may consider what happens on the opening of an electric switch such as is in common use. When this is done, usually a flash is seen. Moreover, the switch may so be held that an arc is maintained between the moving tongue or contact piece and the fixed contact piece. But allowing it to be opened quickly, even by the means of some spring snap arrangement, the opening will still take a very appreciable amount of time compared to the extremely small period required for the spark. No switch could endure, whereof the moving parts moved with a speed even approaching that of a flying bullet.

The upshot hence in the case of a flash seen at the opening of a switch, is that whereas this may have for its commencement a self-induction disruptive spark of our third (or fifth) order, the remainder of the flash will be a momentary arc.

Now we found when examining the arc between two carbons, that the precursory spark volatilised some particles of carbon; that is, heated them so intensely as to turn them to gas. Further, we noted that on the establishment of the arc both carbons were burnt, owing to their oxidisation in the air; but the positive carbon at twice the rate of the negative. Now, metals will volatilise more easily than carbon; and moreover, they also oxidise when heated and exposed to the air, even when not fused. Hence in the case of the flash seen with the switch, and drawing our inference from the arc between two carbons, we find that both contacts are exposed to destruction. Firstly, some of the metal will be volatilised by the precursory spark; and secondly, the positive contact will be burnt and oxidised away at twice the speed of the negative by the following momentary voltaic arc. This however assumes an ordinary current, such as may be large enough to maintain an arc, and an ordinary electromotive force of but a few hundred volts at the outside. In the case of very high voltages, and a current too low practically for an arc, the flash on the opening of a switch would be a momentarily continuous disruptive discharge of our fifth order. Both contacts may consume away somewhat, owing partly to their oxidation on being heated and partly by volatilisation. But returning to the case of a switch in a circuit where there is an appreciable current, we find this peculiarity, that, inasmuch as in point of the time taken by the flash by far the larger proportion is occupied by the arc, it is the arc that works the greater destruction, chiefly to the positive electrode.

Having thus far entered into the subject generally, we may now perhaps consider ourselves the better prepared to examine with some closeness what is our main subject, the sparking that takes place at the brushes on a commutator.

(To be continued.)

Public Use of Mexican Railway Telegraphs.—The Mexican Railway has posted a notice in its telegraph offices prohibiting the use of the Mexican Railway telegraph lines so far as the public is concerned.

THE ELECTRIC RAILWAYS OF THE UNITED STATES.

We reproduce from *Electricity and Railroading*, of Boston, the following list of electric railways actually in operation in the United States at the present moment, and about which particulars are forthcoming. It is a portentous catalogue, and one which may well excite envy in a land where jobs are few and electrical engineers are many. Electric traction, especially where the overhead trolley system is in force, may not be an unmixed blessing—what is?—but there can be no two opinions as to its superiority over every other mode of traction for ninety-nine tramways out of every hundred. We shall publish next week, as is our usual custom, a similar table for the United Kingdom. It is as well that we do not place the two lists side by side; the contrast, be the cause of it what it may, would be painful to our national *amour propre*. It will be seen that, according to this compilation, the electric railway mileage of the United States totals up to over 2,500, with nearly 4,000 motor cars.

We may add that we have considerably compressed this table, since a large proportion of the particulars given by our Boston contemporary are of local interest only. From these totals it will be seen that in the United States three motor cars to every two miles of track is a fair average allowance. In country places, of course, the proportion is more nearly one to one, whilst in busy cities, such as Pittsburgh, it is more like two to one. Another relation, which appears to obtain under widely different circumstances, is that it is necessary to lay down about 20-H.P. of electric plant at the central station for every motor car running on the line. In a Paper read more than two years ago before the American Institute of Electrical Engineers (see *The Electrician*, Vol. XXIV., page 213), Mr. O. T. Crosby evolved another useful relation, namely, that for every car mile run on the line about 1 H.P.H. is expended at the power house. Among the lines contained in the list below, nearly 200 in number, it is worth noticing that only one (Milford) is on the storage-battery system, and only five obtain power from water-falls.

LOCATION. State and Town.	ROAD EQUIPMENT. m=miles, st=standard, g=gauge, gr=girder rail, Tr=T-rail, mc=motor cars, c-br=centre-bearing rail, s-br=side-bearing rail.	STATION EQUIPMENT. T-H=Thomson-Houston, gen=generators, H.P.=horse-power, the date=when the road went into commercial operation.
ARKANSAS:		
Little Rock ...	22m; st g; 35-48 Tr; Thomson-Houston, 28 mc.	5 T-H gen=500 H.P. (Oct., 1891).
ALABAMA:		
Birmingham ...	55m; st g; 40-58 gr; Thomson-Houston, 24 mc.	4 T-H gen=440 H.P. (Oct., 1891).
CALIFORNIA:		
San Francisco...	24m; st g; 40 T and gr; Thomson-Houston, 15 mc.	(July, 1891).
COLORADO:		
C'l'rado Springs	25m; st g; 30 Tr; Sprague, 25 mc (Pullman)	3 Edison gen=600 H.P. (July, 1890).
Denver	6m; 3-6 g; 30 Tr; Sprague, 6 mc.	1 Edison gen=70 H.P. (May, 1890).
„	67m; 3-6 g; 47 Tr; T-H, Short, Edison, 112 mc.	
Pueblo	25m; 4 g; 30 Tr; Thomson-Houston, 15 mc.	3 T-H gen=240 H.P. (June, 1890).
CONNECTICUT:		
Birmingham ...	3·26m; st g; 40 Johnson gr; Thomson-Houston, 5 mc.	1 Van Depoele gen=100 H.P. (April, 1888).
Southington ...	1·8m; st g; 25 Tr; Thomson-Houston, 2 mc.	1 T-H gen = 40 H.P. (March, 1889).
DELAWARE:		
Wilmington ...	10m; 5-2 g; 50-60 g and 48 tram r; Sprague, 10 mc.	8 Edison gen=550 H.P. (March, 1888).
GEORGIA:		
Atlanta	15 m; 56 gr; Short, 10 mc.	2 Short gen=300 H.P. (Feb., 1890).
Augusta	24·7m; st g; 35 T and 49 gr; T-H, Sprague, 26 mc.	3 Edison gen=380 H.P.
Savannah	11m; st g; 35-40 T & 42 c-br; T-H, Westinghouse, 17 mc.	2 Edison gen=220 H.P. (Dec., 1890).
ILLINOIS:		
Bloomington ...	10m; st g; 45 tram & 47 Tr; U E T, Short, 15 mc.	4 U E T gen=200 H.P. (Nov., 1890).
Cairo	4·7m; st g; 40 Tr; Westinghouse, 4 mc.	1 U E T gen=80 H.P. (Sept., 1891).
Champaign.....	4m; st g; 40 Tr; Westinghouse, 4 mc.	1 U S gen=80 H.P. (Oct., 1890).

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LOCATION. State and Town.	ROAD EQUIPMENT. m=miles, st=standard, g=gauge, gr=girder rail, Tr=T-rail, mc=motor cars, c-br=centre-bearing rail, s-br=side-bearing rail.	STATION EQUIPMENT. T-H=Thomson-Houston, gen=generators, H.P.=horse-power, the date=when the road went into commercial operation.
ILLINOIS—*continued.*		
Chicago	5m ; st g ; 63 gr ; Detroit, 4 mc (Pullman).	1 Detroit gen=100 H.P. (Oct., 1890).
„	16 m ; st g ; 60 gr ; Sprague, 20 mc (Pullman).	
Decatur	7m ; st g ; 30-45 T and gr ; Thomson-Houston, 11 mc.	2 T-H gen=160 H.P. (Sept., 1889).
Elgin	12m ; st g ; 40 g & 45 Tr ; Sprague, 12 mc (Pullman).	4 Edison gen=270 H.P.
Harvey	4·3m ; st g ; 40 Tr ; Short, 3 mc.	1 Sperry gen=150 H.P. (Oct., 1891).
Joliet	15m; st g; 38-40 T & gr; Thomson-Houston, 12mc (Pull'n).	2 T H gen=160 H.P. (Feb., 1890).
Kankakee	5⅜m ; 5-8½g; 40 T, g & tram r ; Westinghouse, 4 mc (Pull'n)	1 Western Elec gen=70 H.P. (July, 1891).
La Salle	9m ; st g ; 45 Tr ; Sprague, 8 mc.	2 Edison gen=130 H.P. (Sept., 1890). (Oct., 1889).
Moline	4m ; st g ; 35-50 T and 57 tram r ; Sprague, Westinghouse, 3 mc (Pullman).	
Ottawa	6½ m ; st g ; 40-48 T & gr ; T-H, 8 mc (Pullman).	2 T-H gen=160 H.P. (Jan. 1889).
Peoria	13m ; st g ; 57 gr ; Thomson-Houston, 31 mc.	6 T-H gen=480 H.P. (Sept., 1889).
Quincy	11m ; st g ; 36-52 gr ; Thomson-Houston, 13 mc.	3 T-H gen=240 H.P.
Rockford	4½m ; st g ; 35-45 T & gr ; Short, 7 mc.	
Springfield	8·5m ; st g ; 35-45 T, Johnson g & tram r; T-H, 12 mc.	(June, 1890).
Sterling	6m ; st g ; 40 T & tram r ; 7mc.	2 —— gen=160 H.P. (1891).
INDIANA:		
Elkhart	7m ; st g ; 40 T & flat r ; Detroit, 7 mc.	(May, 1889).
Indianapolis	13m ; st g ; 45-52 gr ; T-H, Short, 15 mc.	3 T-H gen=240 H.P. (June, 1890).
Lafayette	5m ; st g ; 30-56 T & gr ; Sprague, 8 mc.	2 Edison gen=150 H.P. (Sept., 1888).
Richmond	11m ; st g ; 40 Tr ; Thomson-Houston, 10 mc.	2 T-H gen=160 H.P. (Aug., 1889).
South Bend	16m; st g ; 35 T & tram r ; T-H, 6 mc.	1 T-H gen=83 H.P. (June, 1890).
Terre Haute	8m ; st g ; 35-48 T & gr ; Westinghouse, 18 mc.	2 U S gen=200 H.P. (Jan., 1891).
Vincennes	4m ; st g ; 40-65 Tr ; Westinghouse, 4 mc.	1 Westingh'se gen=125 H.P. (Oct., 1891).
IOWA:		
Burlington	12m ; 40 Tr ; Westinghouse, 12 mc.	3 Westingh'se gen=240 H.P. (June. 1891).
Council Bluffs	20m ; st g ; 40-56 T & gr ; Thomson-Houston, 50 mc.	7 Edison & T-H gen=700 H.P. (Oct , 1888).
Davenport	7½m; 35-50 T & gr; Sprague, 15 mc.	2 Edison gen=150 H.P. (Aug., 1888).
Des Moines	29m ; st g ; 45-60 gr; T-H, 32 mc ; (some Pullman).	8 T-H gen=640 H.P. (1888).
Dubuque	10m ; st g ; 50 gr ; Sprague, 12 mc.	2 Edison gen=140 H.P. (June, 1890).
„	2·5m ; st g ; 52 gr ; Sprague, 4 mc.	1 Edison gen=65 H.P. (Dec , 1889). (Sept., 1890).
Keokuk	5½m ; st g ; 30-38 T & gr ; Sprague, 6 mc.	
Ottumwa	4½m ; st g ; 30-38 T & gr ; T-H, 5 mc (Pullman).	1 T-H gen=80 H.P. (Nov., 1889).
Sioux City	25m ; 4 g ; 45-58½ Johnson gr; Sprague, Westinghouse, 30 mc (Pullman).	4 Edison gen=650 H.P. (April, 1890).
KANSAS:		
Fort Scott	5½m ; 4 g ; 35 Tr ; Edison, Sprague, 6 mc.	2 Edison gen=210 H.P. (Dec., 1890).
Topeka	18m ; st g ; 38-40 g and Tr ; Thomson-Houston 30 mc.	7 T-H gen=560 H.P. (April, 1889).
Wichita	25m ; st g ; 35-46 T and gr ; T-H, 25 mc.	4 T-H and Edison gen=340 H.P. (Nov. 1888).
KENTUCKY:		
Covington	30m ; 5·2½ g ; 45 flat r ; Short, 24mc.	3 Short gen=240 H.P. (Sept., 1890).
Louisville	15m ; 5 g ; 58 gr ; Thomson-Houston, Short, 30 mc.	
Paducah	9m ; st g ; 35 T and flat r ; Sprague, 10 mc.	2 Edison gen=130 H.P. (June, 1890).
LOUISIANA:		
Shreveport	5·5m ; st g ; 40-45 T and gr ; Thomson-Houston, 4 mc.	1 T-H gen=80 H.P. (Oct., 1890).
MAINE:		
Augusta	8m ; st g ; 40—r ; Thomson-Houston, 10 mc.	2 T-H gen=160 H.P. (July, 1890).
Bangor	7m ; st g ; 35 T and tram r ; T-H, 22 mc.	2 T-H gen=160 H.P. ; also 4 Holmes turbines =400 H.P. (May, 1889).

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MASSACHUSETTS:		
Attleboro	6·5m ; st g; 40 Tr; T-H, 7 mc.	(April, 1890).
Boston	4·3m ; st g ; 56 Tr ; Thomson-Houston, 14 mc.	(Aug., 1888).
„ (West End St. Ry. Co.)	101 m ; st g ; 74 tram and gr ; T-H, 469 mc.	— T-H & Edison gen=15,260 H.P. (Jan., '89).
Brockton	5·5m ; st g ; 40 Tr ; Sprague, 5 mc.	1 Edison gen=55 H.P. (Nov., 1888).
Holyoke	8m ; st g ; 60 T & gr ; Thomson-Houston, 16 mc	(Aug., 1891).
Lawrence	16m ; st g ; 40-50 T, tram & gr ; Detroit, 15 mc.	3 T-H gen=110 H.P. (Sept., 1891).
Leicester	13·2m ; st g ; 45 Tr ; Thomson-Houston, 17 mc	4 T-H gen=320 H.P. (Aug., 1861).
Lowell	5m ; st g ; 35-50 tram & Tr ; Bentley-Knight, 18 mc.	(Aug., 1889).
Lynn	10·54m ; st g ; 45 Johnson & Tr ; T-H, 10 mc.	3 T-H gen=240 H.P.
Marlborough	3½m ; st g ; 38 Wharton steel gr ; Sprague, 6 mc.	2 Edison gen=55 H.P. (June, 1890).
Milford	6·5m ; st g ; 30 tram r ; Storage, 6 mc.	2 Westinghouse gen=60 H.P. (March, 1891).
Newton (West)	5·48m ; st g ; 45 Tr ; T-H, 16 mc.	(Sept., 1890).
Plymouth	6·5m ; st g ; 35 Tr ; Thomson-Houston, 8 mc.	(June, 1889).
Springfield	18·4m ; st g ; 50 Tr ; Thomson-Houston, 44 mc.	(June, 1890).
MICHIGAN:		
Adrian	2·8m ; st g ; 38—r ; Detroit, 3 mc (Pullman).	(Sept., 1889).
Ann Arbor	5m ; st g ; 65 gr ; Sprague, 4 mc.	(Oct., 1890).
Battle Creek	5½m ; 3-6 g ; 20—r ; Short, 6 mc.	
Detroit	—m; Detroit, 4 mc (Pullman).	2 Detroit gen=130 H.P. (May, 1888).
Grand Rapids	39m ; st g ; 45-68 ; gr Short, 20 mc.	
Ironwood	3m ; st g ; 45 Tr ; Thomson-Houston, 3 mc.	1 T-H gen=80 H.P. (Sept., 1891).
Marquette	4½m ; st g ; 35-50 T & Johnson gr ; Thomson-Houston, 3mc.	1 T-H gen=80 H.P. (July, 1891).
Muskegon	13·5m ; st g ; 38 T and gr ; Short, 18 mc.	3 Short gen=300 H.P. (April, 1890).
Port Huron	5m ; st g ; 16-42 flat & Tr ; Van Depoele, 6 mc.	(May, 1887).
Saginaw	27m ; st g ; 45 s-br ; Detroit, 22 mc (some Pullman).	4 Detroit gen=100 H.P. (Dec. 1889).
Sault Ste. Marie	4·5m ; st g ; 20 Tr ; Detroit, 5 mc (Pullman).	1 Detroit gen=65 H.P. (Sept., 1888).
West Bay City	10m ; st g ; 40 T and flat r ; Sprague, 12 mc.	3 Edison gen (Dec., '89).
MINNESOTA:		
Duluth	3⅜m ; st g ; 35 Tr ; Thomson-Houston, 4 mc.	(May, 1891).
„	13m ; st g ; 45 Johnson gr ; Thomson-Houston, 25 mc.	5 T-H gen=400 H.P. (Nov. 1890).
Minneapolis	65m ; st g ; 50-78 gr ; Sprague, T-H, Short, 132 mc.	6 Edison gen=1,200 H.P. (Dec., 1888).
Saint Paul	80m; st g; 54 g & Tr; Sprague, 100 mc (some Pullman).	8 Edison gen=1,600 H.P. (Feb., 1890).
Stillwater	5¼m; st g; 30 T & gr; Sprague, 6 mc.	2 Edison gen=100 H.P. (June, 1889).
MISSOURI:		
Hannibal	2·5m ; st g ; 36 c-br ; Thomson-Houston, 3 mc.	1 T-H gen=80 H.P. (Aug., 1890).
Joplin	2m ; st g ; 56 gr ; Thomson-Houston, 4 mc.	1 T-H gen=80 H.P. (Dec., 1890).
Kansas City	7m; st g; 52 s-b and gr ; Thomson-Houston, 12 mc.	3 T-H gen=240 H.P. (March, 1890).
„	12m ; st g ; 60 c-b and gr ; Thomson-Houston, 12 mc.	4 T-H gen=320 H.P. (Sept., 1889).
Sedalia	7m ; st g ; 35 Tr ; Sprague, 5mc.	2 Edison gen=110 H.P. (July, 1890).
Springfield	15m ; st g ; 35-45 gr ; Westinghouse, 15 mc.	3 U.S. gen=320 H.P. (Dec., 1890).
St. Joseph	12m ; st g ; 35-52 T, flat and gr ; Sprague, 20 mc.	4 Edison gen=250 H.P. (Sept., 1889).
„	13·5m ; st g ; 30 tram & Tr ; Sprague, 17 mc.	
St. Louis	70m ; 4-10 g ; 78 gr ; Edison, Short, 107 mc.	
NEBRASKA:		
Kearney	7m ; st g ; 45 Tr ; Thomson-Houston, Sprague, 4 mc.	2 T-H & Edison gen=150 H.P. ; 350 H.P. Victor Turbine wheel, and 800 H.P. Hercules (July, 1890).

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NEBRASKA—*continued.*		
Lincoln	12m; st g; 35-45 T and gr; Westinghouse, 10 mc.	2 U.S. gen=160 H.P. (Oct., 1890).
„	37½m; st g; 40-56 T and gr; Short, Westinghouse, 35 mc.	
Omaha	90m; st g; 35-58 T & gr; T-H, Sprague, 67 mc (some Pull'n)	14 T-H gen=1,300 H.P. (Oct., 1889).
N.H.:		
Concord	7⅛m; 3 g; 25-50 Tr; Thomson-Houston, 6 mc.	2 T-H gen=160 H.P. (Sept., 1890).
Dover	7m; st g; 40 Tr; Thomson-Houston, 10 mc.	4 T-H gen=325 H.P.; 600 H.P. turbine, Holmes (Aug., 1891).
NEW JERSEY:		
Asbury Park	3½m; st g; 47 flat s-br; Daft, 21 mc.	7 Daft gen=510 H.P. (1887).
Camden	15m; 5 g; 35-52 s-b and gr; U E T, 6 mc.	(May, 1890).
Newark	4m; st g; 40-65 T and gr; Thomson-Houston, 3 mc.	(July, 1890).
Passaic	10m; 5-2¼ g; 66 gr; Sprague, 36 mc (some Pullman).	
Trenton	Short, 15 mc.	
NEW YORK:		
Albany	14·1m; st g; 55-57 gr; Thomson-Houston, 32 mc.	8 T-H gen=640 H.P. (April, 1890).
„	15½m; st g; 35-50 tram r; T-H, Short, 20 mc.	4 T-H gen=320 H.P. (Sept., 1889).
Amsterdam	3½m; st g; 48 T and Johnson gr; Edison, 5 mc.	1 Edison gen=110 H.P. (Dec., 1890).
Auburn	7·27m; st g; —T and gr; Thomson-Houston, 7 mc.	3 T-H gen=240 H.P. (Feb., 1891).
Binghampton	12m; st g; 25-62 gr; Sprague, 14 mc.	2 Edison gen=210 H.P. (March, 1890).
Brooklyn	6m; st g; 45-60 gr; Thomson-Houston, Short, 12 mc.	
Ithaca	1m; st g; 30 Tr; Daft, 3 mc.	(Jan., 1888).
Jamestown	12m; st g; 30-42 T and c-br; Short, 19 mc.	
Rochester	9m; st g; 40 Tr; Thomson Houston, Short, 11 mc.	2 T-H gen=160 H.P. (July, 1888).
„	61m; st g; 40-78 T and gr; Short, 100 mc.	(Nov., 1890).
Saratoga	3m; st g; 45 Tr; Thomson-Houston, 2 mc.	1 T-H gen=80 H.P. (1890).
Seneca Falls	3½m; st g; 30 Tr; Thomson-Houston, 2 mc.	(July, 1890).
Troy	24m; st g; 66 s-b and gr; T-H, Sprague, 37 mc.	6 Edison gen=640 H.P. (Sept., 1889).
Utica	22m; st g; 40-45 flat and Tr; Thomson-Houston, 25 mc.	6 T-H gen=480 H.P. (April, 1891).
NORTH CAROLINA:		
Winston	6m; st g; 45 gr; Sprague, 7 mc.	2 Edison gen=130 H.P. (Aug., 1890).
OHIO:		
Akron	12m; st g; 52 gr; Sprague, 25 mc (some Pullman).	6 Edison gen=400 H.P. (Nov., 1888).
Alliance	2m; 40—r; Thomson-Houston, Short, 3 mc.	1 T-H gen=80 H.P. (March, 1889).
Ashtabula	4½m; st g; 45 Johnson, T-H, Short, 4 gr.	
Cincinnati	14m; 5-1½ g; 50-58½ gr; Sprague, 30 mc.	6 Edison gen=480 H.P. (June, 1889).
Cleveland	25m; st g; 82 gr; Sprague, Short, 35 mc.	6 Edison gen=640 H.P. (Dec., 1889).
„	43m; st g; 50-75 gr; Sprague, 93 mc.	16 Edison gen=1,800 H.P. (Dec., 1888).
„	30m; st g; 78 Johnson gr; T-H, Short, 58 mc.	
Dayton	2m; st g; 52 gr; Sprague, 2 mc.	(April, 1890).
„	8⅛m; st g; —r; Van Depoele, Wst'hse, 16 mc (Pull'n)	4 Van Depoele gen=500 H.P. (1888).
East Liverpool	8m; st g; 82 Johnson gr; Short, 9 mc.	2 Short gen=300 H.P. (Dec., 1891).
Hamilton	3m; st g; 45 gr; Sprague, 4 mc.	2 Edison gen=130 H.P. (Dec., 1890).
Newark	11m; st g; 35-40 s-b and Tr; Sprague, 4 mc.	2 Edison gen=110 H.P. (Dec., 1889).
Piqua	4m; st g; 35-45 T and gr; Sprague, 6 mc.	(Jan., 1890.
Salem	3·5m; st g; 45 gr; Thomson-Houston, 4 mc.	(May, 1890).
Steubenville	2·5m; st g; — flat r; Sprague, 6 mc.	(Dec., 1888).
Toledo	58m; st g; Thomson-Houston, 49 mc (Pullman).	5 T-H and Edison gen=900 H.P. (Oct., 1890).
OREGON:		
Portland	10m; 3-6 g; 40 T D & R Gr; Sprague, 26 mc (some Pullman).	2 Edison gen=130 H.P. (March, 1890).
„	7m; st g; 30 Tr; Sprague, 17 mc (some Pullman).	4 Edison gen=370 H.P. (Jan., 1890).
Salem	4m; st g; 30 Tr; Sprague, 6 mc (Pullman).	2 Edison gen=125 H.P. (May, 1890).
PENNSYLVANIA:		
Allegheny	18m; 5-2½g; 48 gr; T-H, 55 mc (some Pullman).	8 T-H gen= (Sept., 1891).
Altoona	6m; 5-3 g; 45 g and tram r; Thomson-Houston, 8 mc.	3 T-H gen=300 H.P. (May, 1891).
Braddock	3¾m; 5-2½ g; 48½ Johnson gr; Short, 3 mc.	
Connellsville	4¾m; 5-2½g; 52 gr; Edison, 4 mc.	
Easton	2.6m; 5-2½ g; 35 Tr; U E T, 6 mc.	(Jan., 1888).
Erie	15m; st g; 52 gr; Sprague, 58 mc (some Pullman).	8 Edison & Western Elec gen=1400 H.P. (July, 1889).
Greensburgh	2½m; st g; 35-45 T and gr; Westinghouse, 3 mc.	1 U E T gen=80 H.P. (Oct., 1890).
Harrisburgh	14½m; 5-2½ g; 52 s-b gr; T-H, Sprague, 36 mc.	2 Edison gen=120 H.P. (July, 1887).
Johnstown	11m; st g; 78 gr; Short, 10 mc.	3 Short gen= (Nov., 1890).
Newcastle	2m; st g; 45 gr; T-H, Westinghouse, 3 mc.	(Sept., 1890.)
Pittsburgh	31·7m; 5-2¼ g; 48 gr; T-H, 60 mc (some Pullman).	17 T-H gen=1,700 H.P. (May, 1891).
„	28m; 5-2½ g; 45-66 gr; Sprague, 60 mc (some Pullman).	7 Edison gen=1,135 H.P. (July, 1889).
„	13·5m; 5-2½ g; 63½ gr; Short, Sprague, 32 mc.	5 Edison gen=1,000 H.P. (June, 1891).
„	10·5m; 5-2½ g; 54 gr; T-H, Westinghouse, 20 mc.	6 T-H gen=480 H.P. (March, 1890).
„	2m; 5-2½ g; 65 gr; Short, 2 mc.	
„	2·5m; 5-2½ g; 52 gr; Daft, 8 mc.	2 Mather gen=200 H.P. (April, 1888).
Potsville	6m; st g; 52 gr; Short, 10 mc.	(Dec., 1890).
Reading	3m; 5-2½ g; 35-52 T and gr; Sprague, Westinghouse, 7 mc.	3 Edison & Westingh'se gen=240 H.P. (Nov., 1888).
„	5·5m; st g; 40-52 T and gr; Thomson-Houston, 4 mc.	2 T-H gen=164 H.P. (Aug., 1891).
„	8m; st g; 56 Tr; Edison, 6 mc.	2 Edison gen=210 H.P., 2·45" Hercules wheels =500 H.P. (Aug., '91).
Scranton	15m; st g; 40-52 T and gr; Sprague, 21 mc.	8 Edison gen=530 H.P. (Dec., 1888).
„	1¾m; st g; 45 gr; Thomson-Houston, 5 mc.	(Oct., 1888).
„	9m; st g; 35-52 T and gr; T-H, 13 mc (some Pullman).	
Sunbury	3·5m; 5-2½ g; 56 gr; U E T 3 mc.	2 U E T gen=100 H.P (June, 1890).
Wilkes Barre	7m; 5-2½ g; 54 gr; Sprague, 7 mc.	2 Edison gen=110 H.P. (April, 1888).
„	3⅜m; st g; 35-56 T and gr; Sprague, 4 mc.	(Dec., 1889).
„	16m; st g; —r; Short, 18 mc.	
Williamsport	—m; st g; 60 gr; Westinghouse, 12 mc.	2 U S gen=200 H.P. (Aug., 1891).
RHODE ISLAND:		
Newport	4m; st g; 45 Tr; Thomson-Houston, 8 mc.	(Aug., 1889).
TENNESSEE:		
Bristol	9m; st g; 40 Tr; Short, 5 mc.	1 Short gen=110 H.P. (Oct., 1891).
Nashville	52m; 4-11½g; 35-40 T & gr; T-H, Edison, West'se, 67 mc (some Pullman).	9 T-H and Edison gen=780 H.P. (1891).
TEXAS:		
Austin	5½m; st g; 40 T & gr; Westinghouse, 4 mc.	(Feb., 1891).
Dallas	13m; 35-45 Tr; Sprague, 9 mc (some Pullman).	3 T-H and Edison gen=210 H.P. (March '90.)
Fort Worth	5·2m; 4 g; 35—r; Sprague, 2 mc (Pullman).	2 Edison gen=130 H.P. (Aug., 1890).
„	12·5m; 4 g; 30 Tr; Thomson-Houston. 15 mc.	3 T-H gen=240 H.P. (May, 1890).
Galveston	45m; st g; 30-40 Tr; Detroit, 29 mc.	2 Detroit gen=160 H.P. (Feb., 1891).
Houston	35m; st g; 30-40 c-b & Tr; Sprague, T-H, Short, 21 mc.	2 Edison gen = (Jan., 1891).

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LOCATION. State and Town.	ROAD EQUIPMENT. m=miles, st=standard, g=gauge, gr=girder rail, Tr=T-rail, mc=motor cars, c-br=centre-bearing rail, s-br=side-bearing rail.	STATION EQUIPMENT. T-H=Thomson-Houston, gen=generators, H.P.=horse-power, the date=when the road went into commercial operation.
TEXAS—*continued.*		
San Antonio ...	38m ; 4 g ; 40-56 Tr ; T-H, Sprague, 35 mc.	4 T-H and Edison gen=370 H.P. (Nov., 1890).
„ ...	20m ; st g ; 40 Tr ; Thomson-Houston, 10 mc.	(Sept., 1890).
Sherman.....	4m ; st g ; — Tr ; Sprague, 5 mc.	1 Sprague gen=66 H.P. (April, 1891).
UTAH :		
Salt Lake City..	33m ; st g ; 30-35 Tr ; Sprague, 37 mc.	4 Edison gen=428 H.P. (Aug., 1889).
VIRGINIA :		
Danville	2m ; st g ; 38 Johnson gr ; Thomson-Houston, 4 mc.	1 T-H gen = 80 H.P. (Nov., 1888).
Richmond	18m ; st g ; 30-55 c-br ; Sprague, Westinghouse, 19 mc.	(July, 1890).
Manchester ...	9m ; st g ; 30-45 T and flat r ; Sprague, 6 mc.	1 Edison gen=110 H.P. (Oct., 1890).
WASHINGTON :		
Port Townsend.	st g ; 40 T & gr ; Thomson-Houston, 3 mc (Pullman).	1 T-H gen = 80 H.P. (Aug., 1890).
Seattle.....	5m ; st g ; 40 Tr ; Thomson-Houston, 2 mc.	(April, 1890).
„	8·3m ; st g ; 45 T & gr ; Thomson-Houston, 13 mc.	3 T-H gen = 240 H P. (Nov., 1890).
„	40-45 T and gr ; T-H, 21 mc (some Pullman).	5 T-H gen = 400 H.P. (April, 1890).
Spokane Falls...	8m ; st g ; 30 Tr ; Thomson-Houston, 6 mc (Pullman).	2 T-H gen=160 H.P. ; Victor Turbine (Nov., 1889).
Tacoma	25m ; 40-66½ — r ; Sprague, 26 mc (Pullman).	3 Edison gen=750 H.P. (Feb., 1890).
„	12·6m ; 3.6g ; 40 Tr ; Thomson-Houston, 7 mc.	3 T-H gen=240 H.P. (Jan., 1891).
WEST VIRGINIA :		
Huntington ...	4m ; st g ; 45 T and gr ; Short, 4 mc.	1 Brush gen=100 H.P. (1891).
WISCONSIN :		
Merrill.....	15m ; st g ; 38 gr ; Westinghouse, 3 mc.	(Nov., 1890).
Milwaukee	13m ; 60 gr ; Thomson-Houston, 12mc.	3 T-H gen=240 H.P. (April, 1890).
West Superior..	6·5m. ; 3·6 g ; 35 Tr ; T-H, 7 mc. (Pullman)	2 T-H gen=160 H.P. (July, 1890).

In addition to the lines contained in the above table, electric street railways are stated to be in operation in no less than 79 other towns, but as no technical particulars are supplied we merely give the names of towns as below. It will be observed that in several instances there are two or three electric lines in operation in a single place :—Anniston (Ad.), Oakland (Cal.), Sacramento (Cal.), San José (Cal.), two lines ; Santa Cruz (Cal.), Hartford (Con.), Washington (D.C.), three lines ; Americus (Ga.), Atlanta (Ga.), Columbus (Ga.), Macon (Ga.), Rockford (Ill.), Streator (Ill.), Marion (Ind.), Cedar Rapids (Ia.), Clinton (Ia.), Kansas City, Lexington (Ky.), Louisville (Ky.), Portland (Me.), Cumberland (My.), Brockton (Mass.), Gloucester (Mass.), Lynn (Mass.), Nateck (Mass.), New Bedford (Mass.), Newburyport (Mass.), two lines ; No Adams (Mass.), Pittsfield (Mass.), Quincy (Mass.), two lines ; Salem (Mass.), two lines ; Whitman (Mass.), Worcester (Mass.), Winona (Ma.), Kansas City (Mi.), St. Louis (Mi.), five lines ; Anaconda (Mont.), Great Falls (Mont.), Helena (Mont.), Jersey City (N.J.), Newark (N.J.), Orange (N.J.), Paterson (N.J.), Brooklyn (N.Y.), Buffalo (N.Y.), Elmira (N.Y.), Hudson (N.Y.), Oswego (N.Y.), Syracuse (N.Y.), Tonawanda (N.Y.), Asheville (N.C.), Cincinnati (O.), two lines ; Columbus (O.), Newark (O.), Springfield (O.), Toledo (O.), Portland (Or.), two lines ; Beaver Falls (Pa.), Braddock (Pa.), Allentown (Pa.), Lancaster (Pa.), Shamokin (Pa.), Providence (R.I.), Chattanooga (Ten.), two lines ; Johnson City (Ten.), Knoxville (Ten.), Memphis (Ten.), Dallas (Tex.), San Antonio (Tex.), two lines ; Waco (Tex.), Salt Lake City, two lines ; Anacortes (Wash.), Fairhaven (Wash.), New Whatcom (Wash.), two lines ; Seattle (Wash.), two lines ; Spokane (Wash.), Spokane Falls (Wash.), Wheeling (West Va.), Marinette (Wis.).

The British East Africa Company's Land Lines.—This Company's land line is complete from Mombasa to Lamu, *viâ* Malindi, Golbanti (Tana River), and Witu, a distance of about 200 miles.

THE DEFLECTION AND CONTROL OF GALVANOMETERS.

BY E. TREMLETT CARTER.

The observation of the conditions of electrical stress which produce and limit the amount of deflection in any measuring instrument is an interesting and profitable one ; and it is proposed in this Paper to make a short study of the sources of the energy which produces the deflection in magnetic and thermal galvanometers, whether for measuring current or voltage. It is well known that two forces are concerned in the deflection ; one, the electrical or magnetic force of the quantity measured, which is caused by the coil or heated wire ; and the other the controlling force, which is variously produced by magnetic, gravitational, or other elastic forces. In most instruments the controlling force has to bring the pointer back to zero when the current ceases ; but there is an exception to this rule in the Cardew voltmeter type, in which the deflection is *produced* by the controlling spring and *cancelled* by the contracting wire. In any case, however, there is some transfer of energy when the deflection is being produced or cancelled ; and the source and destination of this energy form a very interesting inquiry. In an ideal instrument the whole of the energy which produces the deflection would be given back when the pointer returned to zero. But, in practice, owing to the imperfect elasticity of the deflection—through friction—the energy is only partially restored. The frictional resistances are opposed both at the forward and at the return motion of the pointer, causing a waste of energy on each occasion.

The energy which is temporarily expended when the deflection is being made must not be confused with that constant expenditure which takes place the whole time the instrument is in circuit. The two have no necessary relationship. The mere $C^2 R$ energy does nothing useful—neither in a magnetic nor in a thermal instrument. It may at first sight appear that the $C^2 R$ function does some useful work in a thermal galvanometer ; that, in fact, it supplies the heat by means of which the deflection is produced. But this supposition would be erroneous. The energy which does the work of the deflection is actually put into the instrument when it is manufactured, namely, at the moment the tension of the controlling spring is brought to the required amount. The *resilience* of the spring is a continual store of energy which is partially and temporarily drawn upon whenever a deflection takes place. This is restored to the spring in full amount when the heated wire cools and contracts. If we trace the passage of this energy from the instant it leaves the spring to the instant it gets back again, we shall follow a thermodynamic study of peculiar beauty. It is well known that all substances which expand on the addition of heat have their specific heats apparently raised by being subjected to increased external pressure, and lowered by being placed under tensile stress. The reason is that in the former case the expanding body does external work against the compressive force, while in the latter case the stress expends some energy in heating the expanding body. On this account, if a thin wire is heated by the passage of an electric current it will take less energy from the current, and will take less time in rising to its limiting temperature if it is under tension than if it is slack. Some of the stored heat of the wire is due to the current, but some of it is due to the expenditure of resilient energy under the relaxation of elastic stress of the spring which holds the wire tight. When the current ceases and the deflection is returning to zero, the conditions are reversed. The contracting wire expends heat on the tension spring, restoring its lost resilient energy ; and, in the ideal instrument, the amount of heat which will thus be converted into work will equal the energy originally taken from the spring. Thus it will be seen that the true $C^2 R$ function has nothing to do with the source of energy which causes the deflection. If the stress-strain diagram of the hot wire of such an ideal instrument be plotted, the curves representing a complete cycle will enclose no area ; but in an ordinary instrument this would not be the case. In such the curve of deflection would lie nearer to the axis of stress than the curve of restoration to zero ; and the area enclosed would represent loss of energy on account of

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friction, pretty much as the area of the Ewing-cycle represents hysteresis losses.

In an electro-magnetic galvanometer the source of energy of the deflection is the electric circuit, but not through the medium of the dissipation function. The medium of exchange of energy is an electromotive force which is set up in the circuit when the needle moves. In a forward deflection there is a back electromotive force, which takes some energy from the circuit; while in the return of the deflection to zero there is a helping or forward electromotive force which restores this energy to the circuit from whence it had been taken. During the deflection this energy exists potentially in the controlling mechanism. Thus, if there is a bar-magnet control, the energy is stored magnetically in the ether; if there is a spring control, the energy exists as resilience of the spring; while if there is gravity control, the energy exists as a stress—*where?* Would that we could say where! *Is* it the ether?

MR. BALFOUR ON TECHNICAL EDUCATION.*

On Monday night Mr. A. J. Balfour distributed the prizes to the successful students in the Manchester Municipal Technical School and the School of Art. It was, of course, expected that he would make a speech; and he made one. It is scarcely possible for a man so able, and holding a position so prominent, to say much, or indeed anything, in public that does not deserve attention, and accordingly very considerable prominence has been given to his utterance on Monday night. But it is very easy to attach much more importance to his words than they deserve, or than, indeed, he would himself claim for them. His knowledge of the subject is limited; he was called in to bless, and if he had not blessed, his hearers would have been disappointed. It is obvious, too, that the facts (?) were all gathered from those earnest spirits who believe that the regeneration of commercial England is to be effected by technical education. Had a less important person spoken we should have kept silence, but the prominence of the event challenges criticism; and here, before going further, it is well to say that we have not one word to urge against the Manchester School of Art, nor, indeed, against its technical school. We have a quarrel, but it is solely with those who advocate the spread of technical education on wholly erroneous grounds, and support their contention with arguments the truth of which they have never attempted to prove. That technical education may be of service we do not care to dispute; that it can do the work, or has ever done the work, claimed for it we emphatically deny.

The principal assumptions on which Mr. Balfour based his speech are that technical education enables the foreigner to compete with us; that if we want to maintain and extend our supremacy we must adopt and extend the principle of technical education; and that although it was quite possible in times past for men who had no scientific training to invent and even discover, it was no longer possible for them to do anything of the kind. Much more space would be required than it is necessary to devote to the subject, to deal with these propositions in minute detail. Concerning the first, it suffices to point out that it is by no means clear that our foreign competitors *are* beating us. If they are, it is simply because so many markets are closed to us by hostile tariffs, and because wages are higher in Great Britian than they are in any other European country. With lower wages and free trade, or even with free trade alone, we could set all competition at defiance, and technical education on the continent of Europe would certainty not prevent us from beating all competitors. Concerning the second proposition, it is enough to say that, notwithstanding repeated challenges, no one has been able to adduce facts to prove that technical education has enabled Germany, or France, or Belgium, to excel us in manufactures or in engineering. No data whatever are supplied on this most important aspect of the question by any writer or speaker. We are met on every side by cloudy generalities with which it is impossible to deal, and which only evoke the ridicule of a large number of men engaged in manufactures and trade. When an adequate attempt has been made to prove that the manufactures of Germany, France, or Belgium are better than ours, and that they are better because of the prevalence of technical schools, we shall be happy to reconsider our position, but not before. There remains, then, to be dealt with only one section of Mr. Balfour's speech, that, namely, in which he urges the theory that it is to technical education we must look for future scientific developments in manufacture. "I think," said Mr. Balfour, "if you study the industrial and scientific progress in this and in other countries, you will find that up to a comparatively recent period theory has always lagged behind practice: you will find that it was not the theoretical but the practical knowledge of men engaged in the workshops, of men engaged in the actual industries of the country, which produced the inventions and made the discoveries which it was afterwards the business of the scientific man to explain and, if need be, to develop. The science of thermo-dynamics was in a very undeveloped condition when Watt invented the steam engine; and if it were worth while, and if I had the requisite knowledge in detail, I might go over each of your great industries to show that the science of the subject did not precede, but, on the contrary, succeeded, the practical knowledge of the subject, and that, therefore, in those days the theoretical education now given in your technical schools could not by any possibility have brought forth the great practical results which we now hope from it with some confidence." In this passage Mr. Balfour stated in well-chosen language the truth for which we have all along contended. But he did not stop here. He went on to explain why technical schools were, in his opinion, now wanted. "But observe," he said, "how greatly this is changed, at all events in some departments of industry. Perhaps the most striking example that I could take would be in the recent developments of electrical science in connection with the recent developments of industries founded upon that science. There you have science constantly, not following in the track of practical invention, but preceding and suggesting the practical inventions which proved to be based, and are based, upon theoretical knowledge, and this change, most clearly shown, perhaps, in electrical science, but surely shown also in engineering, chemistry, and a hundred branches of manufacturing industry—this truth, to which I have called attention, is becoming more and more true of all the industries in which we are engaged." Here, says the *Engineer*, we join issue with Mr. Balfour. It is just as true now as it has been at any time, that science follows in the footsteps of practice. Not a single improvement worth the name has been effected in steam-engines by professors; in other words, by men whose theoretical attainments are beyond question. To take a more recent instance, oil engines. These machines represent a new and most important branch of trade and manufacture. Their construction has involved new applications of thermo-dynamics. But the oil engine did not originate in the laboratory. It has not been invented by a professor. It has not sprung from the brains of a technically-educated Frenchman or German. It is purely the product of the brains of English mechanical engineers; and at this moment professors are toiling after these engineers, and vainly attempting to predicate what must happen, in which they are usually mistaken, and to enunciate laws which are usually wrong. Mr. Balfour was no doubt sorely perplexed to find a subject which could support his contentions, and he not unnaturally pitched on electricity; but he did this simply because he has not watched the progress of events. It is quite true that various discoveries of more or less importance have been made in the laboratory, but they remained utterly barren and useless until the engineer took them in hand. The man of science gave no help whatever to develop them into methods of adding to the comfort, the wealth, or the commercial prosperity of the nation. His function in the arts is to consolidate, to arrange, not to create. Take, for example, multiplex telegraphy or the electric light. What has the laboratory or technical education done for these things? If Mr. Balfour were only behind the scenes, if he only knew how absolutely dependent the man of pure science is on the engineer for the facts on which alone true theory can be based, he would have confined himself to generalities and carefully avoided the particular.

It is not only that the man of pure science does not originate. We go further, and say that scientific training is fatal to originality. There are, of course, men of genius who triumph over all obstacles, and convert them into stepping-stones to success. But to the great mass of mankind a scientific training is, as we have said, a bar to advancement. Nor can it be otherwise. If we look to the history of human progress in the arts, it will be found that it has been based on the method of trial and error. All our arts have been evolved, not created. But it is impossible to work in this way without making mistakes. Yet the scientific method is intended to make mistakes impossible. A single example to illustrate our meaning is all that we can find space for. It can be proved beyond all fear of contradiction that the efficiency of expanding steam is entirely independent of the number of cylinders in which it takes place. Now, a man carefully taught thermo-dynamics a quarter of a century ago would not only not dream of using a compound or triple-expansion engine himself, but he would laugh at anyone who did. Accordingly, we find that the modern marine engine not only did not originate with the man of scientific training, but that it was made in spite of prognostications that it must be a failure. Many other examples of the same truth will no doubt suggest themselves to our readers. We remember once hearing it said of a man of high scientific attainments in reply to the question, "How is it that X. originates nothing?" "Oh, you know, a man in his position cannot afford to make a mistake." It is, however,

* From the *Engineer*.

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only fair to say here that the real men of science are those who claim least for themselves, and attach a value to science, as an aid to commerce, so small that it would astonish the noisy advocates of technical schools. Finally, we would conclude with a word of caution to our readers. No phrase has been more misused or perverted than "technical education." In the fullest and highest sense, it is essential to the well-being of this country, and we do not hesitate to add that there is no country on earth in which it has been carried to such perfection. But it is not in technical schools that it can be learned. It may be a very good thing that boys should be taught a little science and a little manual skill in these places or it may not, but it is a soul-depressing figment of the imagination, that Great Britain must depend in the future on such establishments for her commercial existence.

THE INDIA-RUBBER TRACTS OF UPPER BURMA.*

Some interesting information has reached us in regard to the india-rubber forests and trade of the Bhamo District of Upper Burma. This information is not complete, and may be in some few minor respects faulty; but we believe it to be fairly accurate in the main, and at a time when there is some pessimism displayed as to how long supplies of india-rubber will hold out, the matter is one of public interest. The information referred to tells us that practically all the india-rubber that is put on the market in Bhamo is extracted from the *ficus elastica*. This extends from the latitude of the Indawgyi Lake northwards, and is said by the Kachins to be found as far north as the small Shan State of Khampti on the Upper Irrawaddy westward, and north-west it extends to Assam, but it is not at present known to grow naturally east of the Irrawaddy. The trees are usually scattered either singly or in groups of two and three in dense evergreen jungle, and they are, as a rule, separated by long distances. For instance, on the Jade Mines road, from Nanyong to Numnuyang, 44 were counted in 12½ miles, and this number included three dead trees and seven seedlings. This, too, was a comparatively large number, the average of all the countings made by one forest officer being only one tree for every 10¼ acres in the forests on the northern watershed of the Tanai chaung. The Kachins remark that the district referred to fairly represents others, and from the figures quoted, it is judged that it would be impossible to form forest reserves for *ficus elastica* alone, as it would not be worth while to take up and protect the area necessary to give any large yield of rubber. It is reported that the forests on which the trees are found consist of a dense evergeen jungle, the undergrowth being, as a rule, particularly thick and impassable, composed of small bamboos and evergreen shrubs, besides canes of every description. The rubber seedlings are invariably found growing down from the forks of light-foliaged trees, being unable to stand the dark atmosphere near the ground. The seedlings removed by the Kachins and planted near their villages seldom attain a height of more than from 60ft. to 80ft., whilst those growing naturally in the jungle and starting from a fork at a height of 70ft. or 80ft., and growing upwards and downwards by means of their aërial roots, frequently attain a total height from the ground of 130ft., thus having a very much larger surface available for cutting.

It may be remarked that the india-rubber tracts under reference may be divided into seven sections, but it is not necessary for our present purpose that we should particularise these. The most important section is north of the Tanai chaung. The area is drained by three streams, which help to facilitate transport. Roughly, the produce of all sections may be estimated at 200,000 viss (1 viss=3·6lb. av.) per annum. The transport of the cut rubber is in many cases the greatest obstacle to the exploitation of forests, as men have to go long distances, carrying all their requirements on their own backs, and able to count on getting absolutely nothing while on the hills. The way they work is as follows:—When the rubber is rolled up into balls they carry these down in bamboo baskets to a stream. Here they string the rubber balls together with canes passed through their centres, and thus form long lines of balls 15ft. to 20ft. in length. Then these strings are towed down stream, a number at a time, by means of a chest-band of woven cane. If the streams become too deep for comfort, small bamboo rafts are made and poled down. From other districts cost of transport is often much heavier, on account of the greater length of the land journey. In like manner, there is no uniformity in regard to prospects. While some districts have suffered from overworking, others are still but little used. The process of tapping varies, too, though it does not seem to be anywhere very skilful. In the Jade Mines tract the trees are cut from the very top downwards to the extremity of the smallest roots that can be found, and the roots are followed up underground to great distances. In the Chindwin District the rubber is extracted by more or less horizontal incisions made by two strokes of the ordinary Kachin da, one an upward cut at an angle of 45deg., and the other a similar downward cut. The cuts are made on the upper and lower surfaces of the branches, and the juice as it runs drops to the ground, which is not prepared for its reception beyond a slight clearing of the undergrowth. Of course, the result is that much of the rubber contains earth and rubbish.

From these few remarks it will be understood that the trade in india-rubber procured from Upper Burmese districts labours under various disadvantages. The quantity of rubber produced by two equal-sized trees, one on the hills and one on the plains, differs greatly. The former gives plenty of juice, but not much rubber. The Kachins know this, and as a consequence the quantity of rubber yielded by the tracts which are easily got at is falling off. Certain protective measures are necessary. Then again, the tapping needs to be performed more skilfully, and adulteration must be avoided. And even if all this can be done, needful reforms are not complete. The trade is in the hands of the Chinese, who are supposed to have grown fat on the profits. The pernicious advance system has been in vogue, but is now falling into disuetude. There appears, however, to be any amount of scope for cheating in the way of adulteration, false weighing, &c., and it is suggested that the Government should take a much more active part than it has yet done in regulating the trade; also that a duty of eight annas per viss should be levied. This, it is thought, could be done without stifling or diverting the trade. This is one of some importance. The price runs about Rs.410 per hundred viss in Rangoon, and the shipments from Rangoon during 1891 amounted to some 305 tons. The rubber from *ficus elastica* is about the cheapest in the market, and, doubtless, with proper care, the trade could be developed. But at the present time there appears to be difficulty about protecting the trees, as well as about getting pure rubber and preserving it from adulteration. Now that the subject has received official consideration, however, some steps will probably be taken, and it is possible that Upper Burma will solve the problem that has recently been suggested, "Will supplies of india-rubber soon be exhausted?"

* From the *India-Rubber, Gutta-Percha, and Electrical Trades Journal.*

THE ENGINEERING DETAILS OF THE NEW YORK-CHICAGO LONG-DISTANCE TELEPHONE LINE.*

BY JOS. WETZLER.

Up to the time at which the New York and Chicago line had been contemplated, the longest sustained successful telephonic transmission had been about 500 miles, and it was, therefore, a matter of no small consideration, and one the importance of which the American Telegraph and Telephone Company well recognised, that the operation of a line almost twice this distance should be successful at the very start. The previous experience of the Company stood it in good stead, but the rules which had been laid down for the calculation of the size of wire required for the transmission of speech had been found to be at such variance with the actual practice of the Company that its engineers were necessarily obliged to observe the greatest caution in their recommendations. The most commonly accepted rule for telephonic transmission is that laid down some few years since by Mr. W. H. Preece, which is as follows:—

When K R	=	15,000,	speech impossible.
,, ,,	=	12,500	,, possible.
,, ,,	=	10,000	,, good.
,, ,,	=	7,500	,, very good.
,, ,,	=	5,000	,, excellent.
,, ,,	=	2,500, or under,	perfect.

This rule, it must be pointed out, is entirely empirical, and as such, as frequently turns out to be the case, is only safely applicable to circuits whose length is within the limits of those by which the rule was formulated. As proof of this we may remark here that the telephone line between London and Paris was built according to this rule, and the K R constant of 7,500 was adopted. When the line was finished it was found that transmission over it was very much better than the formula indicated, which went to prove that the rule apparently did not apply to that particular line. But long before the completion of the Paris-London line, it was well-known to the engineers of the Long-Distance Company, that this rule was not generally applicable, for the reason that the circuits at their command showed that transmission was possible over lines having a very much higher K R constant. Thus among the experiments tried by them was the coupling up of lines aggregating in length

* From the *Electrical Engineer* of New York, December 14th, 1892. Abstract.

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from 650 to 1,100 miles. The results obtained are shown in the following table :—

650 miles,	transmission excellent	K R = 31,000.
750 ,,	,, good	K R = 45,000.
885 ,,	,, poor	K R = 62,000.
1,100 ,,	,, none	K R = 91,000.

These experiments were made with a "solid-back"* transmitter, and three cells of Fuller battery, the usual equipment of the long-distance telephone set.

According to the formula enunciated by Mr. Preece, it would require a wire weighing nearly 2,000 pounds to the mile in order to communicate with Chicago, and it was not to be wondered at, therefore, that the engineers of the Long-Distance Company hesitated in applying this rule. The result of their own experience, however, was such as to give them confidence in the selection of a greatly reduced size of wire, and after due consideration it was determined to select a No. 8 B.W.G. wire, having a diameter of 0·165 inch, and weighing 435 pounds to the mile. (See comparative sizes of the theoretical and actual wire depicted in Fig. 1, which we have taken the liberty of adding to Mr. Wetzler's excellent

Fig. 1.—*a*. Wire which should have been used on the New York-Chicago Telephone Line, according to the K.R. Law. *b*. Actual wire used.

article.) This wire has a resistance of 2·06 ohms per mile, and a capacity of 0·0158 microfarads per mile, with wires strung 35 feet above the ground. The thousand miles, practically representing the distance between Chicago and New York, has a K R constant of 32,000. Yet, notwithstanding this enormous excess over the limiting figure laid down by Mr. Preece, it was adopted and the line built. The results obtained are now well known, but even before the building of the line was begun the engineers of the Company were firm in the conviction that it would prove to have such excellent speech transmitting qualities that it would give a sufficient margin to make it possible to add on other lines at the end, and possibly secure communication to cities beyond Chicago, such as Minneapolis, St. Paul, and St. Louis ; while, on the other hand, it would leave large margin for the attachment of local lines within a radius of 100 miles from Chicago.

taken the resistance of one of the wires of a metallic circuit, measured in ohms, and multiplied it by its electrostatic capacity measured in microfarads, to ground. The difference evidently is one of method only, the result being the same. It might be well to point out here that one wire measured against its mate, as done in the calculations of Mr. Preece, is never found to be exactly one-half of the capacity when measured to ground, being usually found to be from 60 to 65 per cent. of that quantity.

The building of the line having been determined upon, the questions of the details of construction to be adopted were given most exhaustive study. In this respect the experience of the Company in its past work has also stood it in good stead, with the result that it is fair to assume that the construction adopted will afford a line of the most permanent character.

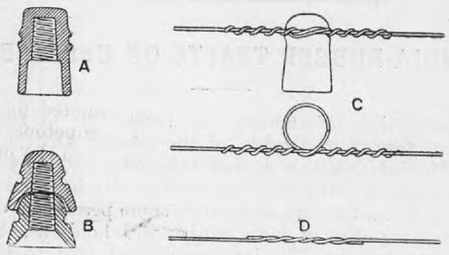

Fig. 2.—Details of construction on the New York-Chicago Telephone Line.

The line is built of standard poles 35ft. long, of the best quality of live green cedar wood peeled, and the knots trimmed close This length of pole permits it to extend not less than 26ft. above the surface of the ground. The cross-arms employed are of thoroughly seasoned, straight-grained Norway pine, 10ft. long, $3\frac{1}{4}$in. thick, and $4\frac{1}{4}$in. deep. These cross-arms are given two thorough coats of metallic paint, and are braced with two galvanised iron braces, which are attached to the cross-arms by means of galvanised iron carriage-bolts. These cross-arms are fastened to the pole, not in the usual way, by means of fetter drive screws, but by a galvanised iron bolt, the pole being bored for the purpose, and the bolt passing entirely through. Washers under the head and nut prevent abrasion of the cross-arms and the pole.

The insulator pins are made of clear split locust, $1\frac{1}{4}$in. in diameter. The type of insulator employed is the regular standard white glass

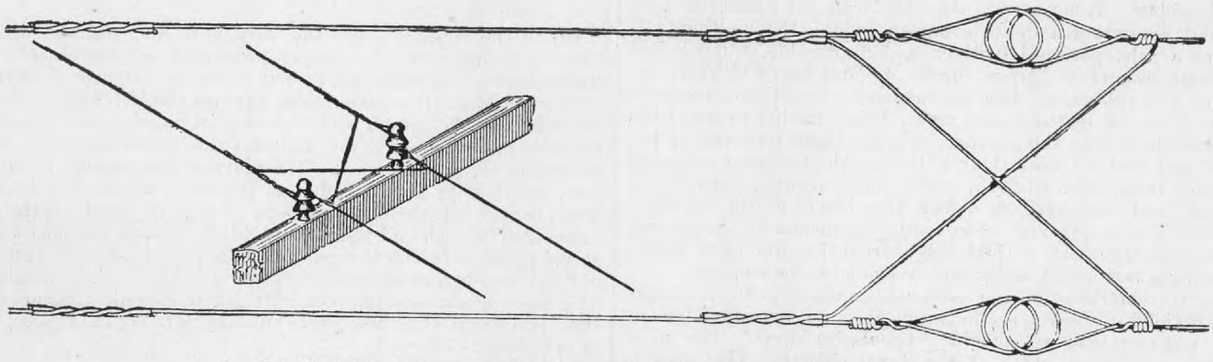

Fig. 3.—Method of transposing wires on the New York-Chicago Telephone Line.

As another proof of the inadequacy of the transmission formula, as laid down, it is only necessary to consider the following K R constants for lines which are now, and have been for some time, in daily operation, as follows :—

Boston and Washington.....	R=26,250
Boston and New York	K R=12,100
New York and Philadelphia	K R= 2,000

From the above it is evident that, while the lower figures giv n by Mr. Preece agree thoroughly well with the results obtained on the long-distance lines, the higher figures are greatly at variance with it, the circuit between Boston and Washington, for instance, exceeding Mr. Preece's figure for speech "impossible" by nearly 75 per cent.

As some question might be raised as to the manner in which the K R constant is here calculated, it might be well to point out the fact that Mr. Preece multiplies the total resistance of the circuit by the capacity of one of its wires measured against its mate, and estimates that the capacity of one wire measured against its mate is one-half of what it would be if measured to ground. In the calculations made by the long-distance engineers, they have

* See *The Electrician*, December 2nd, p. 119.

American Telegraph and Telephone Company's insulators (A, Fig. 2). For the guard wire the 20oz. Western Union double-petticoat insulator, without petticoat, is used. The transposition insulator is of the Hibbard pattern, of white glass, and is shown at B, Fig. 2.

On the corner poles guard irons are employed. Every tenth pole is furnished with a lightning rod made of No. 6 galvanised iron wire. These rods are fastened to the pole every two feet by iron staples extending from the top to the bottom, and at the latter end they are given two hand turns. In ordinary good ground the poles are set at distances of 130ft. to a depth of 6ft., and on curves to a depth of $6\frac{1}{2}$ft. The method of tying the wires is shown at C, Fig. 2. Here it will be noticed that one side of the the wire passes around the line wire and makes five complete turns. The joints in the copper line are made with McIntire sleeves, each sleeve being given three complete twists, as shown at D, Fig. 2.

In laying out a telephone line great care must, of course, be taken to avoid cross-talk and other disturbing influences, which militate so much against clear enunciation, and make wires noisy. For this purpose it is necessary to transpose the wires at proper intervals, and to accomplish this transposition insulators are employed. Fig. 3 shows the method of carrying out the transposi-

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tion. It will be noted that the line coming from the left is dead-ended on the upper insulator, and continued by means of a cross-over connector to the neighbouring line, its mate. This line is also dead-ended on the other upper insulator. In the same way the other two sides are joined so that the position of the conductor on each side of the cross-arm is reversed.

The present line carries two cross-arms, which will eventually carry 10 wires each. The line passes through, or is connected by short branches and loops with, the most important cities between New York and Chicago.

Credit must be accorded to the enterprise and management which has made the New York-Chicago line a possibility, but we cannot close this description without a brief mention of those who have had immediate charge of the work and have brought it to a successful completion. Mr. E. P. Meany, assistant general manager of the Long-Distance Company, has had charge of the construction work of the entire line, and F. A. Pickernell, engineer of the Company, has had general charge of the electrical and mechanical working out of the system; while Mr. A. S. Hibbard, the general superintendent, has had charge of its operation and maintenance. The Company is to be congratulated on the possession of the services of men so thoroughly competent, and whose work will, no doubt, prove of permanent value to the profession at large.

THE OBJECTIVE REPRESENTATION OF HERTZ'S RESEARCHES ON ELECTRICAL RADIATION.*

BY L. ZEHNDER.

The small sparks which Hertz obtained in the secondary conductor in his experiments on rays of electric force are not immediately suitable for representation to numbers of people, because they emit very little light. It is true that sparks can be obtained about 6m. away from the reflector and about $\frac{1}{3}$mm. long, and these sparks can be seen about 3m. further off in a darkened room, but these can only be seen by a very limited number of people. Many devices have, therefore, been employed to make the Hertz effect visible.† The author has endeavoured to attain this object by making the Hertz sparks cause the discharge of a high-pressure set of accumulators through a Geissler tube. The brilliant light of the tube, which continues so long as the primary discharge is continued, is a very impressive method of showing the experiments of electric radiation and reflection. Hertz has himself lately published an account of an experiment in which he has caused the discharge of such a high-pressure battery through a minute air gap by means of ultra-violet light-rays, a method which has some analogy with the experiments about to be described.

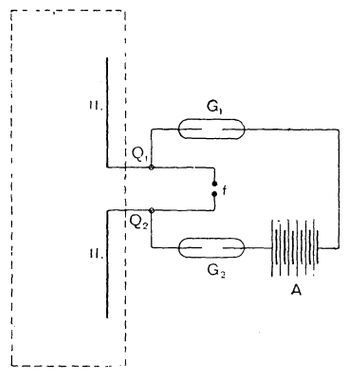

FIG. 1.

The author employed in his researches a reflector with its primary and secondary conductors in the position described by Hertz; the secondary conductor consisted of two brass plates, each of 50cm. long, 5cm. wide, and 1mm. thick. The secondary of the Ruhmkorff coil gave very good sparks of 0·7cm length when worked with the very rapid Deprez interruptor. The battery consisted of a set of 600 small Planté cells, and was coupled in series with a megohm, so that very small currents passed through the Geissler tube, which could thus be worked for hours together.

The results of a few preliminary experiments may be of interest. The first successful experiment in obtaining effects of the electric oscillations in the secondary conductor on the discharge in a Geissler tube, was with the arrangement shown in Fig. 1. II II are the secondary conductors in the focal line of the reflector. Q_1 Q_2 are mercury cups, G_1 G_2 are small Geissler tubes about 4cm. diameter, having their electrodes fairly close together; f is the Hertz spark gap, and A the battery. The spark gap was so regulated that, when the battery was cut off, small sparks jumped across; then the battery was put on and adjusted to such a potential difference that another cell or two caused sparking through the circuit $G_1 f G_2$, the potential difference being thus just too little to start the current. If, now, the Hertz spark was started at f, the current from the battery immediately broke down the resistance of G_1 and G_2, and the glowing of the tubes showed that the Hertz spark had occurred.

The spark gap was now introduced into the tubes themselves. First, a tube containing a spark gap of definite length was slowly exhausted and the behaviour of the spark noted at intervals; the brilliancy of the spark appeared to diminish with the pressure of air. Then the pressure was reduced to 1mm. of mercury; and in order to produce a very small sparkgap, thick platinum-tipped copper wires of about 5cm. length were sealed into the tube and made to touch when hot. On cooling, the copper wires contracted more than the glass, and caused an almost infinitesimal gap between the points, which, of course, increased as the tube cooled. While cooling the secondary, sparks were passed through the gap in the exhausted tube. At first the spark looked just like the ordinary Hertz spark, but, as the wires drew further and further apart, there came a critical point at which the bright spark disappeared. If, now, the tube was looked at in a darkened room the space in the neighbourhood of the electrodes was found to be aglow, the phosphorescence being greatest at the electrodes, and spreading several millimetres on every side. This glow is no doubt the well-known kathode light, and it appeared to be very nearly symmetrical with regard to both electrodes. The anode light could probably not be seen, as it was so near as to be masked by the brighter kathode. It was remarkable that the change from spark to glow occurred quite suddenly when the electrodes reached the critical distance apart. The glow could be made between electrodes further and further apart as the Hertz reflectors were put nearer and nearer together.

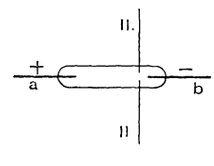

FIG. 2.

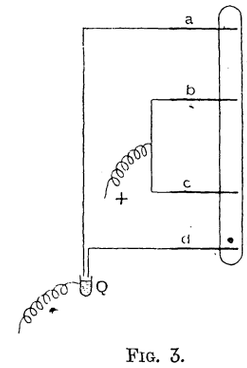

FIG. 3.

The author then proceeded to seal in the same tube electrodes both for the direct-current discharge and the Hertz spark, as shown in Fig. 2. a and b are the electrodes, II II the Hertz secondary conductor. The spark gap was placed near the kathode, since it is known that in the neighbourhood of this lies the greatest resistance of the air path; and by breaking this down by means of the Hertz spark the greatest possible diminution of resistance would be obtained. It was found that if, as before, the potential difference between a and b was adjusted to be just too small to start the current, the Hertz spark would cause it to start if the spark was taking place in a gap sufficiently wide to cause it to take the form of the glow described above, but not otherwise. The Geissler tube continued to glow until its circuit was broken. It is, therefore, only the glow discharge of the Hertz secondary which is capable of so diminishing the resistance of the air path in the Geissler tube as to start the battery current.

The next experiment is shown in Fig. 3. Two sets of electrodes, $a\,b$ and $c\,d$, were sealed into the same tube, a and b being slightly wider apart than $c\,d$. Between this latter pair was the spark gap f. By means of a mercury cup, Q, either pair of electrodes could be coupled up to the battery. If $a\,b$ were coupled to the battery, so that a discharge was set up, no current would pass from c to d if also coupled up; but if, and so long as, Hertz sparks were passing at f, the glow took place between c and d. Thus, by concealing the tube $a\,b$ from sight, the part $c\,d$ would light up whenever a Hertz spark was passing at f. The tube gradually became useless, as after a time the resistance of the gap $a\,b$ became less than $c\,d$.

Many experiments were made with the arrangement shown in Fig. 4. The secondary conductors II II were fastened to the tube B, whose electrodes $a\,b$ served for the accumulator discharge. A is the accumulator, W_1 and W_2 high resistances, m and n switches.

* Abstract from *Wied. Ann.*, No. 9, 1892.

† *See* Lucas and Garrett, *Phil. Mag.* (5) 33, p. 299, 1892, and *Wied. Ann.*, Vol. XL. and XLIII.

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The tube was 0·8cm. diameter inside, and the electrodes were 5cm. apart. The spark gap was at *f*, near the electrode *b*, which generally served as kathode, and the gap was estimated at $\frac{1}{50}$mm. In order to prevent the change of resistance of the tube described in the last paragraph, a certain amount of metallic sodium was passed into the tube by means of the electrode *e*, which absorbed the oxygen remaining in the tube after exhaustion.* The pressure was 1·2mm. of mercury. The resistances W_1 and W_2 were tubes containing a solution of cadmium iodide in amyl

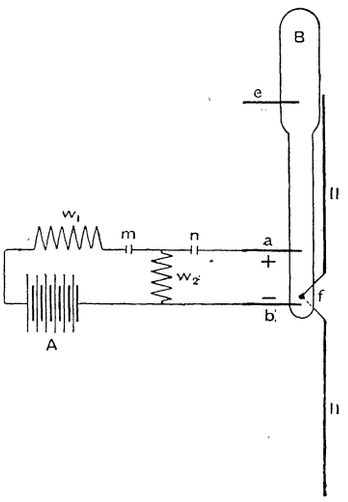

FIG. 4.

alcohol, and were adjustable. W_1 in series adjusted the strength of current, W_2 in parallel adjusted the potential difference on the electrodes. By means of this arrangement the passing of the Hertz spark can be shown very well, using reflectors up to 8m. off. The battery discharge, which is started by the Hertz spark, can be seen easily in a room into which no direct sunlight enters, fully 10m. away. By use of the resistances W_1 and W_2 the potential can be so accurately adjusted that the battery discharge both starts and stops with the Hertz discharge.

The author describes some experiments which tend to show that, owing to the variability of the potential difference of an induction coil, it is not equally as well suited for these experiments as a high potential battery; but he says it may be used where the battery is not available.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December* 2, 1892.

The Westinghouse Glow Lamp.—It has just been announced that the Westinghouse Electric and Manufacturing Company has fixed its prices for the new two-part lamps, the manufacture, sale and use of which, it is claimed, do not infringe the Edison patents. The list prices will be 35 cents for 25 and 20 c.p. lamps, and 30 cents for 16, 10 and 8 c.p. lamps. The discounts will be from $2\frac{1}{2}$ to 10 per cent., according to the quantity ordered at one time, and 10 per cent. regularly to its central stations. The allowance for delivery at its factories of the glass parts of such lamps will be 10 cents each, so that the net price of the 16, 10 and 8 c.p. lamps, which form nine-tenths of those used, will be about 17 cents each. It is estimated that the saving to a central station by the return of the glass parts of the lamps and the low prices of the new lamps will equal nearly 1 per cent. dividend on its capital stock. Although the time set for the placing of this lamp on the market has arrived, it has not yet appeared. That the prices for it have been fixed, however, is taken to be sufficient indication that the arrangements for its manufacture are pretty well settled. A good deal of interest has been aroused among lamp experts regarding the possibility of maintaining a sufficiently good vacuum by means of the processes which outsiders have been given to believe are to be used by the Westinghouse people. An interesting point has been brought up in connection with the advent of the separable lamp. It seems that the original application for a patent on this device was rejected a number of times by the United States Patent Office, on the ground that the idea was not new, and that it was in constant use in such well-known apparatus as glass-stoppered bottles. Later, however, a number of patents were issued on a variety of lamps embodying this principle, but it is claimed that no patent has yet been granted on the fundamental idea. Such patents as were issued, however, are now controlled by the Westinghouse Company, but it has been intimated by reliable authorities that the General Electric Company may take the matter up and endeavour to secure a patent on the original application for a separable lamp. This, it is claimed, it is possible to accomplish, on the ground that the device has not been in public use. This is an interesting point which may have considerable bearing on the future of the lamp industry in this country.

* *See* Warburg, *Wied. Ann.*, Vol. XL., 1890.

NEW YORK, *December* 9, 1892.

Electrical Literature.—Dr. John Hopkinson's "Collected Papers on Dynamo Electric Machinery and Allied Topics" has just appeared from the press of an American publishing house. It is a little strange that these papers have not been published in this form in England, as the demand for them must have been considerable, judging from the frequency with which they are quoted by writers on electric lighting machinery. An Electrical Encyclopædia is proposed in this country by Mr. Park Benjamin, who, as is well known, has for some time been the Editor-in-Chief of Appleton's Mechanical Dictionary. It is proposed to make a volume of about 1,000 pages, and it would probably be strictly an American book. Mr. Park Benjamin has just received from his agent in Italy a unique book; it is a copy of the first edition of Galvani's essay, "De Viribus Electricitatis in Motu Musculari," published at Bologna in 1791. It contains, in Galvani's own handwriting, the revisions and corrections which were incorporated in the second edition, published the following year. The work is, in any form, of extreme rarity, and a copy with the author's own corrections is, of course, of very great interest.

The Edison-Westinghouse Case.—The Edison-Westinghouse case has been going on this week in the United States Circuit Court of Appeals, before Judges Shipman, Lacomb, and Wallace. The arguments of the attorneys occupied three days, and were finished yesterday. It is expected that a decision will be handed down at an early date, probably before the end of the month or early in January. The case is attracting considerable attention, and the point at issue as to whether or not the General Electric Company's organisation is a violation of the anti-trust law is conceded to be an important one for that company. The case is watched with an interest second only to that shown in the big lamp suit, in which the decision was handed down by the same Court. It is asserted that a very strong point has been made by the Westinghouse Company in this matter, and that had it not already been admitted by this Company that it had an incandescent lamp to place on the market which would not infringe the Edison patent, the Court would undoubtedly regard the tactics of the General Electric Company, in seeking to control other branches of the electrical business by its monopoly of the incandescent lamp business, as injurious to general trade. The fact, however, that the Westinghouse people claim to have a lamp of their own, may convince the Court that the present methods of the General Electric Company will not, after all, injure the general business to any extent.

A Large Westinghouse Alternator.—A large alternating dynamo, said to be the largest alternating-current dynamo used in central station work in this country, is now in operation and under test at one of the stations in this City. It is a Westinghouse machine of 6,000 lights capacity. This, of course, will be exceeded by the World's Fair machines constructed by the Westinghouse Company, which are to be sufficient for a load of 10,000 lamps.

NEW YORK, *December* 17*th*, 1892.

The Edison Lamp Decision.—The chief event of the week in electrical circles is the handing down of the decision in the Edison lamp case by Judges Lacombe, Shipman, and Wallace. This decision, as was expected, is again in favour of the

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Edison Company, although the Sawyer-Man people were successful in obtaining a limitation which compels the General Electric Company to sell lamps to the Sawyer-Man Company and its customers. This suit, it will be remembered, was on an appeal from the decision of the lower Court on the application of the Edison Electric Light Company for an injunction to restrain the Sawyer-Man Company from making or selling incandescent lamps. Regarding the question raised as to the propriety of the General Electric Company appearing before the Court as the real prosecutor, the Courts said that whether it is a trust contrary to law or not there can be no question regarding its right to control the patent in question, and it does not in reality enter into the discussion of the question as to whether the General Electric Company is or is not an illegal trust. The following paragraph from the decision indicates the conditions upon which the injunction is granted:—"The injunction order appealed from should be modified so as to cover only lamps made in infringement of the second claim of the patent, the other claims not having been infringed according to the adjudication of the Circuit Court or this Court. It should also contain a provision reserving the right to the defendant to move hereafter for the vacation, suspension or modification of the injunction upon proof of specific instances of refusal on the part of the complainants, or either of them, to supply the lamps of the patent upon terms reasonable under the circumstances of the particular case to the owners of electric light plants, which are modified before the rendition of the interlocutory decree of the Circuit Court sustaining the validity of the patent."

There is much speculation as to what will be the manner of dealing with the lamp companies It is known that some of them had already applied for permission to manufacture by the payment of a royalty. Whether or not any of the smaller companies will be allowed to manufacture or not is as yet unknown, and it is most likely that the new Westinghouse lamp—which is promised, but which, by the way, has not yet appeared on the market—may change to a considerable extent the condition of affairs, should it prove a commercial success. Some of the smaller companies could, doubtless, obtain from the Westinghouse Company a licence to manufacture the lamp, and, owing to the fact that it is much cheaper, would probably prefer to do so rather than manufacture an Edison lamp which could not be put upon the market at the same price. It is said that some of the new Westinghouse lamps are now in use in lighting the Administration Building at the World's Fair grounds in Chicago.

Obituary.—Mr. M. M. M. Slattery, the designer and patentee of the Slattery induction system, the patents for which are controlled by the Fort Wayne Electric Company, which is a licensee of the General Electric Company, died at Fort Wayne, Ind., on Wednesday last.

The Endowment of Commercial Electrical Research.—A Bill has been introduced in Congress by Senator Vest, of Missouri, for the purpose of securing an appropriation for the encouragement of experiments in the application of electricity to long-distance electric railways, to agricultural work, and especially to the proposed Chicago and St. Louis electric railway, the project of Dr. Wellington Adams. This Bill was referred to the Committee on Commerce. It is urged in favour of the Bill that the appropriation should be made because of the benefits which would generally result from the development of such a project as the more rapid transmission of mails. Whether or not the general government will see fit to take a hand in such work remains to be seen.

Apprentices.—A law has been recently passed in the canton of Neuchâtel, says *Industries*, on the subject of apprenticeship. By this law apprentices are placed under the supervision of competent authorities, delegated for that purpose by the communes, who are to see that all receive thorough instruction in their adopted callings, while the technical knowledge and professional aptitude of the apprentices are to be ultimately tested by an examination.

CORRESPONDENCE.

THE COST OF ELECTRIC SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your issue of December 16th, while it contains letters enlarging on the desirability and difficulties of differential charges, contains also the description of a meter whereby all these difficulties appear to be overcome in any system of distribution in which separate wires to the meters can be economically laid. Mr. Scott's meter is, as far as I know, the first to practically embody a principle which appears to have been simmering in the minds of more than one engineer. It seems to admit of two methods of application:—The registering current may be maintained for the same time, but the intervals between successive currents may be changed in any manner; or the periodicity may be kept constant, but the duration of the current may be changed, as in the case of the steam admission in the latest type of Parsons' Turbine. Of course, any combination of the two methods might also be adopted, though for the sake of economy in the registering current it is desirable that its duration should bear only a small ratio to the total period. In the turbine a compounded electro-magnetic steam relay makes the period of admission dependent on the output of the generator, and it would probably be easy to devise an automatic control over the central station clock, which would make the duration or the periodicity of the registering current depend upon the total output of the station according to any pre-arranged law. The price of electrical energy could then be made automatically to vary as the nth power of the output of the station, "where n has any value, positive or negative, integral or fractional." It is clear that on this system the meters would not record Board of Trade units, nor could the energy employed be determined from the simple register of the meter. The dials ought, therefore, to be made to register directly in £ s. d.; a system which has the merit of being readily comprehended by the average mind, trained as it is in all our schools to work arithmetical problems of every description in money, though too often to the total neglect of all other kinds of units.

I do not think that the clauses against preferential charges in the Electric Lighting Acts will create any difficulty, as it may fairly be held that the undertakers do not "show any undue preference to any local authority, company, or person," when all are charged alike on the same sliding scale. The system will, however, render the testing of meters by the local authority a much more complicated business than it is at present, and one objection to the charge per unit being dependent on the station output at the time, instead of depending simply on the hour of the day or the season of the year, is that any large consumer by turning on his lights can alter the price for every other consumer. It may also be objected that the central clock places all the meters too much under the control of the staff at the supply station, but this difficulty may easily be met.

Major Flood-Page alludes to a very serious question which the Electric Lighting Companies will have to face at an early date. I am interested in an institution which provides its own electric supply, the plant being at present arranged for about 20 kilowatts, though this will have shortly to be more than doubled on account of extensions of the building. It is convenient to blow off the boiler on Saturday afternoon, but it is generally necessary to use a few lights on Saturday evening, and there are no accumulators on the premises. In the summer, too, lights are frequently required for short periods which scarcely justify firing the boiler when no steam is required for heating purposes. The institution is within the compulsory district of a public supply company, and it was obviously far cheaper to pay a fixed charge of something like £5 per annum for the hire of a meter and transformer, in addition to the usual rate of charge for current, than to make a special arrangement for the production of current on the premises at these exceptional times. At the same time, it is obvious that the Institution can be but a poor customer to the supply company, and the use of the current between 5 p.m. and 9 p.m. on Saturdays is certainly not conducive to the interests

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of the Central Station. In this particular case the company was asked to supply only a six-kilowatt transformer, and the use of the alternating current for experimental purposes may, perhaps, make a reasonable return on the expenditure of £60 to which the Company was put in laying a special main for 150 yards. But other institutions in which steam is employed for heating or for power may adopt the same system, if only to obviate the necessity of duplicating their electric lighting plant to provide against break-down, and may not show the same consideration to the Electric Lighting Company. For a supply station to be liable at any time to be called upon for 1,000 lights in a large hotel, hospital, or other establishment, merely because the private machinery has broken down, or the engineer in charge wishes to wash out and inspect his boiler, is a hardship against which provision should be made. WM. GARNETT.

GILBERTIANA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Both my friends, Mr. Dredge and Dr. O'Reilly, who write you on page 223, have fallen into the same singular misapprehension respecting my reference to Messrs. Wiley and Sons, of New York, the firm that has gained for itself an evil notoriety by its issues of the commonly-called pirated edition of Ruskin's works, and which is announced as about to publish an American edition of "De Magnete." My statement that the Gilbert Club had nothing to fear from a publication issuing from this notorious house referred—I thought obviously—to the quality of their publications. The cheap imitations which they brought out of Ruskin's beautiful books showed to what degradation artistic work may be brought. No true lover of art would ever dream of looking for figs from such thistles. The lowered artistic and typographical quality of such productions was the point of my reference, which only incidentally touched the question of the well-known literary piracy. There is, therefore, no need to reply further to Dr. O'Reilly for his defence of the literary highwaymen who were so generous as to offer to their victim a percentage of their ill-gotten gains, though the true history of Mr. Ruskin's indignant refusal is not yet forgotten on this side of the water.

Now, as to Mr. Dredge's rambling story. I have met Mr. Mottelay but once, when he saw me at my laboratory for about half-an-hour, in the interval between the delivery of two lectures. He left me with the impression that he would come again for a fuller exchange of ideas; for I had told him that I wished to show him my library and various Gilbertiana. For some six weeks (for he left me no address) there lay on my writing-table ready for him a copy of my biographical tract on Gilbert, and a membership form in the Gilbert Club ready for his signature. He told me that before the Gilbert Club began its work he had had the intention of making a translation of "De Magnete," and had already begun it. I told him that he was not the first, as I knew of two or three others who had independently begun translations years before. As to the "astonishing inaccuracies" of which Mr. Dredge speaks, I am not clear as to whether it is Mr. Mottelay, or Mr. Dredge, or myself, that is to be the more astonished at them! How Mr. Dredge comes to think (*a*) that Mr. Mottelay could possibly pirate a work of which he has never seen one line, or (*b*) that I could think so, or (*c*) that the big show at Chicago can possibly patch up the reputation of Messrs. Wiley and Sons in the eyes of lovers of Ruskin's works, are matters at which we may all three be indeed astonished. In my brief conversation with Mr. Mottelay (at which Mr. Dredge was not present) there was small room for inaccuracy. If my memory serves me rightly, we discussed, of Gilbertiana, but three things:—(i) I asked Mr. Mottelay if he could throw any light on the question whether there was, or not, an edition published at Frankfort, as alleged by Ferguson, and which I have never seen or been able to trace. (ii) I drew the attention of Mr. Mottelay to a certain word which is spelled differently in the three known editions of "De Magnete," the meaning of which is a puzzle to scholars. Mr. Mottelay had not noticed this, and could not assist me in the meaning. (iii) I told Mr. Mottelay of a suggestion that had been made as to the significance of the mysterious asterisks in the margin of the folio edition of 1600, which had been thought to constitute a cryptogram, but of which the true meaning was discovered when the preface came to be translated. Mr. Mottelay certainly said nothing to me about inaccuracies in a translation of which only a small part has been done by me, and of which he had not at that date (nor since) seen a single line. As I have said before, I believe Mr. Mottelay to be an honourable man. And now I entirely refuse to believe that Mr. Mottelay would say behind my back what he did not say openly when he met me face to face. What I do not understand is that Mr. Mottelay should not, after our frank and friendly conversation, and the assurance that a place should be reserved for him in the membership of the Gilbert Club, have further communicated with me in the way he had led me to suppose he would do concerning matters in which we both take so great an interest.

Dr. O'Reilly asks me what will be the probable date of publication of the Gilbert Club's English translation of "De Magnete." I can only reply that it is not my fault that the work is not already published. The rough translation was all but complete two years ago, and the members of the Editing Committee who have been working at the revision are all busy men. We are all doing our part as a labour of love, seeking no remuneration for our efforts. The publication of the American translation will not make a grain of difference to us; our work is beyond that stage. Our edition, which is a limited one, is already subscribed for and guaranteed. There will be plenty of room for a cheaper issue to those who are not original subscribers to the memorial edition. My anxiety that the good fame of Gilbert's book shall not be tarnished by the publication of his works in any inferior style is justified by the issue only this year in Berlin of the miserable so-called facsimile photo-reprint of the folio of 1600, and by the ominous circumstance that the American translation is to issue from the publishing house that has so debased the imprint of Ruskin's splendid volumes. Facts are facts, and cannot be disposed of by throwing the epithets "inaccurate" and "abusive" at the man who knows them and states them.—Yours, &c.,

SILVANUS P. THOMPSON.

We have received, too late for insertion, a very long letter from Mr. A. Shippey on this subject. Many of his remarks are answered by Prof. S. P. Thompson's reply. A considerable portion of his letter deals with Mr. Shippey's own family history, his grandfather, resident in Colchester, having owned a copy of "De Magnete." Mr. Shippey appears to be unaware that translations of Gilbert's work have already been published, and that Mr. Mottelay's edition, if published before that of the Gilbert Club, will not be the first version in English.

"I may say," he writes "(although it is not generally known), that it was through my own instrumentality which brought Dr. Gilbert's work to the light of the nation—which historical volume had been buried in the archives of the Royal Institution for years, until it was ferreted out by me in order to compare it with the description of my own volume, which book when brought to me by the librarian was covered with the dust of bygone days; and at the same time he made the remark that 'he did not think it had seen daylight for many, many years.' Hence I feel I have a perfect right to lay claim to the modern discovery of this hidden treasure. . . . ."

LUMINOUS DISCHARGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Since writing my letter which appeared last week, I have been able to obtain experimental proof that the ring discharge in an exhausted bulb undoubtedly acts like a current in respect to its magnetic effects. Two gutta-percha covered wires are wound together so as to form a coil, the two wires forming a primary and a secondary circuit, P and S respectively, each consisting of four turns (*vide* Fig. 6, *The Electrician*, Dec. 9th, page 155. Reproduced on opposite page).

A pair of Leyden jars, with a spark gap, D, discharge through P, and S is connected to a third coil T, also composed of four

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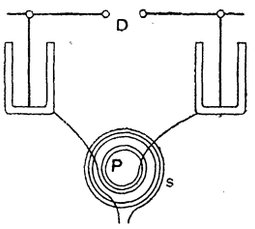
turns of gutta-percha wire. In T an exhausted bulb A is placed, and inside P and S another bulb B. The spark gap can be so adjusted that the bulb A is either not lighted at all, or only a faint ring-shaped discharge appears in it. On removing bulb B the ring discharge in A will at once become *brilliant*, to be again rendered faint or invisible on replacing B. This can be repeated over and over again. (It is not necessary to perform this experiment in the dark as the discharges are plainly visible in full gaslight or even in daylight.) This shows that the ring discharge in B acts in the same manner as the current induced in a metal ring, which will give the same effect if used instead of bulb B, viz.: it diminishes the mutual induction between P and S.



With regard to the experiment described in last week's *Electrician* by Dr. Jones, might not the effect of allowing the contact breaker to work be that the condenser is sometimes in *series* with the primary, reducing its impedence, and allowing a larger current to flow through it, as described in Dr. Fleming's "Alternate Current Transformer," Vol. II., page 51? At all events it would be interesting to try the effect under the same conditions when the contacts of the break were separated by a piece of ebonite or other insulator.—Yours, &c. E. C. Rimington.

The Park, Norwood, S.E.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I was much interested in your editorial remarks on above, and in Mr. Rimington's letter on the same subject in last week's issue.

In a Paper on the nature of the electric current, read by myself about a year ago, before the Telegraphists' Electrical Society, I gave an explanation of the phenomenon somewhat similar to that given by Mr. Rimington. It was supposed at the time the experiments were first performed that the effect could not be an electrostatic one, because an envelope of wet blotting paper round the bulb failed to screen it off to any appreciable extent. With all respect to the opinion of Prof. J. J. Thomson on this point, I should like to point out that this badly conducting envelope in this case would probably screen off just as little of the electrostatic as of the magnetic action, for two reasons. The first is that if the electrostatic strain is produced during and by the process of formation of the magnetic field, it is produced just as readily inside the envelope as outside. Again, a badly conducting envelope will only effectually screen off a steady or slowly changing electrostatic field, and in this particular case the field is a rapidly—probably a very rapidly—varying one.

For my own part I regard the *electrostatic* as the generator of the *magnetic* field, at least as far as the dielectric inside the helix is concerned. The electrostatic field coexistent with a helical current, I have endeavoured to show, consists of closed rings of lines of induction or strain, which have a radial motion towards the axis of the helix, thus conforming to the law whereby a magnetic field during formation produces an electrostatic strain at right angles to the lines of force, and to the direction of propagation, which again is at right angles to the lines of static induction.

We are not accustomed to regarding lines of induction as existing in a dielectric, except they be attached to two definite points, that is, they have two ends; but there is no reason why they should not form closed rings, although, of course, it is only for a very small space of time that they can maintain themselves as such.

I feel every confidence in predicting that were an insulated or uninsulated straight conductor passed through the middle of a large vacuum tube, and a sufficiently strong Leyden jar discharge passed through it, the luminous effect produced (assuming the return wire to be at a sufficiently great distance) would be a glow round the conductor, most intense near it, and dying away as the radial distance increased (assuming also that stratification or other effects did not come into play). The effect in a straight tube parallel to a conductor would, of course, be like a segment of the former.—Yours, &c.,

J. E. Taylor.

P.O. Telegraph Instrument Factory, Holloway, N.,
December 26, 1892.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Tenders Accepted.—The tender of the Staveley Iron Company has been accepted by the Blackpool Corporation for excavating for, and laying, cast-iron pipes, and making good the streets for the electric light conduits.

———— The tender of Messrs. Goddard, Massey and Warner, of Nottingham, has been accepted for the lighting of the pier and pleasure gardens at Bournemouth by electricity. The Town Council are applying for powers to borrow £4,000 to cover the estimated cost of the work.

Arundel Castle.—In our Trade Notes last week we announced that Messrs. Reed, Blight, and Co. had secured the contract for lighting Arundel Castle for the Duke of Norfolk; this is inaccurate. The contract secured by Messrs. Reed, Blight, and Co. is for the station building, the whole of the electrical work being in the hands of the Brush Electrical Engineering Co.

Partnership Dissolved.—The partnership existing between Messrs. W. H. Allen, R. W. Allen, and Richard Wright, engineers, of York-street Works, Lambeth, S.E., has been dissolved so far as regards Richard Wright. Debts will be paid and received by Messrs. W. H. and R. W. Allen, who continue the business under the old name.

Personal.—Mr. A. Grundy is joining Messrs. Baily and Grundy, of Paddington, as manager of the electrical and contract department from the commencement of the new year.

The Pilsen Electric Company.—This Company have recently been incorporated in the engineering business of Messrs. Gwynne and Co., at their new premises in Brook-street Fetter-lane, London, E.C. Under the transfer arrangements, Messrs. Gwynne and Co. acquire the whole business, patent, and other rights of the Pilsen Company. Mr. Rankin Kennedy is managing the electrical department.

Messrs. King, Mendham and Co.—This firm have recently carried out an extensive installation of the electric light at the large clothing establishment of the "Don" Association at Bristol. The installation includes three 1,000-c.p. arcs. The dynamos are supplied by the Newton Electrical Engineering Company of Taunton.

Key's Electric Company (Limited).—In reference to the voluntary winding up of this Company, a meeting will be held at 8, Old Jewry, E.C., on January 25th, at 4:30.

Primary Syndicate (Limited).—It has been resolved to wind up this Syndicate, and Mr. T. D. C. Parker, the secretary, has been appointed liquidator.

The Brush Electrical Engineering Company.—This Company report that during the past year most of the departments of their extensive works have been fully employed, more particularly in the execution of contracts for central station work. Considerable progress has been made with the large station at Bankside for the City of London Company, and the Brush Company are now employed in erecting additional sets of generating plant to enable the City Company to cope with the urgent demands made upon them for the electric light. The strike at Huddersfield somewhat interfered with the work on the large station which the Brush Company have on hand for the Corporation, but this difficulty having been overcome the works are now being rapidly pushed forward. The Brush Company have been successful in securing central station contracts from the Corporations of Worcester and Hanley, for extension of plant at Newcastle, Sheffield, Bournemouth, Chatham and Rochester, Hastings, Exeter, and Shanghai, and amongst the orders for plant for new installations, those at Prescot, Windermere, Killarney, Port Louis, and several towns on the Conti-

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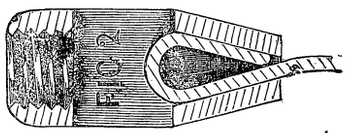
nent and in the Colonies, may be mentioned. Arc lighting plants have been supplied to Dublin and Glasgow, and the Hanley contract includes arc lights. Exhibition lighting contracts include the Douglas Exhibition and the whole of the electrical plant used at the International Horticultural Exhibition at Earl's Court. With such extensive facilities for supplying large demands, it is not surprising to learn that a great number of isolated installation plants have been supplied by the Brush Company, and these include Arundel Castle and a long list of private mansions throughout the country. The Princess-street Station of the Caledonian Railway, and the Victoria Station of the London, Brighton, and South Coast Company have also been lighted by the Company. Ship lighting plants have been supplied to Her Majesty's ships "Sappho" and "Scylla," to two cruisers built for the Argentine Government, and to a steamer for the Austrian-Lloyd Company. Considerable improvements have been made in the construction of train-lighting plant, with the result that orders have been received for new machines for train lighting on the London, Brighton, and South Coast system, the Adelaide Government railways, &c. A number of important electric traction and power transmission contracts have been secured by the Company, both in this country and abroad. In only one department has the general depression in trade been felt—the rolling stock department; but, notwithstanding this depression, several important contracts for locomotives and rolling stock have come in, including that required for the new Beira Railway, and for the railway at Bangkok, Siam. The Brush Company have been successful in establishing during the past year in the New South Wales Courts the validity of the Edison patent for incandescent lamps, of which, as our readers are aware, the Company are the owners for the Australian Colonies, India, the Cape of Good Hope, and Natal In closing this brief *résumé* of the year's work of the Company, we may refer to the serious loss sustained by the death of the Chairman, the late Duke of Marlborough, whose activity in all matters affecting the welfare of the Company was well known.

THE "LEWIS" LINK.—This a simple device for connecting the top rod of a lightning conductor to a copper strip. It reduces the number of parts, a great desideratum, and ensures thereby a direct continuity. The Link is the invention of, and is manufactured by, Mr. Joseph Lewis, of Great Winchester-street, E.C.



THE SECTIONAL STANDARDS (LIMITED).—In our issue of October 28th last we illustrated the posts used for lighting the streets of Oxford. These posts were designed at Munich, in Germany, and we expressed our surprise in the article referred to that it was necessary to go to Germany for such designs. The Sectional Standards (Limited) is a company which has been established to supply, amongst other manufactures, electric lighting posts, and from advanced sheets of a catalogue now in preparation we find that some exceptionally well-designed examples of this class of work will shortly be placed on the market. The specimens illustrated are of both the useful and the ornamental type. These standards are manufactured in England, and can be supplied in sections of any length. They are suitable for electric lighting posts, brackets, &c., telegraph poles, and similar requirements. As these goods can be shipped in sections as raw material, a considerable demand should arise from the colonies and other parts of the world where public lighting is contemplated.

FIRE.—A serious fire broke out on Sunday last at the Cadby Hall Works of Woodhouse and Rawson United (Limited), through the over-heating of a drying stove. In spite of the efforts of the firemen, the ground floor was completely burnt out, and the remainder of a large building of two floors, 100ft. by 40ft., very severely damaged.

THE REFUSE DISPOSAL COMPANY.—We have received from this Company a pamphlet on "Steam Power from House Dust, for Electric Lighting and other Purposes." By means of a patented system of sifting and sorting of house refuse, the waste paper, rags, iron, broken glass, bones, bottles, and large pieces of coal and coke are separated and are sold or utilised for paper making; while the ashes, breeze and "dust" are used in destructors for raising steam. The table published in *The Electrician* of July 8th, 1892, showing the coal consumption of the various electric supply companies in London, is quoted, and numerous calculations and estimates are given, showing the economic features of the system. It has been recognised by those who have given attention to refuse destructors that some system of storage is necessary where steam is only wanted for a few hours a day, since the destructors can only be used with convenience on regular work.

COST OF THE ELECTRIC LIGHT.—The *Newcastle Leader* of the 22nd contained an article dealing with the cost of electric lighting, more particularly in reference to the favoured coal district of Newcastle.

CALENDARS FOR 1893.—Useful hanging pad calendars are to hand from the Remington Standard Typewriter Company, and from the Indo-European Telegraph Company, the latter showing the tariffs over the Indo Company's system, including the revised rates to Australia.——The E.P.S. Company sends us their pad blotter, which, in addition to other useful features, contains illustrated printed particulars of the Company's specialities, a diary, and a letter index.——A useful pad calendar also reaches us from Messrs. Fletcher, Russell and Co. (Limited), of Warrington. ——The Brush Electrical Engineering Company send us a handsomely-bound waistcoat-pocket diary.

SOCIAL.—The *employés* of the Oxford Electric Company were entertained at a dinner at the works on Christmas Eve, Mr. George Offor, the general manager and secretary, presiding.

BATAVIA EXHIBITION, 1893.—Messrs. Henry Hemans and Co., of Queen Victoria-street, E.C., notify us that as British agents to the above Exhibition, they have opened an office in Kalibesar, Batavia, for promoting the interests of the British section.

BLACKROCK.—The Township Commissioners have had under discussion the question of petitioning Parliament in favour of the Dublin Southern Districts Tramway Bill, which is to come before Parliament at the next Session. It is a Bill to authorise the Tramway Company to improve their tram lines and to introduce electricity as a motive power. The matter has been shelved pending the calling of a special committee.

BOURNEMOUTH.—The Lighting Committee reported that they had considered the surveyor's report upon his examination of the various schemes and tenders submitted in competition for the lighting of the pier and gardens by electricity As stated above, the scheme and tender of Messrs. Goddard, Massey, and Warner, of Nottingham, has been accepted for the lighting of the pier and gardens by electricity. The Lighting Committee further recommended that Messrs. Goddard, Massey, and Co. be asked to submit an additional tender for providing 3,000 1-c.p. lamps for illuminating purposes and for laying on the light to the fountains to be constructed in the gardens, and the Committee's recommendation was adopted, the Chairman of the Lighting Committee (Councillor Moore) remarking that the Committee considered the surveyor's report a very clever and exhaustive one, and that if carried out they would get a very satisfactory lighting of the gardens and pier.

CARDIFF.—The agreement between Mr. W. H. Massey, the consulting electrical engineer, and the Cardiff Corporation, was settled at the last meeting of the Gas Works and Electric Lighting Committee, and Mr. W. Harpur, the Borough engineer, submitted the drawings of the electric lighting station. Mr. Massey's estimate of the total cost of the station and buildings is £32,500, which would, however, leave provision for a larger number of lights than would be immediately required. The estimates were approved and forwarded to the Local Government Board for their sanction, immediately upon receipt of which tenders will be advertised for.

DORKING.—Mr. J. Torr Todman has just completed an extensive electric lighting installation at the large timber works of Messrs. Taylor and Brooker, of Dorking, including nine "Solar" arc lamps, two of 2,000 and six of 1,000 c.p., and a number of incandescence Babcock-Wilcox's boilers are used.

EDINBURGH.—The deputation appointed by the Town Council to inspect and obtain information regarding electric lighting matters from the chief English centres have completed their visit, and have, in association with Mr. Murray, electrical engineer, of Biggar, N.B., compiled a set of questions to which the engineers and managers of the various central stations visited have supplied the answers, and from this document a report will be drawn, and presented to the present Corporation shortly.

FALMOUTH.—The Lighting Committee have suggested improvements in the lighting of various parts of Falmouth, and they have under consideration the question of electric lighting for the Borough.

IPSWICH.—The Corporation is very generally blamed for its action in the matter of the electric lighting powers granted to two companies in the town, with the result that Ipswich is now without the benefit of the electric light, which for a considerable period has been the illuminant of its principal streets. We understand the Corporation, through the Paving and Lighting Committee, have decided not to take up their Provisional Order. It is probable, therefore, that another opportunity will be given to private enterprise to supply the town with a much-needed commodity.

KINGSTOWN.—The Board of Works are about to erect an electric operative room on the east pier, Kingstown; the frontage to be on the lower walk.

LLANDUDNO.—At the last meeting of the Improvement Commissioners a letter was read from Mr. Kingsland on behalf of a Syndicate, for permission to construct an electric tramway along the parade connecting the Great and Little Orme's Heads. It was decided that the consideration of the subject should be deferred to a future meeting.

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WINDERMERE.—In reference to the laying of the electric lighting cables by Mr. Fowkes, at a meeting of the Local Board, a resolution has been passed to the effect "that the Board withhold its consent to Mr. Fowkes laying his cables through their district until his agreement with the Company has been submitted to them, and has received their instructions and approval."

PATENT RECORD.

APPLICATIONS FOR PATENTS.

December 5, 1892.

22,261. A. F. HILLS. London. Improvements in electric arc lamps.

22,271. C. W. HAZELTINE. London. Improvements in and connected with carbons for electric arc lamps. [Date applied for under Patents Act, 1883, Sec. 103, May 6, 1892, being date of application in United States.]

22,274. E. W. STREETER. London. A new or improved shade or screen for electric and other lights.

December 6, 1892.

22,585. G. L. ANDERS and W. KOTTGEN. London. An improvement in microphone transmitters.

22,308. E. W. APPLEGATE. London. Improvement in incandescent electric lamps.

22,333. E. HARTMANN. London. Improvements in ammeters and voltmeters.

22,344. W. WALTER and F. R. WILKINS. Birmingham. Improvements in galvanic batteries.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

20,413. BAMBERG. Electrolytic apparatus for making caustic soda, &c.

22,255. SWINTON. Electric telephone transmitters.

22,265. STEPHEN and DAVIS. Telephony and telegraphy.

22,304. THOMPSON. Electric signalling for telegraphic purposes.

1892.

1,096. SHIELS. Electric signalling on trains.

1,924. GRIMSTON. Electric switch.

5,654. REIGNIET. Dynamo-electric machines.

COMPANIES' MEETINGS & REPORTS.

Fowler-Waring Cables Company (Limited).

The fourth ordinary general meeting of the Fowler-Waring Cables Company (Limited) was held on Thursday, at the Offices, 32, Victoria-street, Westminster, S.W., Mr. Wm. Fowler (Chairman) presiding.

The SECRETARY (Mr. D. Stephen) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, it now rests with me to move—

"*That the report and accounts as distributed to the shareholders be received and adopted by this meeting.*"

In doing so I wish to make a few observations with regard to the present position of the Company. Of course we all regret that it is not possible to declare a dividend, but I do not think any of us are surprised, having regard to the fact that the Company is still young and has therefore difficulties which all new companies have to contend with. But I wish to point out the important increase in the business of the Company, and the improvement in its position, since I addressed you about a year ago. During the past year—that is, the year ending September 30, 1892—the increase in the business has been fully 20 per cent., and instead of having a loss on the year's working of £1,500 we have a profit of £480. This may not seem a great change in itself, but it is a very important improvement, as we now show a profit on the working of the year for the first time. But there is more than that to say with reference to our present position. If you take the period from September 30, 1892, to the present day there is an increase in the business, as compared with the same period last year, of more than 100 per cent., which shows clearly, I think, that the business is rapidly developing. The most important point to bring before you to-day is, I consider, the fact that our working capital is insufficient, as has been shown during the year by our having to issue debentures to the extent of £10,000, almost the whole of which have been taken or placed by the Directors. Now, it is important to observe here that probably still more capital may be required as the business develops, and it is perfectly evident that if the shareholders are not disposed to co-operate with the Board by subscribing for new capital, it must be raised at their heavy expense. That is perfectly evident. The Directors are not disposed to allow the Company to be injured by insufficiency of working capital. I may say that we, the Directors, have entire confidence in the future of the Company, if sufficient capital be provided. For real and permanent progress sufficient working capital is indispensable, for, without it, we cannot keep pace with the constant development of our business. That, I think, every man of business will admit. I wish, therefore, to impress upon the shareholders the urgency of co-operating with the Directors, when the time comes, in providing the requisite additional capital. I may observe that one reason why we do not show more immediate profit is, that we have to provide larger plant than the current business may require, because we must be prepared to execute large orders speedily and well at any time. I wish also to say that I have never seen since this Company was founded—and I think I may claim to have been a diligent Director—such a list of inquiries and probable orders as we have before us at the present time. That, I believe, will be regarded as a very satisfactory feature, and one that ought to help the shareholders in forming their opinion as to the future of the Company, and the desirability of contributing towards the raising of further capital. I really think this is substantially all I have to say. I regret to see that we are to-day almost entirely a body of Directors turned into a committee for the purpose of forming a general meeting, but what I have said will, I hope, be read by other shareholders, and I trust it will appear satisfactory to them, as I think it does to us. Perhaps someone will be kind enough to second the motion for the adoption of the report.

The Lord MEDWAY seconded the motion.

Mr. SEON said it was a considerable surprise to him that there was to be no dividend. He had invested £700 in the Company, and when he did so he had no idea he should have to wait three or four years for any return. Perhaps the Chairman would say when he thought there was any reasonable expectation of the shareholders getting a dividend.

The CHAIRMAN: Well, gentlemen, I cannot assume the functions of a prophet at this moment, but I really believe—although I do not wish to pledge myself absolutely, or the Board either, for I have no authority to do so—that if we go on during the present year as we have begun it, we shall see something in the way of a dividend next year. With regard to what the shareholder has said about his holding, I may say that I have a great deal more in the Company myself than he has, and as I have never yet received a sixpence in fees or dividends, I am exactly in the same position as he is. I regret there being no dividend as much as he does, and more, because I feel the responsibilities of a Director. I am extremely sorry at the way things have turned out. When this Company was formed, a very intelligent friend of mine—who, I am sorry to say, is now dead—said to me: "You have an excellent Board, and very good prospects; but you won't make any money for three years." I said to him: "You are an encouraging person, certainly." And he replied, "Well, that is my experience. I have had a large experience of telephony, and I find it takes a long time to make money in this kind of business." That has been our experience. We have worked against great difficulties, but I believe we are now surmounting them. Promises I cannot make; I can only express my hope and belief that we are now on the point of paying dividends, and I think the fact that we show a profit for the past year, although small is, at any rate, encouraging (Hear, hear).

Col. WYNDHAM MURRAY, M.P., remarked that it was foreshadowed at the last meeting that there would be a dividend to divide this year. As that statement had not been carried out, he thought it would be an advantage if the Chairman could say upon what grounds he based his anticipation. He did not wish to impute blame to anyone in the matter. He also wished to draw attention to the fact that when he bought his shares it was stated that the Company had been realising 24 per cent. upon its capital, and that there was a possibility and probability of an increase in the percentage. He thought that was a point which required some explanation.

The CHAIRMAN: I have just looked at what I said last year, and undoubtedly it is true that I did then anticipate our being able to pay a dividend this year, and I am just as much disappointed as anyone else that we are not able to do so. There have been great difficulties to contend with, one of which must be obvious to anyone, namely—that the fixed expenses in a business like this at the commencement are always very large in proportion to the business done. You cannot keep them down beyond a certain point, and at the same time ensure efficiency. That has been our experience, and we did not have the amount of business up to September 30, 1892, that we anticipated last year. We have done our best, and we have had excellent management, which is everything. I never felt more satisfied with the management of the business than now. I greatly fear holding out anticipations for the coming year, because, as has been seen to-day, if I say a word of hope which is not realised, I shall be found fault with. At the same time, I must say that I feel we are in a better position—a great deal better—than we were in a year ago. I cannot prophesy what will be the fruits of the current year, because I am unable to tell what fluctuations may arise. With regard to the statement in the prospectus alluded to, it must be borne in mind that that statement was perfectly true, as far as the capital then involved in the business was concerned. There can be no question about that, and it would not surprise me in the least if similar results are obtained in years to come; but it is a different thing to pay interest on a small capital like that in the business at that time than on the larger capital which we now have. One of my colleagues just reminds me that if you look at the share list you will find a large proportion of the shares is held by the Directors and their friends, so that our interests and yours are identical. This is not a concern in which the Directors are making money at the expense of the shareholders; in fact, we are in a worse position than the shareholders, because, for all our trouble and labour in connection with the Company, we receive no reward. But we have worked in your interest and our own, and I hope and believe we shall succeed.

The motion was then agreed to unanimously.

The CHAIRMAN then moved:—

"*That the appointment of Mr. Geo. F. Smart as a Director, Col. J. T. North and Mr. R. S. Waring having resigned their seats at the Board, be confirmed.*"

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Mr. GEORGE FLEMING seconded the proposition, which was carried.

Mr. WALTER CHAMBERLAIN proposed the re-election of the retiring Directors—Mr. William Fowler and Mr. George Fleming.

Mr. R. W. EDDISON seconded, and it was unanimously approved.

On the motion of Mr. Leon, seconded by Mr. George Fleming, the retiring auditors, Messrs. Cooper, Brothers, and Co., were re-appointed.

The proceedings then terminated.

The following is the report above referred to :—

The Directors announce that there has been again an increase in the volume of business done, as compared with the previous twelve months, with the result that this year a small profit has been earned. The business is steadily growing, and the Directors believe will show continuous development with increasing profits as time goes on, more especially because a larger turnover reduces the average charge for general expenses, an item which is always disproportionately heavy in a new business ; meanwhile, good orders in different departments have continued to come in since September 30th.

The actual capital of the Company has, unfortunately, proved insufficient for its requirements, and the Board therefore, in May last, authorised an issue of Debentures to the amount of £10,000. Of this sum, £5,500 has been taken up, chiefly by the Directors themselves, after full opportunity of subscribing was given to each shareholder. This amount has sufficed for the present, but the employment of a still larger working capital will be necessary before any considerable development of the business can be suitably met. The Directors believe that such an increase would be justified by the results

Colonel J. T. North and Mr. R. S. Waring having ceased to be Directors, Mr. Geo. F. Smart has been chosen to fill one of the vacancies thus occasioned. The retiring Directors, Mr. William Fowler and Mr. George Fleming, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers and Co., offer themselves for re-election.

Mr. A. E. MAYOR, the General Manager of the Company, reports :—

"In reviewing the progress of the Company for the past year it is satisfactory to note an increase in the volume of business. The electrical industry, however, has not escaped the prevailing depression, and our turnover has not yet reached a figure which would fully employ the resources of the works and staff. A brief *résumé* of the principal work completed during the year will sufficiently indicate the extent of the Company's operations, and the direction in which further developments may be confidently anticipated. In my last report I referred to our contract for mains with the London Electric Supply Corporation—this has been extended, and we are still delivering large quantities of high tension concentric conductors for their system in London. We secured the contract for, and have now completed, the extensive underground electric light system at Exeter, and have at present a similar contract at Brighton. A number of Irish towns have been cabled on our system, and we are carrying out the contract for the electric light mains of a large town in Sweden. Negotiations are well advanced for similar contracts in this country. In general electric lighting work our manufactures have met with increasing favour, and have been in several instances specified for specially difficult conditions, to the exclusion of other systems.

"In telegraphy, the railway companies continue to employ our various types of telegraph cables, and we have now in hand a contract with the Secretary of State for India. This has been placed with our Company after prolonged tests and experiments by the officers of the Government in India, who have satisfied themselves as to the high value of our insulating material in resisting the deteriorating effects of the heat and moisture of the Indian climate. We are justified in expecting that this contract will be followed by the further application of our cables for electrical work in hot climates where permanent efficiency cannot be secured with rubber or gutta-percha.

"Recent enterprise in telephony has stimulated the manufacturers to special exertions in the production of cables suitable for the transmission of telephonic currents over long distances, and notable advances in this direction have been made within the last few years. Since the organisation of the Company's factory at North Woolwich, this important work has been the subject of constant experiment and investigation, and we are now manufacturing long-distance telephone cables of the highest efficiency. It is satisfactory that the resources of our works, and the perfection of the machinery and appliances, have enabled us to undertake, and successfully to complete, large contracts both in this country and abroad for the new type of cable.

"Notwithstanding the preliminary difficulties which always beset a new industrial undertaking, and the exceptionally keen competition which we have had to meet from the beginning of our business, the constantly growing demand in every branch of electrical engineering, and the high favour with which our manufactures have been received, foreshadow the early success of the Company."

Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited).

The third annual ordinary general meeting of the shareholders of this Company was held on the 23rd inst. at the City Terminus Hotel, under the presidency of Mr. J. Jepson Atkinson.

The SECRETARY (Mr. J. Shurmer) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, at the outset of my remarks I would like to remind you that ours is a syndicate company, formed not for carrying on industrial operations, but for the sale of our patents in foreign countries, and that the value of our assets therefore largely depends on the success of the subsidiary Companies so formed. I need hardly remind you that in the three years of the Company's existence we have met with no little success, inasmuch as we have disposed of several of our most important patents, and have paid back in dividends the whole of our priority share capital. The accounts which are before the meeting are plain, and do not require much explanation, except, perhaps, a word in regard to the market value of our assets. At the end of last year the value of these assets was considerably higher than it is at the present moment, but it is in accordance with the usual practice to show such investments at cost price in the balance-sheet, whether they be at a discount or at a premium. I am convinced that in the course of the coming year the market value of these assets will very materially improve. It is the intention of the Board to have the accounts for 1892 prepared immediately upon the expiration of the present year, and to meet the shareholders with the same not later than February next. The year 1891, which is now under consideration, did not see the formation of any new Elmore Companies, and the year, as mentioned in the report, has been one of establishment and development of existing Elmore factories. I feel exceedingly loath to venture upon prophecy or more promises in regard to the position and prospects of this or of any of the Elmore Companies, but, Gentlemen, I cannot refrain from assuring you most emphatically and deliberately, after further close and personal experience of the working of the Companies since we last met you, that notwithstanding the seeming failures and the many disappointments that have beset our path, yet the coming year will be one of substantial prosperity to the manufacturing Companies from a shareholder's point of view. We have to admit that we have, no doubt, been too sanguine in respect to the length of time required to overcome the difficulties of starting and developing a new business, aggravated as they have been in one case by the smallness of the working capital available ; but these difficulties are now removed and the Elmore process to-day is perfectly successful on a commercial scale, and I am certain that as a consequence our own assets will considerably improve, and as a further consequence we shall be able to dispose of other of our unsold patents. We have refrained from alluding in our report to the new operations of the Company during the present year, as it is our intention, as I have already said, to meet you again very shortly ; but I may here say that we have during the present year had to very largely assist the French Elmore Company financially, our advances to them being secured by mortgage at interest. The wisdom of this policy cannot be better seen than by looking at the undoubted success which that Company has now achieved at its Works, and which could not have been achieved but for the assistance we have rendered them, and thereby we have secured an established value to our very large stake in the French Elmore Company in the shape of shares and debentures, which would certainly have been practically wiped out had any financial disaster occurred to the French Company. Not only so, but in helping to make the French Company a commercial success we have also been doing good service to the other Elmore Companies. It would have been a great pleasure to the Directors to have found themselves again in the position of declaring a dividend of 100 per cent. to the priority shareholders, but, as stated in the report, we hope to be able to do this in the course of 1893 ; and if you ask me on what grounds I think it is possible, I reply that I honestly believe and know that the Elmore process is perfectly successful, and that, consequently, with proper management, the Companies themselves will be successful, thus enabling us to realise our investments for considerable sums in cash, and at the same time enabling us to dispose of other of our patents. Only this week we had a firm offer of a substantial sum in cash down for our ordinary shares in the French Company. This we have declined, as we do not consider it good enough, in view of the assured financial and industrial position which the French Company now really occupies, and it was to give that Company time to attain to this position that we have reluctantly deferred our meeting until so late in the year. As before stated, however, we intend to publish the 1892 accounts within the next few weeks, and now that the funds required by the French Elmore Company have been arranged for, I have every reason to believe that between now and our meeting in February next the value of our investments, as shown in the balance-sheet, will have considerably improved above the price at which they stand to-day. We shall be happy to answer any inquiries from the shareholders. I will now propose :—

"*That the accounts and report, as submitted to this meeting, be received and adopted.*"

Mr. JOHN MACFARLAN seconded the motion.

General FIFE inquired what quantity of finished work the French Company now put out per week.

Mr. INVERARITY said he would propose as an amendment :—

"*That the report and accounts be not passed.*"

He did not, he said, propose the amendment in any captious spirit, but in order that the rights and privileges of the priority shareholders should be defined and laid down at that meeting. He regretted very much to see that those rights and privileges had been seriously invaded, if not damaged, by the Directors in making large loans to the French and German Companies.

The SECRETARY stated that nothing had been lent to the German Company by the Company.

Mr. INVERARITY said he believed that £5,000 had been lent to the French Company, and, in addition to this, £50,000 was last year and the year before lent to the French Company, which, he believed, had not all been realised. He maintained that these advances to the French Company were illegal, and beyond the power of the Directors to make. Clause 110 of the Articles of Association said that the priority shareholders should be entitled to all profits up to 100 per cent., and there were no reservations to that. This laid down for the priority shareholders

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clear privilege. Another clause stated that "the rights and privileges of the shareholders shall not be affected or dealt with except under an extraordinary resolution passed at a general meeting." No such meeting had been called, and no such resolution had been passed by the shareholders. The money had, therefore, been lent by the Directors on their own responsibility, and, therefore, he maintained that such loans were absolutely illegal. What he desired to know was, how far it was intended to go in this direction. They might be asked to assist in a similar way other companies. Ten per cent. interest had also been guaranteed by the Directors on £200,000 of preference shares in the French Company, and the interest was guaranteed out of this Company's profits, and without the shareholders' consent. He warned the Directors that he held them individually and collectively responsible for any loss he might sustain. The Directors ought to have called the shareholders together, under Article 6, and have asked them for power to lend money to the French Company, when, no doubt, they would have given the requisite authority. Then, he did not grudge the Directors their fees, but, under the 54th clause of the Articles of Association, it was stated that the remuneration of the Directors should be settled at that meeting. The remuneration charged in the accounts had not been settled at the metting, and this matter was also illegal.

After a few remarks from Mr. Nias and Lieut. Philips,

The SOLICITOR stated that the 22nd Clause of the Memorandum of Association was as follows :—"To lend money to such persons and on such terms as may seem expedient, and in particular to customers of, and persons having dealings with, the Company, and to guarantee the performance of contracts by members of, or persons having dealings with, the Company," and so on. Then, with regard to the question of the Directors' remuneration, Clause 72 laid down that the Directors were entitled to take up to £1,500 a year. Both those acts were, therefore, legal ; but he desired them to understand that he said nothing whatever as to whether they were judicious or injudicious. The Memorandum of Association, he reminded them, overrode the Articles.

Mr. FREDERICK L. RAWSON (a Director) observed that the real point in regard to the assistance which had been rendered to the French Company was not a question of law, but of expediency; but if the Directors had acted wrongly they must be held responsible.

Mr. SIMPSON stated that on the debit side of the accounts there appeared to the credit of the Company £9,000, as investments given as security for a loan to the French Elmore Company, and the entry added "as *per contra*." There was no debit, practically, at that time at all against this, and if the Directors had parted with these securities, why did they give themselves credit for them among the assets? Then, comparing 1891 with 1890, there was a "leakage" of about £30,000 in the value of the French and German securities held. In 1890, too, they had cash at the bankers' amounting to £37,691, whereas in the balance-sheet now presented to them, up to December 31, 1891, there was the remarkably small sum of £726. He wanted to know what had become of the difference, for he could see nothing in the accounts to show where it had gone to. The certificate of the auditors did not certify that the accounts were correct, but merely that they tallied with the Company's books ; and the certificate was dated the 5th of April last. Why, therefore, were not the accounts presented to them until eight months later? The securities were valued at eight times their market value. He regarded the balance-sheet as erroneous with respect to the points he had mentioned, and he considered it a farcical document as any practical guide to the position of the Company. He seconded the amendment.

Mr. SWEETING inquired the amount which had been received from the sale of the American patents, and the amount to be received.

A SHAREHOLDER asked for an explanation of there being only four Directors mentioned on the present report compared with eight at their last meeting, He also spoke of the dwindling down of the assets.

Mr. F. L. RAWSON, in reply, at the request of the Chairman, said he desired first to deal with the main policy of the Company, as that was really the pith of the whole matter. If the Directors had done anything wrong, it was in respect to the main policy of the Company. He, therefore, desired to put before them the position they were in at the end of last year and during the beginning of this year, because that was when the policy was determined. At that time they were all in great expectation. There had been a meeting of the English Elmore Company, when they understood that the works were turning out large amounts, and were about to turn out still larger amounts and to pay big dividends. At the time in question they were all "expecting to become millionaires in a very short time." He had not been able to be present at the beginning of their meeting, but he supposed that the Chairman had informed them that, with respect to the actual Elmore process, they had not been mistaken, and that where they had all been wrong was in regard to the general organisation of the Elmore business, which had not at all been satisfactory. Their own Company at the time in question were in this position: that they held a large amount of securities ; in fact, nearly all their assets consisted of shares in the different Elmore Companies, the remainder of their assets being patents for working the Elmore process in various countries. Patents were things which could be sold if things went all right, but if they went wrong they could not be sold ; and patents were of no use unless they had money to work them. At the time referred to they found that the French Elmore Company—it was of no use disguising the matter—were very "hard up," and the question was whether that Company was going to fail or not. In his opinion, speaking as an expert, if the French Company had failed, he believed the whole of the Companies would have failed. He spoke as an expert with a thorough knowledge of the subject, and he did not believe that there would have been an Elmore Company alive at the present time if the French Company had failed. They must remember that the English Company had not only at that time not borne out the statements it had made, but had nothing like borne them out. All the Elmore Companies were "hard up" at that time, except their Company, which had a certain amount of money. The French Company came to them and said, "We are going to fail unless you lend us some money." As the shareholders might imagine, they led to long and anxious consultations among the Directors at the beginning of the year, and, so far as he was concerned, he found himself in one of the most difficult positions he had ever been in. The question was, how were they going to pull the French Company through while that Company was getting over their initial difficulties? He discussed the matter with nearly all the large shareholders, and eventually the conclusion come to was that the best thing would be to lend the French Company a certain amount of money, taking the security they had, which was a second charge on the property after the £50,000 of debentures. The decision was arrived at with considerable anxiety, because he knew that if the matter went wrong he would be generally condemned, and that if it went right no one would thank him. He advised the Board technically, telling them, "If you do not find the money there will be a smash all round, and your position as the Foreign Elmore Company is that you may be able to distribute a small amount of money on your priority shares. I also advise you that if you find this money the French Company may be able to get enough money to pull the thing through." The Directors cross-questioned him as to his opinion, and he gave them facts and figures. They afterwards lent the money to the French Company, which was saved, and then the question arose, how were the French Company to get the rest of their money. He believed that at the beginning of this year the French Company had to get £90,000, and this seemed a Herculean task. What took place was this, that the French Company borrowed a certain amount from this Company on a second mortgage, and this Company helped them by lending them securities, the French Company becoming debtors to them. They lent securities to the French Company on which the latter could borrow money, whereas they could not borrow on their own credit. If it had not been for a mistake which the French Company made at the beginning of January, this Company would have got their money back ; but the French Company made the fatal mistake of letting people know their financial position. One of the shareholders had asked why the Directors had not called a meeting of the shareholders to get authority from the latter to lend the money to the French Company, but if they had done this they would have made the same mistake which he thought the French Company had made, in allowing people to know what their financial position was. The sole reason why the Elmore shares went to the high prices they were once quoted at was because people believed so strongly in the Elmore process. He himself bought 1,000 Elmore shares at $8\frac{1}{8}$ and 1,000 at $7\frac{1}{8}$—not as a speculation, but in the belief, which he shared with the other Directors and their friends, that they would make a fortune out of it, as they imagined that they had such a good thing. The fact was that they had made a mistake in not allowing sufficient time in their calculations for the development of the thing, but had been under the impression that everything would be all right in six months or nine months. As he had said, the French Company made a fatal mistake in letting their financial position be known. Their shares were at $2\frac{1}{2}$ $\frac{3}{4}$, but within twenty-four hours they fell to under 2, when it was "good-bye" for the chances of that Company getting the money they required, which he believed they could otherwise have obtained. This Company held £60,000 in the shares of the French Company, as well as debentures ; and why they helped the French Company was that, in his opinion, it was the only company at the time that could save them, the English Company being so slow in getting to work. If there had been a smash-up at the time, this Company could not have sold their patents, and the shares which they held would have been worthless. He thought, therefore, that they would probably agree with him when he said that, under the circumstances, they had done right in assisting the French Company by lending them money. They took legal advice on the proceeding, and they were told that if they genuinely believed they were going to pull the French Company through they would be acting rightly in assisting that Company, but not otherwise. The secretary reminded him that the amount lent was £35,000. The result of the course taken had been that the French Company had managed to pull through and pay their French creditors ; and he might inform them that the French law was very severe. He was informed that if a creditor were not paid at once an undertaking was sold up immediately. The French Company had paid off practically the whole of their French creditors. They had borrowed a certain amount from other people besides this Company ; and as to the placing of their Debenture stock, which was the real difficulty of the French Company, they had a contract with responsible people, and he was informed they had received £19,000 on account. They could, therefore, consider that the French Company were now through, and that all the difficutly and danger which their own Company had run was over. It did not matter much to them now if the French, or even if the English, Elmore Company smashed, because there were the returns of the French Company's working, which showed a steady out-turn of ten or eleven tons a week. This fact put this Company in an altogether different position in regard to the American and the other patents which they held. They had now people coming to them who were prepared to buy the Russian patents. They had had an offer for the Belgian patents, but they had declined it. They had not given a guarantee on £200,000 of the preference shares of the French Company ; they had limited it to a smaller amount, and on the later preference shares they had given no guarantee. In his opinion the French Company would not have got the £19,000 that he had referred to, unless this Company had given them their guarantee. When they lent the money to the French Company they got a good rate of interest for it as well as a bonus, and the bonus would more than cover anything which they might have to pay under their guarantee. With regard to the question of the Directors' fees he believed that they had taken £1,500. They had a certain amount of interest in the Austrian Company, their shares in which, however, would not become of any value worth mentioning until

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hat Company made profits, and until the Austrian Company got a sufficient amount of capital to turn out a decent quantity of stuff. He advised the Austrian Board not to endeavour to get their capital until the French Company had emerged from their difficulties, pointing out that the latter Company was the key to the whole position. They would have gathered from what he had said, the reason why the Directors had not called that meeting earlier—namely, that if they had had their meeting, and it became known that the French Company was in the position he had stated, the latter could not have got their capital. The other Directors had resigned their positions on account of personal differences, but one of them had had to leave because of his official position, and another of them, Mr. William Elmore, had resigned because the Directors of the English Company had insisted on his giving all his time to the work of that Company in Leeds.

The CHAIRMAN remarked that Mr. William Elmore resigned his position on the Board of this Company, because he thought it would not be right for him to draw remuneration from the Company while he was away.

Mr. RAWSON observed that that was a very good reason also; but he had been given to understand that the new Directors of the English Company had stated that they would have nothing to do with the Company unless Mr. William Elmore gave his whole time to it. He would be quite contented as an expert to see a regular output of 10 tons a week by the French Company, because he knew that with such an output established it would be no more difficult to turn out 20 tons, or, for that matter, 100 tons. An output of 12½ tons ought to pay expenses, but the works were laid out for turning out 80 tons a week. The French Company gradually increased their output up to 14½ tons a week. They then made arrangements for getting out their debentures, when the whole thing fell through, for the reason he had stated, and for a short time they had not the money to buy the copper to put into the tanks. He had recently seen one of the *employés* of the French Company, who had informed him that directly they got the money they required their out-turn would be 18 tons a week. What the Americans wanted was to see 20 tons a week turned out. As to whether this Company would help other companies in the future. he did not care to take such a responsibility as to lend them money, and he would be glad if the shareholders would take this responsibility off his shoulders. On December 31, 1890, their securities stood at £178,000, and there were sundry creditors £47,000, who had been paid off out of investments which the Company had held. At the date mentioned there were sundry debtors £22,000, securities £178,000, and cash in hand £37,000, making a total of £237,000; but the sundry creditors had been reduced from £47,000 to £5,000, and deducting this £42,000 from the £237,000 the difference was worked out.

Mr. PIXLEY, one of the auditors, explained the question regarding the item in the accounts of £9,000 referred to by Mr. Simpson.

Mr. RAWSON, continuing, stated that the cash they received for the American patent had been lent to the French Company.

A SHAREHOLDER: How much?

Mr. RAWSON: £35,000. That is the total amount we have lent, and we have saved the French Company with it. There is about £200 more to receive.

Mr. INVERARITY inquired whether, if the shareholders passed the accounts, the Directors would agree to lend no more money until the next annual meeting.

Mr. RAWSON said that they certainly would. Was he, however, to understand that the meeting would authorise the Directors to lend their securities, which were paper securities, in order to help the other Companies?

Mr. INVERARITY: No. (Voices: No, no.)

The CHAIRMAN said that he gathered that the amendment was withdrawn. (Voices: No, no.)

Mr. RAWSON: The amendment is a direct negative.

The SOLICITOR: It is not an amendment; it is only voting against the resolution.

The CHAIRMAN then put the resolution which he had proposed to the meeting, when 23 voted for it and 22 against it. There being some misunderstanding, he submitted the motion again, and announced that the numbers in favour of it were 28, and against it 22. He, therefore, declared it carried.

Resolutions were afterwards passed re-electing Mr. F. L. Rawson to his seat at the Board, and re-appointing the auditors.

Oxford Electric Company (Limited).

The annual general meeting of this Company was held at the offices, 45, Broad-street, Oxford, on the 9th inst., Sir Henry Mance presiding. The Company has supplied us with the following particulars:—

Mr. GEORGE OFFOR (General Manager and Secretary) having read the notice of meeting,

The CHAIRMAN explained that no accounts could be presented, as they would have to be made up in accordance with the Act of Parliament to December 31st, after which they would be audited by the Board of Trade and presented to the shareholders as early as possible in the spring. He took the opportunity of congratulating the shareholders upon the satisfactory progress of the Company since the opening of the works on June 18th last, the Corporation, the University, and the citizens generally having supported the Company in a very practical manner, and started them on what promised to be a most prosperous career. A contract for street lighting had been entered into with the Corporation for three years upon profitable terms to the Company; the current had also been introduced into seven of the Colleges, viz., Brasenose, Hertford, University, Trinity, Balliol, St. Mary Hall, and Magdalen. An agreement had been entered into for lighting St. John's College throughout, which would be completed during the Christmas vacation. In addition to the above, the theatre, some of the hotels and banks, and many of the leading commercial establishments had been supplied, the number of places connected with the Company's mains being upwards of 70.

With the election of the auditor, and a vote of thanks to the Chairman, the proceedings terminated.

Edinburgh Electric Supply Corporation (Limited).

The annual meeting of this Corporation was held at 17, St. Andrew-square, Edinburgh, on Friday last, Mr. Walter Berry presiding.

The Managers (Messrs. George Deas and Co., C.A.) submitted the third annual report, which stated that the interest taken in the electric lighting of Edinburgh is daily gaining strength, and there is a strong feeling in favour of supporting a financially strong and locally influential Corporation such as this, which the citizens of Edinburgh have themselves formed. Judging from present appearances, certain portions of this city will be lighted by electricity before this time next year; and the Directors have every reason to hope that this Corporation will be employed by the Town Council to carry out the work.

The CHAIRMAN, in moving the adoption of the report, said that when he addressed them on the occasion of their second annual meeting he said that they were unable to report any progress towards a definite realisation of the object for which the Corporation was formed. He had, to some extent, to repeat the same story that day, but with the satisfactory addition that their fate must very soon be decided; for the Town Council, which had to determine if it would undertake the electric lighting of Edinburgh on its own account, or delegate the authority to others, had recognised that the operations to enable it to comply with the conditions laid down by the Board of Trade must be commenced forthwith. He did not think it probable that the Town Council would undertake the work themselves. They had plenty on hand, and were already overworked. He thought it most probable that they would entrust it to this Company—(1st), because of the local and representative position of their shareholders; (2nd) because of their unquestionable financial power; and (3rd) because their shareholders would be the most important consumers, and would have a paramount interest in seeing that the work was well and substantially done, with as little disturbance to the streets as possible. Their interest and those of the Town Council were in many respects identical. They should, of course, look for a fair return for their capital and risk, but to a certain extent their Company might be considered as co-operative. He had no authority from his co-Directors for giving an opinion, but personally he thought they were entitled to aim at 7 per cent. dividend on their shares. The Directors had never advertised for shareholders, or offered founders' shares or any other inducements, but, nevertheless, applications had come in, and they had now on their list 212 names, subscribing £32,775. The great majority of their shareholders had taken small preliminary holdings with the avowed intention of increasing their interests largely if the business was carried on, and he had no doubt that all the capital which they might choose to issue would be immediately absorbed when they were prepared to offer it. The Directors had met frequently during the year, and had given much attention to new developments in electric lighting both at home and abroad, and they were quite prepared, with the assistance of their consulting and acting engineers, to enter upon negotiations at any moment. He trusted that their patience would be rewarded, and that at their next annual meeting they should not only merit the congratulations of their shareholders, but the acknowledgments of a long-suffering public for thorough work performed. He would only add that they had as many conditional orders for installations promised as justified them in anticipating solid financial success.

Mr. JOHN M. M'CANDLISH seconded the motion. He thought the inhabitants of Edinburgh were getting very impatient on the subject of the introduction of electric lighting. They were behind many smaller towns in this matter. He also thought the public would not view with favour the Corporation taking the electric lighting into their own hands, but would rather see them making suitable terms with a Company such as this. Certainly no other Company had anything like the claim that they had on the Corporation.

The report was adopted, and thanks were given to the Directors for their gratuitous services.

Yorkshire House-to-House Electricity Company (Limited).

The first ordinary general meeting of this Company was held on Wednesday at Leeds, Mr. Grosvenor Talbot presiding.

The report, a copy of which has appeared in *The Electrician*, was taken as read.

The CHAIRMAN, in moving the adoption of the report, pointed out the great amount of work which had been performed by the present Directors. The prospectus was issued on March 26th, and by April 4th all the necessary requirements for the application of a Provisional Order had to be completed. It was, however, done, but only by the great exertions of the Directors, who held almost daily meetings. They obtained the Provisional Order, which gave them power to light with electric light the whole of the borough of Leeds. So far as he was able to ascertain, he was informed that they were not likely to be interfered with so long as they supplied a proper light. They had purchased a site in Aire-street which possessed very many advantages, one of these being that they were immediately adjoining their lighting area. The question of material was a very important one for them, and so far as this was concerned they had obtained very great advantages. They could obtain water from the river Aire, which only required filtering. They obtained this for nothing. By purchasing this site they had also dispensed with the cost of a central

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town office. Then they could have coal brought up to their works on the canal. They had 109 shareholders in the Company, who had taken up 7,298 shares. The capital which they possessed was quite sufficient to carry out the installation. Then came the question of system, and he was pleased to say that the system suggested by Mr. Hammond, their engineer, and which was working successfully in other parts of the country, had been adopted. This system, he was pleased to say, had been inspected by Mr. W. H. Preece, who had expressed his approval of it. All the plant was now manufactured, and ready for laying down at the works. Up to the present time they had applications for the installation of 8,000 8-c.p. lamps. When the works got fully going he had no doubt that they would have as many lamps to light as they could supply. The cables had not yet been laid all over the borough, but only the Headingley portion remained to be completed, and this could be done in a very short time. If it was possible for a company to make the supply of electricity pay, they would do so.

Mr. R. W. EDDISON briefly seconded the resolution.

Mr. R. W. HAMMOND, in supporting, pointed out the many advantages to be derived from the electric light, especially by shopkeepers. He intimated that the Leeds Corporation had power to purchase the works when they thought proper.

The resolution was carried unanimously.

Mr. Grosvenor Talbot and Mr. Robert W. Eddison, retiring Directors, were re-elected, and the proceedings terminated.

The General Electric Power and Traction Company (Limited).

The second general meeting of this Company was held at Winchester House, Old Broad-street, yesterday. The notice calling the meeting stated that:—

"Owing to the protracted illness of the Secretary, the accounts cannot be got ready in time for the meeting, but the above meeting will be adjourned until an early date in January, when the accounts will be submitted. The business will be purely formal."

The meeting was held *pro formâ*, and adjourned to January 31, next, without discussion.

NEW COMPANIES, STATUTORY RETURNS, &c.

AFRICAN TRANS CONTINENTAL TELEGRAPH COMPANY (LIMITED).—This Company was registered on December 27th, with a capital of £140,000, in £1 shares, by Hollams, Sons, Coward and Hawksley, solicitors to the Company, Mincing-lane, London, E.C. The objects are to construct or procure the construction of telegraphs anywhere on the Continent of Africa; to construct or procure the construction of any other telegraphs in connection therewith, or which may seem, directly or indirectly, calculated to feed or develop the Company's telegraphs in Africa or elsewhere; to carry on the business of a telegraph, telephone, and electric light, heat and motive power supply company; in particular, to establish, work, manage, control and regulate telegraph and telephone exchanges and works for the supply of electric light, heat and motive power; to transmit and facilitate the transmission of telegraphic and telephonic communications and messages; to undertake the supply of electric heat or motive power for public or private purposes; to carry on any other business, calculated directly or indirectly to increase the value of the Company's property or connected in any way with electricity; to construct, lay down, carry out, work, sell, let on hire, and deal in telegraphs and telephones and all kinds of works, machinery, apparatus, conveniences and things capable of being used in connection with any of the foregoing objects, and in particular, cables, wires, lines, stations, exchanges, reservoirs, accumulators, lamps, meters, and engines, and to carry on the business of electricians, electrical contractors, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation and employment of electricity and the transmission of telegraphic and telephonic messages. The subscribers are:—

	Shares.
E. M. Euan-Smith, 253, Cromwell-road, S.W.	1
J. F. Jones, 25, Colfe-road, Forest Hill, S.E.	1
R. C. Bolton, Clifton House, Crouch End, N.	1
C. W. Chandler, 45, Hayter-road, Brixton, S.W.	1
A. E. Jowett, 12, Camp-road, St. Albans, Herts	1
M. O'Shaughnessy, 33, Upper Kennington-lane, S.E.	1
Edwin Pryer, Claremont, Alston-road, High Barnet	1

Registered without Articles of Association.

AUTOMATIC GEM AND GOLD SEPARATOR SYNDICATE (LIMITED).—This Company has been registered with a capital of £1,000, in 1s. shares, to acquire, develop, and turn to account certain inventions of W. S. Lockhart, of 67, Granville-park, Blackheath, S.E. (who is appointed managing Director), relating to the separation of gold, and gems from other substances by means of electricity or otherwise.

BRISTOL AND KINGSWOOD ENGINEERING AND BOILER COMPANY (LIMITED).—Thi Company has been registered with a capital of £15,000, in £1 shares, to carry on the business of boiler makers, mechanical, electrical and general engineers, &c., carried on at Bristol under the style of "W. Pope and Co. and Batt and Phillips." The Directors include G. J. T. J. Parfitt, of Keynsham, Bristol, electrical engineer.

JAMES CHESTERMAN AND COMPANY (LIMITED).—This Company has been registered with a capital of £75,000, in £100 shares, to carry on the business of manufacturers of and dealers in engineers' tools, callipers, gauges, &c., and as mechanical, electrical, and general engineers, at Bow Works, Sheffield.

W. POPE AND SON (LIMITED).—This Company has been registered with a capital of £12,000 in £10 shares, to acquire the business of mechanical and electrical engineers carried on at Slough, by W. Pope and Son, and to develop and extend the same.

TINKERS' (LIMITED).—This Company has been registered with a capital of £50,000, in £10 shares, to carry on the business (among other things) of copper workers, steel converters, iron and steel plate manufacturers, iron and steel cable makers, electricians, and electrical, mechanical, consulting and general engineers, at Newton Hyde, Cheshire.

ALUMINIUM COMPANY (LIMITED)—The annual return of this Company, made up to November 17th, has been filed. The Company was registered on June 18, 1887, with a capital of £400,000, divided into 60,000 "A" and 20,000 "B" shares of £5 each, to acquire from Webster's Patent Aluminium Crown Metal Company (Limited) the patents of Mr. Jarvis Webster for the manufacture of alumina, aluminium and other metallic alloys, and also the patent rights of Mr. Hamilton Y. Castner, for the manufacture of sodium and potassium. At the time of making-up, all the shares had been taken up, and the 20,000 "B" shares issued as fully paid. Upon the 60,000 "A" shares, the full amounts have been called and all calls (£300,000) paid. The principal shareholders include the Right Hon. Arthur J. Balfour, M.P., and Gerald W. Balfour, M.P.

DAN RYLANDS (LIMITED).—The annual return of this Company, made up to December 12th, has been filed. This Company was registered on September 14, 1888, with a capital of £130,000, in £5 shares. The capital has since been increased to £275,000, divided into 20,000 ordinary and 35,000 preference shares of £5 each. 16,617 ordinary and 25,965 preference shares have been taken up, and 4,000 ordinary and 1,980 preference shares have been issued as fully paid. Upon the remaining 12,617 ordinary and 23,985 preference shares the full amounts have been called, resulting in the payment of £183,010.

NATIONAL ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to December 9th, has been filed. The Company was registered on October 28, 1889, with a capital of £100,000, divided into 100 founders' and 199,000 ordinary shares of £5 each, to supply electricity generally. At the time of making up, 100 founders' and 10,425 ordinary shares were taken up, and the full amounts called, resulting in the payment of £51,920, and leaving £705 in arrears.

SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to December 13th, has been filed. The Company was registered on May 19, 1882, with a capital of £1,000,000, in £5 shares, to acquire the patents of Mr. J. Wilson Swan relating to electric lighting. At the time of making up, 78,949 ordinary and 19,750 fully paid shares have been taken up. Upon the 78,949 ordinary shares, £3. 10s. per share has been called, resulting in the payment of £279,851 10s., a sum of £3,530 has been paid on 1,201 forfeited shares, and £98,750 has been considered as paid on the 19,750 fully-paid shares.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended December 25th were £927, as against £871 for the corresponding period of last year, being an increase of £56. The total receipts for half-year amount to £21,584, against £19,457 in the corresponding period of 1891, being an increase of £2,127.

COMMERCIAL CABLE COMPANY.—The general offices in London of this Company have been removed from 18, Bishopsgate-street Within, to Bishopsgate House, 55 and 56, Bishopsgate-street Within, E.C.

CROMPTON AND CO. (LIMITED).—The Directors of this Company have declared interim dividends for the six months ending September 30th last at the rate of 7 per cent. per annum on the preference shares of the Company, and at the rate of 5 per cent. per annum on the ordinary shares.

CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED).—The annual general meeting of this Company was held at the registered offices, 4, Great Winchester-street, on Wednesday the 21st inst., Mr. Robert M. Meyer presiding. Mr. George Offor having read the notice of meeting, the Chairman announced that no accounts could be presented until about the month of March, as the Act of Parliament required them to be made up to December 31st and subsequently audited by the Board of Trade. The only business transacted was the appointment of J. D. A. Norris, Esq., as auditor for the ensuing year.

ELECTRICITY SUPPLY CORPORATION (LIMITED).—This Corporation notifies that the 5 per cent. interest payable to debenture holders on the 1st January next will be payable at the Union Bank of London on presentation of the coupons.

ELMORE'S PATENT COPPER DEPOSITING COMPANY (LIMITED).—The share register of this Company is closed till January 1st next, as are also the share registers of the Wire Manufacturing Company (Limited) and the Foreign and Colonial Copper Depositing Company (Limited).

ELMORE'S WIRE MANUFACTURING COMPANY (LIMITED).—We understand that the report of the Directors of this Company announces that ample working capital has been provided for, that the works are completed

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and have been furnished with a large supply of raw copper, and that practical operations have commenced. We have been unable to obtain a copy of the report from the secretary of the Company.

STOCK EXCHANGE QUOTATIONS.—The Stock Exchange Committee have ordered the £125,000 Four and a-Half per Cent. Perpetual Debenture Stock of the Brush Electrical Engineering Company (Limited), and the further issue of £94,100 Four per Cent. Mortgage Debenture Stock of the Eastern Telegraph Company (Limited), to be quoted in the Official List.

QUEEN ANNE'S MANSIONS LIGHTING AND HEATING COMPANY (LIMITED).—This Company notify that the coupons due on January 1st on the Six per Cent. Mortgage Debentures will be paid at the National Provincial Bank of England on and after that date.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Dec. 23, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,254.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 21.	Price Wednesday, Dec. 28.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 28. Highest.	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	49½ 50½	50 51	4 18 0	Jan., Apr., July, Oct.	..	..
£2,876,140	Stock	25/0	Do. Preferred	91 92	91¼ 92	5 16 4	" "	91⅜	91⅛
£2,876,140	Stock	5/0	Do. Deferred	10½ 10⅝	10½ 10⅝	..	" "	..	..
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	10⅜ 11¼	10⅜ 11¼	5 15 7	Mar., June, Oct., Dec.	11	..
£68,200	£100	5%	Do. 5 per Cent. Bonds	101 104	101 104	4 16 2	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	106 110	106 110	4 10 11	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175 180	175 180	3 17 9	Jan., Apr., July, Oct.	177	..
16,000	10	8/0	Cuba Submarine	11⅛ 12⅛	11⅛ 12⅛	6 19 2	February and August	..	..
6,000	10	10%	Do. Preference 10%	17⅛ 18⅛	17⅛ 18⅛	5 8 1	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2½ 3½	4 11 5	April and October..	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅛ 11⅜	11⅛ 11⅜	6 3 4	Jan., Apr., July, Oct.	11⅜	11⅛
400,000	10	2/6	Eastern	14⅜ 14⅞	14⅜ 14⅞	4 7 5	" "	14⅞	14⅛
70,000	10	6%	Do. 6 per Cent. Preference	15¾ 16¼	16 16¼	3 5 5	" "	..	..
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109 112	109 112	3 11 5	May and November	111	..
£200,000	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	14⅜ 15	14⅜ 15	4 13 4	Jan., Apr., July, Oct.	14⅛	14⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	111½	110
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs. 1900	104 107	104 107	4 13 6	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103 106	103 106	4 14 4	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	103 106	3 15 6	February & August	..	..
180,227	10	1/3	Globe Telegraph and Trust	9¾ 10	9¾ 10	4 15 0	Jan., Apr., July, Oct.	9⅞	9¾
180,042	10	6%	Do. 6 per Cent. Preference	14⅞ 15⅛	14⅞ 15⅛	3 19 4	" "	15 1/16	15
150,000	10	5/0	Great Northern	19½ 19¾	19½ 19¾	4 6 1	Jan., April, and July	20	19½
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104 107	104 107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	44 46	44 46	5 8 8	May and November	44½	..
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108 111	108 111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October..	..	..
3,381	£100 Cert.	30.0	Submarine Cables Trust 6%	116 120	116 120	5 0 0	" "	119	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	102	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	104 108	104 108	7 8 2	June and December	..	..
88,321	10	6d.	West India and Panama	1⅛ 1⅜	1⅛ 1⅜	..	" "	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10 10½	5 14 3	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8 9	8 9	6 13 4	" "	..	..
£30,000	100	5%	Do. 5 per Cent. Debentures, 19.7	105 108	105 108	4 12 7	June and December	..	..
64,242	15	3/0	Western and Brazilian	7 7½	7 7½	6 0 0	" "	7⅛	..
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5½ 5⅝	5½ 5⅝	6 10 4	" "	5⅝	5½
33,129	7½	4/6	Do. 5 per Cent. Deferred	1½ 2	1½ 2	..	" "	1⅜	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106 109	106 109	5 10 1	February & August	..	..
€237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106 109	106 109	5 10 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
€173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
22,,850	14/0	1½d.	Consolidated Telephone Const. & Maintenance	15/16 1 1/16	15/16 1 1/16	7 16 5	May and November	..	..
220,000	£1	4½d.	Oriental (11s. paid)	15/16 1 1/16	15/16 1 1/16	7 18 2	Yearly	..	..
454,747	5	2/6	National	4¼ 5	4¼ 5	6 0 0	June and December	4⅛	4⅛
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 15	14 15	4 0 0	" "	14⅜	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13⅜ 14¼	13⅜ 14¼	4 4 3	" "	..	..
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	4¼ 4½	4¼ 4½	..	" "	..	..
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112 114	112 114	..	January and July ..	114	..
48,000	£10	..	New Telephone, Limited (£4 paid)	4⅜ 5	4⅜ 5	..	..	..	..
58,000	5	1/0	United River Plate	2¾ 3¼	2¾ 3¼	..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	10¼ 10⅜	10¼ 10⅜	..	..	..	..
20,000	£10	..	Do. 6 per Cent. Preference	5 5½	5 5½	10 18 2	..	..	..
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	5 5¼	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	1½ 2½	.. ..	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5½	.. ..	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	6 6½	.. ..	..	January and July ..	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	3 3/16 3 1/16	3 3/16 3 1/16	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 5/16 5 7/16	5 5/16 5 7/16	..	March	..	..
111,000	5	..	London Electric Supply	3/8 1/2	3/8 1/2	..	..	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	..	6⅞	..
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	103¼	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	..	..	..	..
18,680	£5	2/6	St. James' and Pall Mall	7¾ 8¼	7¾ 8¼	..	..	..	..
7,900	£5	7%	Do. 7% Preference	8¼ 8¾	8¼ 8¾	4 0 0	..	..	..
42,858	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 10 0	..	5⅞	5½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/9⅜	Brush Electrical Engineering	3 3½	3 3½	..	..	..	..
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2⅛ 2⅜	5 1 1	..	2⅜	..
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July ..	5 7/16	..
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	1⅜ 2¼	.. ..	..	..	..	..
45,000	10	12/0	Electric Construction	2½ 3	2 2½	..	..	2⅜	2¼
70,000	2	10/0	Elmore's Patent Copper Depositing	¾ 1	⅝ ⅞	..	..	¾	..
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½ 22½	21¾ 22½	5 11 1	February & August	22	21¾
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/9 4/3	3/9 4/3	..	..	..	..
78,949	5	4/2⅔	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July	46⅔	45½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103 106	103 106	4 14 4	January and July	..	..
..	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	..	..	..	..
..	£5	8%	Do. Preference (fully paid)	¾ 1½	.. ..	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
£50,000	£10	..	City and South London Railway	.. ..	.. ..	..	..	..	..
600,000	Stock	½%	Do. Stock	35 38	35 38	..	..	..	..

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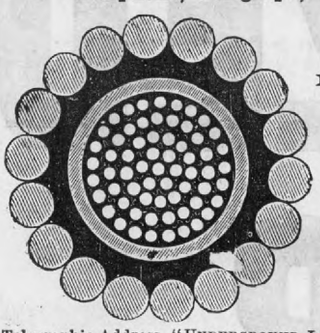

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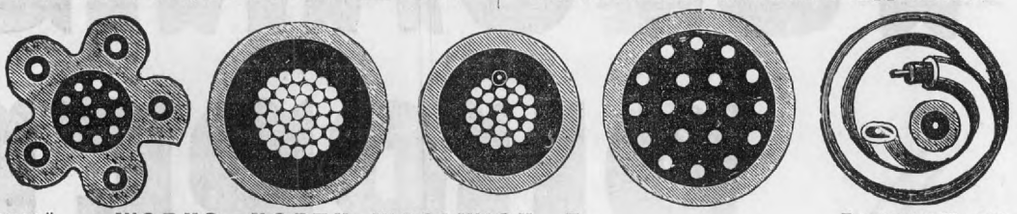

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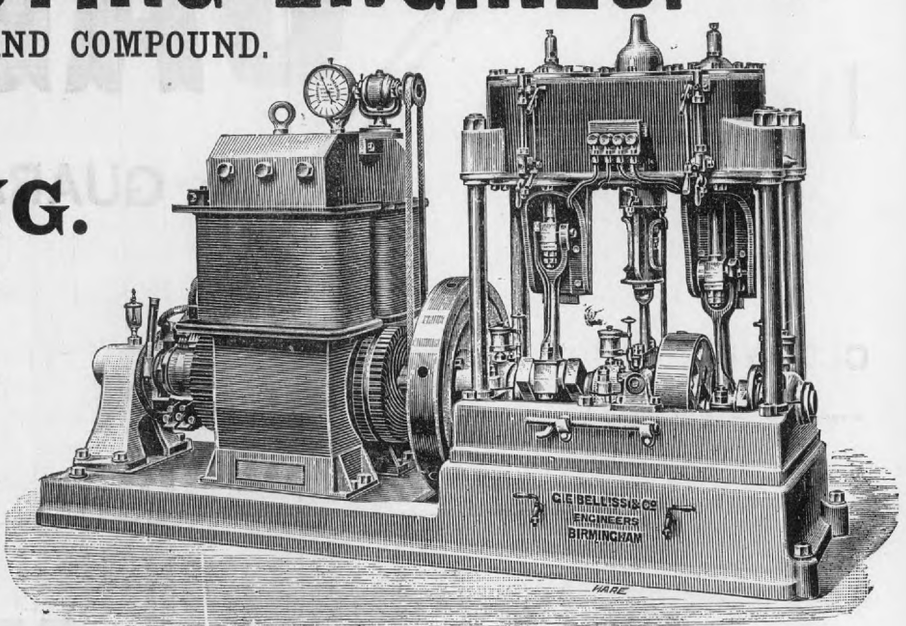

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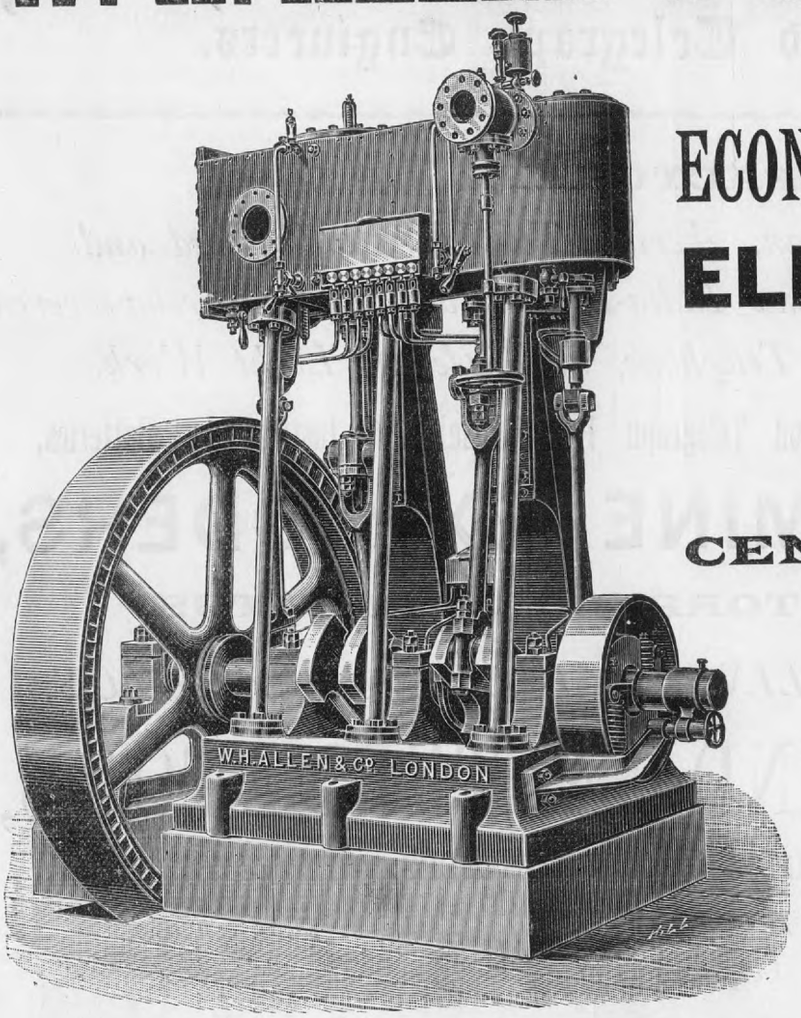

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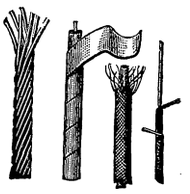

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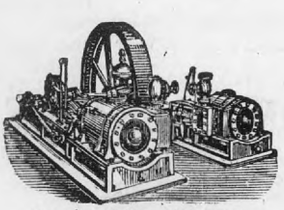

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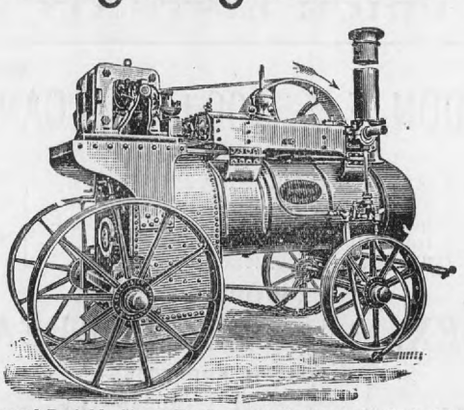

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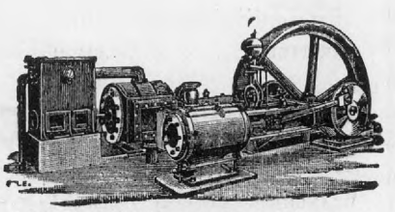

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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NOTES.

In accordance with our usual custom, we publish in our first issue of a new year, various statistical tables, showing the state of different branches of the electrical industry. That such tables have a real value is evident, from the compliment which other journals have done us by following our custom. To draw up and send out circulars full of inquisitive interrogations is no difficult matter, but the result may be a sheet on which blank spaces are more numerous than the entries with which the table is supposed to be filled. To take a bundle of ready-made accounts, and to attempt to tabulate them, may result in a confusion of cross brackets, due to diversity in the form of such accounts. We have always endeavoured to restrict our annual tables to such details as may be reasonably expected from those to whom our inquiries are addressed, and when we hear from a secretary that "the lot of papers and forms sent from one source and another asking for information and wanting immediate reply would tax the resources of a large staff of clerks," we feel that we are not to blame; and it is not until we hear from another that "filling in replies to such queries as yourselves and others address to us costs both time and money, and we have not much to spare of either," that we begin to regret the compliment to which we have referred. Certain tables are printed in our columus as soon as is possible after the information has been published. The list of electric lighting provisional orders granted was thus given in our issue of September 30th last, and our analyses of the returns made by the London Electricity Supply Companies to the Board of Trade were given on July 8, 1892.

The amalgamation of the New Telephone Company with the National Telephone Company raises the question of the status of "The Association for the Protection of Telephone Subscribers." An agreement with this Association was entered into by, and was recorded on the prospectus of, the New Telephone Company. It was natural that this Association should have hailed with satisfaction the advent of a company which proposed to reform the greatly-grumbled-at service which is afforded in London, and the New Telephone Company, tempted by the considerations offered by the Association—viz., the suspension of negotiations with the Post Office, and the handing over *en bloc* of 1,700 members as a nucleus for future subscribers—promised certain concessions, amongst which a £12. 12s. rental was a prominent feature. In a letter to the Press, on behalf of the Association, it is asked: "If the improvement, extension and cheapening of the telephone, which has become a commercial necessity, has been crippled by the over-capitalisation of the existing monopoly, what benefit will the public derive from the strengthening of that monopoly, by the extinction of its only present competitor, at a cost of an addition of one million sterling to the capital on which telephone renters have to furnish by their subscriptions adequate interest?"

The discussion which has followed Mr. Human's letter on earthing the middle wire has been remarkable for its suggestiveness, rather than for useful information or definite addition to our knowledge. In his reply this week, Mr. Human clears up one or two misunderstandings, and reviews some of the correspondence. In our comments on his first letter, we remarked that we had hitherto refrained from advocating this system, since it appeared that the matter was hardly ripe for decision, or even for discussion. The subject divides itself into two sections, and the landmark between them is legally known as "the consumers' terminals." Our correspondents have considered the consumers' side, for the reason, no doubt, that central-station engineers, having mains in their charge under slightly different conditions, find that their experiences do not agree; we hope, on a future occasion, to record some of these.

It is hard to imagine what a dynamo or an arc lamp would be like if the air, instead of being an insulator, were a conductor; but a moment's thought is enough to show how important the passive properties of air are to electricians. Mr. Tesla, in an article we publish this week, maintains that, under certain exceptional circumstances, the air by no means possesses the convenient properties usually assigned to it. With alternating currents of great rapidity, it appears not only that the distribution of the current is altered in consequence of the "skin effect," but that the air near the conductors receives and dissipates part of the energy of the current. Some of the experiments Mr. Tesla mentions are very remarkable, although none of them are quantitative, and no definite conclusion can be drawn from them. The amount of energy which various air motions actually represent would be an interesting matter to find out, but we are not aware that anyone has yet measured the energy of a musical sound, or of any less regular air disturbance.

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M. VIOLLE has communicated to the *Comptes Rendus* some interesting notes on the temperature of the electric arc. In an abstract which we print in another column, it will be found that he corroborates by spectro-photometrical observations the well-recognised view that the intrinsic brightness, and therefore temperature, of the arc is a constant. The chemical theory of the monomolecular and polymerised constitution of carbon makes the extraordinary latent heat of carbon vapour rational, for the watts expended or the volts lost at the incandescent surface of the positive carbon are thus accounted for, not only by the physical change of state from solid to vapour, but by a simultaneous change in the chemical constitution of the carbon.

THE results of M. VIOLLE'S calorimetric tests must be received with caution. His result agrees with that of ROSETTI, and confirms the extrapolated temperature which we ventured to deduce from the experiments of Profs. DEWAR and FLEMING. But M. VIOLLE appears to assume that the temperature of his button of carbon was not only constant throughout its mass, but that that temperature was the important one which he desired to measure. Careful observation of the crater of an arc shows that at the part of the surface at which volatilisation is taking place, this high temperature is only superficial. A sudden interruption of the current is followed by an apparently instantaneous fall of temperature, and a sudden diminution of the current is immediately followed by a very interesting development of flocculent patches of light, which quickly coalesce into a smaller crater. Theoretical considerations, moreover, indicate that since volatilisation takes place apparently from the solid without the intervention of the liquid state, only a mere layer of indefinite tenuity can take part in volatilisation, and it is highly probable that only an extremely thin layer of carbon is raised to the high temperature of volatilisation.

WE alluded some little time ago to the fact that the City of London Electric Lighting Company anticipated that they would be able to lay the fog fiend—or, at any rate, mitigate the terror of him—by an arrangement with the Dock Committee and others to send the Company timely warning of the approach of a fog bank. The idea showed some initiative, though we ventured to doubt the efficacy of the measures proposed, in view of the suddenness and sporadic distribution of a London fog. The condition of things which obtained on Wednesday last, for instance, was calculated to outwit the most elaborate organisation: Kilburn, dense mist; Hampstead, bright sunshine; Camden Town, fog; Broad-street, clear; Fleet-street, a villainous compound of mist and soot!

To put an eight-candle lamp into each boot while dressing in this weather is a great luxury, but not an expensive one. Boots being tolerably adiathermanous, the temperature soon rises, and on the right side of the soles. Those who are not early risers, and who do not provide their servants with electric light in the basement, will do well, when there is no fog, to connect the lamps in series, since if no other lamps are on, the meter will probably fail to start. But if it does, the cost will not exceed about one-twentieth of a penny, five minutes being ample, the cost of a week's boot-warming being, therefore, under a halfpenny.

Cardiff.—Acting under the advice of Mr. W. H. Massey, the Town Council have decided to adopt an alternate current transformer system of distribution at a cost of £32,500.

Earthing the Middle Wire.—According to *L'Industrie Electrique* the Compagnie Continentale Edison have earthed their middle wire for more than a year with satisfactory results.

Kimberley Exhibition.—The Kimberley Exhibition was formally closed by the Mayor on the 8th ult. The Exhibition has not been a financial success, the accounts showing a deficiency of £14,000.

Hull.—The municipal central lighting station is to be formally opened on the 16th inst., by the Mayor. On the following day, the Mayor will open an Electrical Exhibition in the Sessions Court, Council Chamber and Library.

Heckmondwike.—At Monday's meeting of the Local Board a recommendation of the Electric Lighting Committee to empower the clerk to take the necessary steps for obtaining the sanction of the Local Government Board to the electric lighting scheme was approved.

The Electric Lighting of Malta.—Mr. W. H. Preece arrived at Malta on Friday last from London to confer further with the local Government on the proposed installation of the electric light. He was accompanied by Prof. George Forbes and Mr. Henry Edmunds.

Southport.—The Town Council has by a large majority resolved to reject a £15,000 scheme for developing the foreshore, and has adopted instead an enlarged scheme estimated to cost £20,000. The adopted scheme embraces amongst other items an electric tramway.

Institution of Electrical Engineers.—At the next meeting of the Institution on Thursday, the 12th, the discussion on Dr. Fleming's Paper will be resumed. In consequence of the unavoidable absence abroad of Mr. Preece, the new President, he will deliver his Inaugural Address on the 26th inst.

India-rubber.—The following is an extract from a Reuter's telegram received from the Imperial British East Africa Company from Mombasa :—" The india-rubber season has been very good, notwithstanding the drought, and the customs returns from this product have been unusually large."

Bewdley.—Bewdley, a quiet, old-fashioned town of less than 10,000 inhabitants, has appointed a committee to make inquiries as to the utilisation of the river Severn for electric lighting purposes, notwithstanding that one member of the Town Council rudely characterised the whole idea as " bosh."

Preston.—At a recent meeting of the Town Council, Alderman Hibbert drew attention to the electric light pillars that were being put down in Fishergate. He objected to the character of the castings, and said they were not such that any municipality ought to be satisfied with. They were " coarse ness itself.

Prime Movers for Electrical Engineering.—A course of 12 practical lectures on this subject will be delivered at the School of Electrical Engineering, 12, Prince's-street, Hanover-square, W., by Mr. E. Tremlett Carter. The course will commence on Tuesday, January 17th. For further particulars see our advertisment columns.

Obituary.—The death is announced of M. Amédée Guillemin, a popular science writer. He was born at Pierre (Saône-et-Loire) in 1826, was educated at Beaune and Paris, taught mathematics, and then adopted journalism, and in 1861 began a series of popular treatises on astronomy and physics.

The Electric Transmission of Power.—The Compagnie de l'Industrie Électrique are laying down a 365 H.P. transmission of power plant at the Biberist paper mill, in the canton of Soleure. The fall from which the power is obtained is 17½ miles distant. Two Thury generators, arranged in series and

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coupled direct to Escher-Wyss turbines, supply current at a pressure of 6,800 volts. The plant will be ready by March.

Coast Communication.—In the interim report which the Royal Commission on Coast Communication has drawn up it is recommended that five lightships and a certain number of rock lighthouses shall be connected with the coast by telegraph cable. Those places will be selected which furnish the best opportunities for testing the possibility of such communication, and at the same time reveal the extent to which it is likely to be valuable in saving life or property.

Cable Interruptions and Repairs:

Cable.	Interrupted.	Repaired.
Penang-Medan.....	December 1, 1892	December 17, 1892.

Cables actually interrupted.	Date of Interruption.
Cayenne-Vizeu	September 24, 1892
St. Thomé-Loanda	November 24, 1892
Senegal-Pernambuco	December 27, 1892
Mozambique-Laurenço Marques	January 5, 1893

Institution of Civil Engineers.—Monday last was the seventy-fifth anniversary of the Institution of Civil Engineers, which was established for the advancement of mechanical philosophy, and which ten years later was incorporated by Royal Charter under Great Seal. It consists to-day of 5,122 corporate members, 389 associates and 830 students, together 6,341. —At the last meeting of the Institution, before Christmas, the Council Room was brilliantly illuminated with glow lamps, and other parts of the building were being wired for electric light.

The Electric Lighting of South Kensington.—A provisional agreement has been entered into, subject to its confirmation by Parliament, by which the Chelsea Electricity Supply Company agree to sell and transfer to the Kensington and Knightsbridge Electric Lighting Company all the rights and powers obtained by them in 1889 for the electric lighting of South Kensington. The sum to be paid by the Kensington and Knightsbridge Company for these rights is £7,000, and the transfer is to take place within one month after the agreement has received Parliamentary confirmation.

Association for the Improvement of Geometrical Teaching. —The general meeting of this Association is to be held at University College, Gower-street, on Saturday, January 14th, at 11 a.m. and 2 p.m. After the conclusion of the formal business, Mrs. Bryant, D.Sc., will give "A Model Lesson on Geometry, as a basis for discussion," and papers will be read by Mr. G. Heppel, M.A., on "The Use of History in Teaching Mathematics," and by Mr. F. E. Marshall, M.A., on "The Teaching of Elementary Arithmetic." All interested in the objects of the Association are invited to attend.

Telephone Wires.—At a recent meeting of the St. Helens Paving Committee an application from the Liverpool Corporation for permission to erect ten telephone poles along the Rivington-road was read. The borough surveyor thought the wires should be put under ground, and thought it time that the National Telephone Company, whose trunk wires in St. Helens are overhead, should put them under ground. It was decided that permission should be given, subject to the Liverpool Corporation removing the poles if required by the St. Helens Corporation, and notice was given of the intention of the St. Helens Corporation to have in the near future all telephone wires under ground.

The South Staffordshire Electric Cars.—On Saturday last the electric system of the South Staffordshire Tramway Company was opened with no little ceremony. The invited guests included the Bishop of Lichfield, the Mayors of Walsall, Wednesbury, and West Bromwich, and the members of the governing bodies of the district, the Chairman and Directors of the Company, the Directors of the Electric Construction Corporation, the electric equipment contractors. The new cars have since Saturday been extensively patronised by the public, but on Tuesday morning the trolley wire at the junction of Park-street with the Bridge, Walsall, snapped, causing a temporary disarrangement of the service.

Cheltenham.—The adjourned discussion on the report of the Electric Lighting Committee recommending the adoption of a scheme for the introduction of a high-pressure system of supply, and deferring for the present the question of lighting the streets with electricity, was resumed at the meeting of the Town Council on Monday last by Mr. Waghorne, who moved an amendment referring the matter back to the Committee, with a request that they should take further professional opinion upon the scheme recommended by the Committee on the advice of the borough surveyor and Prof. Ayrton. Mr. Norman, Chairman of the Committee, eventually accepted the amendment, which was agreed to.

Presentation to Mr. C. E. Spagnoletti.—A meeting was held at the offices of the Great Western Railway Company's Telegraph Department, on the 28th ult., to present Mr. C. E. Spagnoletti with a testimonial upon his retirement from active service. The presentation consisted of an illuminated address and several articles of plate, subscribed for by the members of the Telegraph and Electric Light Departments. The chair was taken by Mr. H. T. Goodenough (Mr. Spagnoletti's successor), who, in requesting Mr. Spagnoletti to accept the gift of the members of the department, claimed for Mr. Spagnoletti the title of "Father of Railway Telegraphy." Mr. Spagnoletti, after thanking the staff, gave a brief *resumé* of his career, with special reference to the history and development of railway electrical appliances.

Electrolytic Action in Condenser Tubes.—Some brass condenser tubes in the U.S. cruiser "Baltimore," after being in service for a year or more, were, says *Engineering*, found to have experienced a peculiar change. In many places the metal was changed to almost pure copper, of a spongy texture, the zinc having completely disappeared. An investigation showed the probable cause of the failure to have been an electrolytic action between the tin lining of the tubes and the brass, the sea-water circulating through the condenser forming the electrolyte. Had the tin-coating remained perfect, no corrosion would have resulted; but the mud and grit carried in suspension through the condenser cut away the tin-coating in spots, and it was at these spots that the change of the metal occurred. It was concluded that if the tubes had not been tinned at all they would have remained intact.

The Electrical Utilisation of Water Power in Japan.—The Japanese are apparently determined to extract the maximum of use out of their public works, if the Kioto Canal is any criterion. The total length of the canal is $6\frac{7}{8}$ miles, and in its short course it passes through three tunnels. At a distance of $5\frac{1}{4}$ miles from Lake Biwa the canal is divided into two parts, one being practically continuous at the same level as the main portion, and the other being at a level of 118ft. below. The upper branch is used entirely for irrigation purposes, while the lower branch receives all the boat traffic from the upper main canal. Instead of having a succession of locks from the upper to the lower levels, a cable railroad has been built to connect them. The water from the upper canal is led through three 36in. pipes, 1,300ft. long, to a power-house, and is delivered to a set of Pelton water-wheels at a head of 100ft. These wheels supply the power for the cable road, and also drive dynamos which supply current in Kioto for all sorts of purposes.

The Effect of Electrical Excitation on Salivary Secretion. —In a Paper recently communicated to the Académie des Sciences (*Comptes Rendus*, Tome CXV., No. 24, page 1,103), M. Wedensky describes in considerable detail some experiments carried out by him with regard to the influence of amperage and frequency on the secretions of the submaxillary gland. A first series of experiments showed that the best frequency for provoking secretion was about 40, and that the longer the current was applied the lower did the best periodicity become. Starting with a frequency considerably below the best, the curve rises slowly and almost in a straight line, and finally turns over (100-250 $\sim$) and becomes parallel to the abscissa. In a second series of experiments, the frequency was varied during one and the same application. By decreasing the frequency the gland, which had previously ceased to secrete, could be made to do so again, and even for a time renew secretion at a higher frequency. Much the same result was obtained by altering the current. There was a considerable time lag between the alteration of the irritant cause and the corresponding alteration of the secretory effect.

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The Bressa Prize.—By the will of Dr. Cesare Alessandro Bressa, a sum of money was left to the Royal Academy of Sciences of Turin, for a prize to be given at intervals for the best scientific work written, or the most important discovery made, during the preceding period of four years. It is now announced by the Academy that the last term of four years closed on December 31st, 1890, when the prize was secured by Prof. Hertz, and that a new term, dating from January 1, 1891, to December, 31, 1894, is now in progress. Scientific men and inventors of all nations may compete. The prize is worth 10,416fr. Those who desire to compete must declare their intention of doing so within the time above mentioned, by means of a letter addressed to the President of the Academy, and must send the work which they offer for adjudication. The work must be printed; manuscripts are not considered. The works of unsuccessful competitors will be returned to them, when asked for, within six months from the awarding of the prize. The last paragraph of the notice issued by the Academy on the subject of this competition states that:—"The Academy gives the prize to the scientific man considered most worthy of it, even if he has not presented himself at the competition."

The Glasgow Tramways.—A sub-committee of the Glasgow Town Council have published their report on the different modes of tramway traction. The sub-committee state that they have gone carefully into the offers for a complete system of overhead trolley electric traction to be worked from one central station. The routes cover about $6\frac{1}{3}$ miles of double track. The Committee conclude from the offers that a substantial and complete installation, including cars for a six-minutes service and equipment of lines, would cost about £10,000 per mile of double track, exclusive of ground. A complete equipment for horse traction on a similar service could be put down for £5,000 per mile of double track. The cost of a cable system is set down at about £20,000 per mile of double track. The Committee state that while they clearly recognise the advantages of electric traction, they are, at the same time, fully alive to its disadvantages and the difficulties which would have to be faced in the event of its adoption. Taking everything into consideration, they are of opinion that the inducements it offers, as compared with horse traction, are not sufficient to justify the acceptance of any of the offers for an electric installation. At the same time they would recommend that the further development of all forms of electric traction be carefully followed. The cable system is to have further special consideration by the Committee.

Brussels.—As we recently stated, the electric lighting contract between the India Rubber, Gutta Percha and Telegraph Works Company of Silvertown, is at last signed. The following particulars of the plant to be employed in the pioneer station may be of interest:—The chief feature in the scheme lies in the plan of distribution, the cables *throughout* being insulated with vulcanised india-rubber, and run in separate cast-iron pipes. The station, when finally completed, will have six units of 500 H.P. each, any one unit, if required as a reserve, or for exceptional loads, for a short time being capable of working up to 625 H.P. The battery of accumulators will eventually be increased to 1,250 16-c.p. lamps normal capacity. The site of the station is on that at present occupied by the Eglise Ste. Catherine, Place Ste. Catherine, near the Boulevard Anspach. The church is to be removed by February next. The boilers are safety multitubular, with 226 square metres heating surface each, with pumps and economisers complete. The engines are two horizontal, compound, condensing Sulzer type, by Carels, of Ghent, 500 H.P. effective, each capable of working up to 625 H.P. effective, if required. The four dynamos are slow speed multipolar machines, rope driven, two to each engine. The distribution is on the three-wire system. The station is to be in complete working order by October next. The current is to be sold by meter, and the Silvertown Company are to work the station for two years after delivery to the satisfaction of the town.

Electric Traction for Railways.—Amongst the Foreign Abstracts published by the Institution of Civil Engineers we note an abstract of a Paper by a German engineer named Bork, who appears to have a very high idea of the future of electric traction as applied to railways. Electrical machines with a high-pressure current have, he says a far higher efficiency than locomotives, allowing 10 to 17 per cent. loss in transmission. Further, at high speeds, electric traction is much more efficient than locomotive traction, *e.g.*, to drive a train at a speed of 50 miles per hour up a gradient of 1 in 200 by electricity requires only half the energy that it does in the case of locomotive traction. He estimates that a stationary engine will only require 1·76lb. of coal per I.H.P.H., against 3·3lbs. in the case of a locomotive. For passenger and express trains with a speed from 30 to 50 miles per hour, the author makes out that only 60 per cent. of the energy required in the case of locomotive traction is needed by electric traction. The author then shows the gain of electric traction over locomotive traction for express service by supposing a train of 60 tons travelling at 50 miles per hour on a gradient of 1 in 200, which would need 548 I.H.P. for locomotive traction, and 280 I.H.P. for electric traction, or a gain of 51 per cent.; for a speed of 33 miles per hour, the gain is 69 per cent., or a mean gain of 60 per cent. for an average speed of 42 miles per hour. Cost of loco-traction per 1,000 miles, £33·7; cost of electric traction per 1,000 miles, £22·4; gain $= \frac{22{\cdot}4}{33{\cdot}7} \times 100 = 66$ per cent. Taking into account the interest on capital, depreciation, &c., together with the increased frequency of the trains and their greater speed, we have a gain over the present system of $\frac{23{\cdot}5}{33{\cdot}7} \times 100 = 70$ per cent. The author concludes by advising the construction of an experimental line, or section of a line for which he gives full details as regards costs, and so forth.

Impending Electric Railway Patent Litigation.—It appears from a circular recently issued by the General Electric Company says the *Electrical World* of New York, that it is on the warpath in earnest in endeavouring to obtain control of the electric railway field. Owning as it does the inventions of Edison, Thomson, Van Depoele and Sprague, who are recognised as the creators of the modern electric railway, it certainly appears to stand some chance of covering the field quite effectually. The circular gives the list of lawsuits which the Company has instituted against electric railways in different parts of the country on whose roads some devices are used for which the General Electric Company claims to have the patents. Among the subjects of the pending suits are the following:—The under-running trolley, covered by four patents of Van Depoele, dating from 1889 to 1892, the latter especially being claimed to be a "broad patent for under-running, upward-pressing contact trolley;" electric motor trucks, covered by three patents of Sprague, the earliest dated 1885, covering motors which are sleeved on the axle and supported by springs at the other end, also for individual motors for separate axles; duplicate controller switches at opposite ends of the car, reversing motor and regulating resistance of motor circuit, a recent patent of Sprague; trolley having constant pressure with pole at varying angles, an early patent of Van Depoele; arched suspenders for electric railway trolley wires, three patents of Van Depoele; lightning arrester, Thomson's patent, 1885; constant potential regulation by a compound dynamo, Edison's patent, 1882; overhead switches and arched suspender and pull-off for trolley wires, five patents of Van Depoele. The circular concludes with the statement that the Company believes that all the apparatus and devices employed in the modern electric railway are broadly covered by these patents, and that the Courts will so determine them. There is little doubt that if the Courts do decide all these cases in its favour, the General Electric Company will have a practical monopoly of the electric railway interests for some years to come, as there appears to be little left for anyone to use in the construction of an electric railway which would not come under one or the other of these patents. For the present we will reserve our opinion as to the probable outcome of these suits. That the fight will be a bitter one is not at all unlikely, and perhaps, as in some other cases, it will last about as long as the remaining life of some of these patents.

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ELECTROMAGNETIC THEORY.—XLII.

BY OLIVER HEAVISIDE.

(*Continued from page 241.*)

§ 178. Using the same kind of point-source, let it act intermittently and alternatingly; say, on positively for an interval α, then off for an interval β, then on negatively for an interval α, followed by off for an interval β, and so on recurrently, like positive and negative applications of a battery with dead intervals. The result is, by the last case, to divide the spherical space occupied by the disturbances at a given moment into concentric shells, of depths $v\alpha$ and $v\beta$ respectively. In the latter is no disturbance, since they correspond to the dead intervals. In the former are the steady displacements appropriate to their distance from the source, consecutive shells being positive or negative according to the state of the source when they started from it. On their boundaries are electromagnetic sheets generating these steady states continuously on one side, and destroying them on the other.

Next, do away with the dead intervals, so that the applied force is like that of a common reversing key, first positive of full strength, and then negative of full strength, but without any interval. The result is to completely fill up the sphere of disturbance, the successive shells of depth $v\alpha$ containing steady fields—alternately positive and negative—being brought into contact, and only separated from one another by the electromagnetic sheets. This may be considered rather an unexpected result. Our impressed force is periodic, but expresses the extremest form of variation, namely discontinuities, and is only expressible simple-harmonically by an infinite series of simple-harmonic forces of all frequencies from zero to infinity. But only when the impressed force varies is electromagnetic disturbance generated, so that when in the above manner we confine its variations to be momentary, the electromagnetic disturbances are also momentary, with the consequent result that we have our dielectric occupied by quite steady states of displacement separated by infinitely-thin electromagnetic shells. The latter travel. The steady states also appear to travel, but do not really do so. They are being continuously generated and destroyed at their boundaries, but are quite steady elsewhere.

If the impressed force vary simple-harmonically instead of discontinuously, the result is less simple. We find that there is no clean separation into steady states and electromagnetic waves, the two being mixed inextricably. We can see this by substituting for the simply periodic variation of the force a very great number of constant forces of small duration and of different strengths, so as to roughly imitate the simple-harmonic variation. Every discontinuity in the force will behave in the way described, and the final result of the superimposition of effects, when we proceed to the limit and have continuous simple-harmonic variation of the force, is a train of simple-harmonic waves proceeding from the source. They are not pure electromagnetic waves, and there is no steady state anywhere. The wave-length λ is given by $\lambda = v\tau$, where τ is the period of the impressed force, or the reciprocal of the frequency. The electric and magnetic forces are simple-harmonic functions of the time everywhere, right up to the extreme wave-front of the disturbance, where, of course, is an electromagnetic sheet following a different law. But should the source occupy a finite spherical space, then the bounding sheet becomes a shell, of depth equal to the diameter of the sphere, as before described. Now the steady fields become insensible at a great distance in the discontinuous case; to correspond with this we have the fact that the simple harmonic waves tend to become pure as they expand. The greatest departure from the pure state is round about the source. Here the frequency becomes a matter of importance. When very low, the wave-length is great, and we should, therefore, have to go a great distance to find any sign of wave-propagation. Moreover, the waves themselves would be exceedingly weak. Only round the source is there sensible disturbance, and it is practically the steady displacement appropriate to the momentary state of the source, accompanied by a weak state of magnetic force connected with the displacement nearly in the instantaneous manner. That is, the time-variation of the displacement is the electric current, and the displacement itself is sensibly that of the static theory. Under these circumstances there is next to no waste of energy.

But by increasing the frequency we can completely alter this state of things. For we increase the rate of change of the impressed force, and therefore the strength of the electromagnetic waves generated, for one thing. Besides this, we can bring the region of electromagnetic waves nearer to the source, and so contract the region in which the displacement was approximately static as much as we please. In the limit with very great frequency we have nearly pure electromagnetic waves close up to the source. The waste of energy increases very rapidly with the frequency, varying as its fourth power with simple-harmonic waves. The extremest case of waste is that of a discontinuity, already mentioned, as when setting up the steady state we waste half the work done, and then, when the force is removed, waste the other half.

§ 179. When the sphere of impressed force is of finite size, another effect comes into view of a somewhat striking character, of which the theory of a point-source gives no information. By increasing the frequency sufficiently, we shall reduce the amplitude of the external vibrations, and on reaching a certain frequency depending upon the size of the sphere, they will entirely vanish. That is, at a certain frequency, a simple harmonic impressed force, acting uniformly within a spherical space in a dielectric, produces no external effect whatever. The vibrations are stationary or standing, and are purely internal, or confined to the sphere itself. By general experience of statical problems this would seem to be impossible. But we must expect to find strange manners when we go into strange lands.

This strange behaviour arises from the general electromagnetic property that the true source of disturbances due to impressed force (electric or magnetic) is the curl thereof. The impressed force itself, on the other hand, is associated with the supply of energy. (*See* § 87.) In the present case the surface of the sphere of impressed force is the seat of its curl, its intensity varying as the cosine of the latitude, if the polar axis be parallel to the impressed force; and consequently, as already described for the case of setting up the steady state, the electromagnetic waves proceed both ways from the surface at which they originate. The train of waves going inward contract, then cross at the centre and expand again. We have, therefore, two trains of outward waves, and the external effect may be imagined to be due to their superimposition. That they may sometimes assist and sometimes partly cancel one another, according to relative phase, may be readily conceived, and the theory indicates that at any one of an infinite series of definite frequencies there is complete cancellation externally. This refers to the simple-harmonic state. There is always an external effect initially, at any frequency—namely, the initial electromagnetic shell of depth equal to the diameter of the sphere of impressed force, because it consists entirely of the beginning part of the first outward wave, the second one only reaching to its rear; but on the inner side of this shell there may be no disturbance, except within the sphere of impressed force. The waste of energy is not continuous at the critical frequencies, but consists merely of the energy in the initial shell. The impressed force works continuously, but as much positively as negatively within a period, so that it is inactive on the whole.

Effects of the above described kind are principally remarkable from the contrast they present towards more familiar effects, especially those of a statical kind. The behaviour of electrification on a sphere may be taken as an illustrative contrast. We know that if we have a spherical surface in a uniform dielectric covered with electrification, the displacement is partly internal and partly external. Only when the electrification is uniformly spread does the displacement vanish internally, and become wholly external. This was formerly explained by the inverse-square law. Every element of electrification was supposed to exert force equably in all directions round itself, internally as well as externally, and a mathematical consequence of this is the complete cancellation of the internal force when the electrification

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is uniformly spread on the surface of a sphere. The same reasoning was applied when the sphere was not of the same nature as the external medium—when it was a conductor, to wit. Now the internal force is also zero in this case. Moreover, it is zero whatever be the nature of the internal material (without electrical sources). But it is certainly untrue that the electric force due to a point-source of displacement is the same in all directions around it when the medium is not homogeneous. So the reason for the absence of internal force is entirely wrong, although it seems right in one case, viz., that of homogeneity. The true, and sufficient, and comprehensive reason for the equilibrium, and the absence of internal force is the satisfaction of the second circuital law when the external electric force is perpendicular to the surface. This is independent of the nature of the internal matter, and is obviously to be preferred to a hypothesis that is only valid sometimes. Varying the internal material will make the law of spreading of force be different in any number of ways, and, if we like, different for every element of electrification, by arranging various kinds of heterogeneity. But independently of this, we might vary the law of force in many ways in special cases. Thus, in the case of a uniform spread of electrification on a sphere, we may imagine the displacement from any particle of electrification to radiate in any symmetrical manner that will give zero displacement inside and a uniformly radial displacement outside. The simplest case after the usual uniform spreading in all directions, is a planar spreading. Let every element of electrification on the surface send out its displacement in the tangential plane only, though equally in all directions in that plane. This will give the correct static result. It is not altogether a fantastic example, for we can make an electromagnetic problem of it by letting the electrified surface expand at the speed of light. Then the assumed law of spread is the actual law, for every element of electrification is the core of a plane electromagnetic wave. The resultant magnetic force due to all the waves, however, is zero, and the resultant electric force is as in the static problem. (See §§ 61 and 164.)

Now when we have vibrating electromagnetic sources on a spherical surface producing electromagnetic waves simple-harmonically, we also in general have both internal and external effects, for there is an internal as well as an external train of waves. But whilst they cannot cancel internally, they may do so externally. Here is one contrast with the static problem, and along with it is another, viz., that it is the nature of the external medium that is now indifferent (with a reservation), whereas in the static problem we have independence of the nature of the internal medium. The reservation hinted at is connected with the initial uncancelled electromagnetic shell. The external medium should allow it to escape, or absorb it somehow, so that it will not interfere with the effects under consideration. To regard the zero external effect as being actually due to the coexistence of two trains of waves which cancel one another is merely a mathematical artifice, however, because neither train of waves exists. If they did exist we should have to vary their nature to suit the constitution of the external medium, just as in the problem of static equilibrium we require different laws of force to suit the nature of the internal medium. The comparison of the static with the kinetic problems show a complete reversal of relations as regards nternal and external.

What we can do with a single surface electromagnetic source we can repeat with others inside it. We see, therefore, that the whole sphere of impressed force may be filled up with vibratory sources of the most vigorous nature without producing any (except initial) external effect, if their periods be properly chosen in relation to their situation, which problem admits of multiple solutions. This is suggestive as regards the stores of energy bound up with matter.

§ 180. In the above very little has been said about the distribution of electric and magnetic force from part to part of an electromagnetic wave. This varies greatly in different kinds of waves, and cannot be explained without the formulæ. But there is one very important property of pure electromagnetic waves (which also holds good, more or less approximately, in general) which may be described at present. As already mentioned, the electric and magnetic energies are equal in a pure electromagnetic wave. Now the density of the electric energy is $\frac{1}{2}cE^2$, if E is the electric force (intensity), and that of the magnetic energy is $\frac{1}{2}\mu H^2$. If we equate these, we obtain a relation between E and H. Thus

$$\frac{1}{2}cE^2 = \frac{1}{2}\mu H^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Also $$\mu c v^2 = 1. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Therefore $$E = \pm \mu v H. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The positive or negative sign depends on which way the wave is going. Disregarding this, the electric and magnetic forces have a constant ratio. They are therefore in the same phase, or keep time together in all their variations. Along with this, they have the property of being perpendicular to one another (that is, **E** and **H** are perpendicular, not E and H), and their plane is in the wave-front, or the direction of motion of the wave is perpendicular to **E** and to **H**. It is the direction of the flux of energy. These properties hold good in all parts of a pure electromagnetic wave, although the magnitudes and directions of the electric and magnetic forces may vary greatly from one part of the wave to another.

The above is also the state of things that obtains, more or less perfectly or imperfectly, in long-distance telephony over copper circuits of low resistance, and by lowering the resistance per mile we may approximate as nearly as we please to the state of pure electromagnetic waves. It is the self-induction that brings about this state of things, showing such a contrast to the more familiar relations between the electric and magnetic forces on circuits in general. Like a kind of fly-wheel, the self-induction imparts inertia and stability, and keeps the waves going. It is the long-distance telephoner's best friend who was, not many years since, spurned with contempt from the door. Some people thought there was a very absurd fuss made about self-induction, and that it was made a sort of fetish of; so, knowing no better, they poured much cold water on the idol. But, whatever opinions we may hold regarding their competence as judges, there can be no question about the stern logic of facts. Self-induction came to stay, and stayed it has, and will stay, having great staying power. Whatever should we think of engineers who declined to take into account the inertia of their machinery? There was also some considerable fuss made about a supposed law of the squares, or KR law as it was or is called, according to which you could not telephone further than KR = such or such a number, because the speed of the current varied as the square of the length of the line, or else inversely. But in spite of the repeated attempts made to bolster up the KR law, the critical number has kept on steadily rising ever since. I see now that it has gone up to 32,000. But it need not stop there. Make your circuits longer, and it will go up a lot more.

As regards the ether, it is useless to sneer at it at this time of day. What substitute for it are we to have? Its principal fault is that it is mysterious. That is because we know so little about it. Then we should find out more. That cannot be done by ignoring it. The properties of air, so far as they are known, had to be found out before they became known.

(To be continued.)

THE RATE OF PROPAGATION OF ELECTRIC WAVES IN AIR AND IN CONDUCTORS.*

BY ED. SARASIN AND L. DE LA RIVE.

In a former series of investigations on the propagation of Hertzian electric waves through air† we came to the conclusion that the rate of propagation of such waves through air was sensibly the same as along conducting wires. The beautiful experiment of Hertz, which we contented ourselves with repeating under almost identical conditions, consists, as is

* From the *Comptes Rendus*, December 26, 1892, p. 1,277, Vol. CXV., No. 26.

† *Comptes Rendus*, March 31, 1891, Vol. CXII., No. 13. Also *The Electrician*, April 10, 1891, p. 701, Vol. XXVI.

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known, in causing electric waves to impinge normally upon a large plane metallic surface, and in observing by means of a circular resonator moved along the normal to the centre of the mirror the interference of the direct and reflected waves. The metal shield which did duty as a mirror in our first investigations had almost the same dimensions as those of the shield employed by Hertz himself, *i.e.*, 2·8m. × 3m.; dimensions too small to allow of the observation of more than one node in front of the mirror with resonators 50cm. and more in diameter. We in-

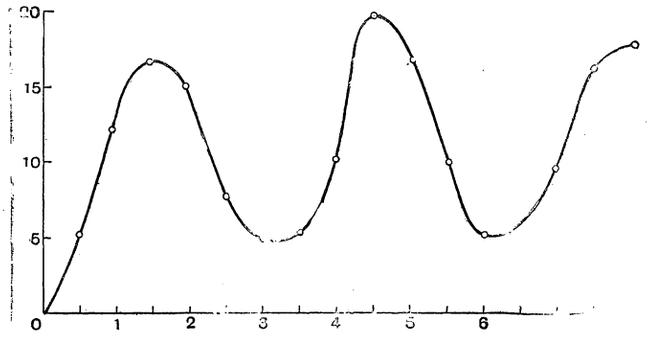

FIG. 1.

creased the size of our mirror as much as our laboratory permitted us to, making its breadth 5m., and in this way improved the experimental conditions for small circles of 35cms. diameter and less. We did not, however, get much advantage with larger circles. But the experimental demonstration of the equality of the rate of propagation in air and in wires was not altogether satisfactory in the case of large wave-lengths, and as Hertz* himself remarked, it was desirable that this should be done in a definite manner by experiments on a much larger scale, with a mirror of sufficiently large size to permit of the observation with a 75cm. circle of several interference nodes and antinodes. These conditions we have realised to the best of our ability in the course of a fresh series of researches, which we have the honour of presenting to the Academy to-day.

The great difficulty was to find sufficient room. Thanks to the courtesy of the Geneva Municipality, who placed at our disposal a still vacant space in the large turbine hall of the Geneva power works, we were enabled to do what we wanted. Against one of the walls of the building was placed a large metal screen, 8m. high by 16m. broad, consisting of zinc sheets 2m. × 1m. nailed over one another on a wooden frame. To

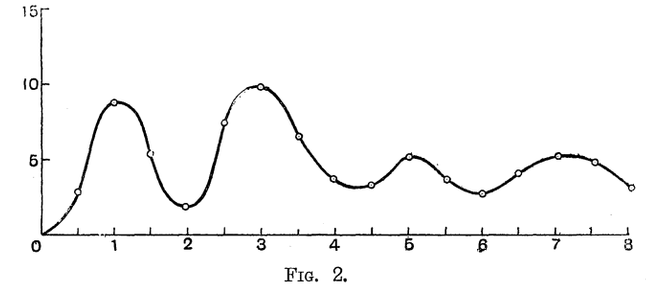

FIG. 2.

enable us to observe the secondary sparks along the normal to the centre of the mirror—that is to say, along a line 4m. from the ground—we erected in front of the mirror a bridge 10m. long and 1·5m. broad, supported on three wooden trestles, and surmounted by a light framework of laths covered with black paper, and forming a completely dark tunnel. In this dark-room was placed the optical bench, which we have previously described, the length of which was increased to 9m., and along which the resonators were moved, their centres being kept normal to the middle of the mirror. The primary conductor was arranged 15m. away from the mirror, elevated on a support and facing the centre of the mirror. It consisted as before of two brass rods 7mm. thick, connecting two spheres 30cm. in diameter. The new arrangement, which we had previously adopted for the oscillator, and which consists in producing the primary spark in oil instead of in air*, appreciably facilitated this experiment by greatly increasing, as we have stated, the secondary spark in length and brilliancy, thus affording an opportunity for micrometric measurements of the spark gap. The resonators which we successively employed were provided with micrometer gauges, the screws having a $\frac{1}{4}$mm. pitch, and the scale being such that we could read directly a $\frac{1}{100}$th of a millimetre. In this manner we determined at equal intervals from the mirror the size of spark gap necessary to prevent sparking. Taking distances from the mirror in metres as abscissæ, and micrometer gauge readings in hundredths of a millimetre as ordinates, curves (Figs. 1 and 2) were obtained respectively with the 0·75m. and the 0·5m. circle. These two circles, which only yielded imperfect results with 3m. and 5m. mirrors, and on which we, for that very reason, engaged in fresh investigations, gave with the large mirror results quite comparable with those obtained with the smaller circles in our previous experiments. We deduced the wave-length of each resonator, either by observation of the nodes and antinodes in the two principal positions of the circle, parallel to the mirror (in the plane of the wave) or horizontal (in the plane of vibration), or by plotting the curve of the decreasing and increasing intensities of the secondary sparks.

The question of the equality of the rate of propagation in air and in wires appears to us to be definitely settled by the use of the large mirror. The 0·5m. circle, in fact, gave us three very well defined antinodes and three nodes. The 0·75 circle gave three antinodes and two nodes, equally well defined. The mean of a large number of determinations for the two circles is as follows :—

	1st Antinode.	1st Node.	2nd Antinode.	2nd Node.	3rd Antinode.	3rd Node.
	m.	m.	m.	m.	m.	m.
50cm. circle ...	1	2	3	4	5	6
75cm. circle ...	1·5	3	4·5	6	7·5	—

These are identical with those obtained by us with the same circles along wires. Thus the conclusions arrived at by us in our previous researches are fully confirmed for large wave lengths, viz. :—

The secondary resonator has a fixed wave length, whatever may be the size of the oscillator, the strength of the oscillation alone varying.

One quarter of the wave length of a circular resonator is very approximately equal to twice its diameter.

In the case of normal reflection the first node is exactly at the mirror.

Finally, our principal result is that—

The rate of propagation of electric waves is the same in air as along conducting wires.

ON THE DISSIPATION OF THE ELECTRICAL ENERGY OF THE HERTZ RESONATOR.†

BY NIKOLA TESLA.

Anyone who, like myself, has had the pleasure of witnessing the beautiful demonstrations with vibrating diaphragms which Prof. Bjerknes exhibited in person at the Paris Exposition in 1889, must have admired his ability and painstaking care to such a degree as to have an almost implicit faith in the correctness of observations made by him. His experiments "On the Dissipation of the Electrical Energy of the Hertz Resonator," which are described in the issue of December 14th of the *Electrical Engineer*,‡ are prepared in the same ingenious and skilful manner, and the conclusions drawn from them are all the more interesting as they agree with the theories put forth by the most advanced thinkers. There cannot be the slightest doubt as to the truth of these conclusions, yet the statements which follow may serve to explain in part the

* *La Lumière Electrique*, Vol. XLI., p. 252. See also *The Electrician*, August 14, 1891 p. 418, Vol. XXVII.

* *Comptes Rendus*, September 19, 1892, Vol. CXV., No. 12. See also *The Electrician*, September 30, 1892, p. 578, Vol. XXIX.

† From the *Electrical Engineer* of New York.

‡ See *The Electrician*, November 18, 1892, p. 69.

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results arrived at in different manner ; and with this object in view I venture to call attention to a condition with which, in investigations such as those of Prof. Bjerknes, the experimenter is confronted.

The apparatus, oscillator and resonator, being immersed in air, or other discontinuous medium, there occurs—as I have pointed out in the description of my recent experiments before the English and French scientific socities—dissipation of energy by what I think might be appropriately called *electric sound-waves or sound-waves of electrified air*. In Prof. Bjerknes's experiments principally this dissipation in the resonator need be considered, though the sound-waves—if this term be permitted—which emanate from the surfaces at the oscillator may considerably affect the observations made at some distance from the latter. Owing to this dissipation the period of vibration of an air-condenser cannot be accurately determined, and I have already drawn attention to this important fact.

These waves are propagated at right angles from the charged surfaces when their charges are alternated, and dissipation occurs, even if the surfaces are covered with thick and excellent insulation. Assuming that the "charge" imparted to a molecule or atom either by direct contact or inductively is proportinate to the electric density of the surface, the dissipation should be proportinate to the square of the density and to the number of waves per second. The above assumption, it should be stated, does not agree with some observations from which it appears that an atom cannot take but a certain maximum charge ; hence, the charge imparted may be practically independent of the density of the surface, but this is immaterial for the present consideration. This and other points will be decided when accurate quantitative determinations, which are as yet wanting, shall be made. At present it appears certain from experiments with high-frequency currents, and this dissipation of energy from a wire, for instance, is not very far from being proportionate to the frequency of the alternations, and increases very rapidly when the diameter of the wire is made exceedingly small. On the latter point the recently published results of Prof. Ayrton and H. Kilgour on "The Thermal Emissivity of Thin Wires in Air" throw a curious light. Exceedingly thin wires are capable of dissipating a comparatively very great amount of energy by the agitation of the surrounding air, when they are connected to a source of rapidly alternating potential. So in the experiment cited, a thin hot wire is found to be capable of emitting an extraordinarily great amount of heat, especially at elevated temperatures. In the case of a hot wire it must, of course, be assumed that the increased emissivity is due to the more rapid convection, and not, to any appreciable degree, to an increased radiation. Were the latter demonstrated, it would show that a wire, made hot by the application of heat in ordinary ways, behaves in some respects like one the charge of which is rapidly alternated, the dissipation of energy per unit of surface kept at a certain temperature depending on the curvature of the surface. I do not recall any record of experiments intended to demonstrate this, yet this effect, though probably very small, should certainly be looked for.

A number of observations showing the peculiarity of very thin wires were made in the course of my experiments. I noted, for instance, that in the well-known Crookes instrument the mica vanes are repelled with comparatively greater force when the incandescent platinum wire is exceedingly thin. This observation enabled me to produce the spin of such vanes mounted in a vacuum tube when the latter was placed in an alternating electrostatic field. This, however, does not prove anything in regard to radiation, as in a highly exhausted vessel the phenomena are principally due to molecular bombardment or convection.

When I first undertook to produce the incandescence of a wire enclosed in a bulb, by connecting it to only *one* of the terminals of a high tension transformer, I could not succeed for a long time. On one occasion I had mounted in a bulb a thin platinum wire, but my apparatus was not adequate to produce the incandescence. I made other bulbs, reducing the length of the wire to a small fraction ; still, I did not succeed. It then occurred to me that it would be desirable to have the surface of the wire as large as possible, yet the bulk small, and I provided a bulb with an exceedingly thin wire of a bulk about equal to that of the short but much thicker wire. On turning the current on the bulb the wire was instantly fused. A series of subsequent experiments showed that when the diameter of the wire was exceedingly small, considerably more energy would be dissipated per unit surface at all degrees of exhaustion than was to be expected, even on the assumption that the energy given off was in proportion to the square of the electric density. There is likewise evidence which, though not possessing the certainty of an accurate quantitative determination, is nevertheless reliable because it is the result of a great many observations, namely, that with the increase of the density the dissipation is more rapid for thin than for thick wires.

The effects noted in exhausted vessels with high-frequency currents are merely diminished in degree when the air is at ordinary pressure ; but heating and dissipation occurs, as I have demonstrated, under the ordinary atmospheric conditions. Two very thin wires, attached to the terminals of a high-frequency coil are capable of giving off an appreciable amount of energy. When the density is very great, the temperature of the wires may be perceptibly raised, and in such case probably the greater portion of the energy which is dissipated *owing to the presence of a discontinuous medium* is transformed into heat at the surface or in close proximity to the wires. Such heating could not occur in a medium possessing either of the two qualities, namely, perfect incompressibility or perfect elasticity. In fluid insulators, such as oils, though they are far from being perfectly incompressible or elastic to electric displacement, the heating is much smaller because of the continuity of the fluid.

When the electric density of the wire surfaces is small, there is no appreciable local heating ; nevertheless, energy is dissipated in air by waves, which differ from ordinary sound-waves only because the air is electrified. These waves are especially conspicuous when the discharges of a powerful battery are directed through a short and thick metal bar, the number of discharges per second being very small. The experimenter may feel the impact of the air at distances of six feet or more from the bar, especially if he takes the precaution to sprinkle the face or hands with ether. These waves cannot be entirely stopped by the interposition of an insulated metal plate.

Most of the striking phenomena of mechanical displacement, sound, heat and light which have been observed, imply the presence of a medium of a gaseous structure—that is, one consisting of independent carriers capable of free motion.

When a glass plate is placed near a condenser the charge of which is alternated, the plate emits a sound. This sound is due to the rythmical impact of the air against the plate. I have also found that the ringing of a condenser, first noted by Sir William Thomson, is due to the presence of the air between or near the charged surfaces.

When a disruptive discharge coil is immersed in oil contained in a tank, it is observed that the surface of the oil is agitated. This may be thought to be due to the displacements produced in the oil by the changing stresses, but such is not the case. It is the air above the oil which is agitated and causes the motion of the latter; the oil itself would remain at rest. The displacements produced in it by changing electrostatic stresses are insignificant ; to such stresses it may be said to be compressible to but a very small degree. The action of the air is shown in a curious manner, for if a pointed metal bar is taken in the hand and held with the point close to the oil, a hole two inches deep is formed in the oil by the molecules of the air, which are violently projected from the point.

The preceding statements may have a general bearing upon investigations in which currents of high frequency and potential are made use of, but they also have a more direct bearing upon the experiments of Prof. Bjerknes which are here considered, namely, the "skin effect," is increased by the action of the air. Imagine a wire immersed in a medium, the conductivity of which would be some function of the frequency and potential difference, but such that the conductivity increases when either or both of these elements are increased. In such a medium, the higher the frequency and potential difference the greater will be the current which will find its way through the surrounding medium, and the smaller the part which will pass through the central portion of the wire. In the case of a wire immersed in air and traversed by a high-frequency current, the facility with which the energy is dissipated may be considered as the equivalent of the conductivity ; and the analogy would be quite complete, were it not that besides the air another medium is present, the total dissipation being merely modified by the presence of the air to an extent as yet not ascertained. Nevertheless, I have sufficient evidence to draw the conclusion that the results obtained by Prof. Bjerknes are effected by the presence of air in the following manner :—1. The dissipation of energy is more rapid when the resonator is immersed in air than it would be in a practically continuous medium, for instance, oil. 2. The dissipation owing to the presence of air renders the difference between magnetic and non-magnetic metals more striking. The first conclusion follows directly from the preceding remarks ; the second follows from the two facts that the resonator receives always the same amount of energy, independent of the nature of the metal, and that the magnetism of the metal increases the impedance of the circuit. A resonator of magnetic metal behaves virtually as though its circuit were longer. There is a greater potential difference set up per unit of length, although this may not show itself in the deflection of the electrometer owing to the lateral dissipation. The effect of the increased impedance is strikingly illustrated in the two experiments of Prof. Bjerknes when copper is deposited upon an iron wire, and next iron upon a copper wire. Considerable thickness of copper deposit was required in the former experiment, but very little thickness of iron in the latter, as should be expected.

Taking the above views, I believe, that in the experiments of Prof. Bjerknes, which led him to undoubtedly correct conclusions, the air is a factor fully as important, if not more so, than the resistance of the metals.

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ON THE TEMPERATURE OF THE ELECTRIC ARC.*

BY J. VIOLLE.

The author states that he experimented under widely different conditions—from 10 amperes and 50 volts up to 400 amperes and 85 volts. Nevertheless, he found the intrinsic brilliancy of the positive carbon identical for all arcs. The measurements taken by the spectrophotometer in various parts of the spectrum, and the photographs taken, left no doubt whatever on this point. It follows from this that the temperature of the arc is constant—that is to say, it is that of the volatilisation of carbon.

The author produced a 400-ampere arc, the end of the positive carbon, after five or six minutes, presenting a white-hot mass for a length of 1cm. Before commencing the experiment, a hollow was effected about 2cm. from the tip of the carbon, and when, owing to the wearing away of the carbon, there only remained a button of the same brilliancy throughout, a blow caused the button to break off and fall into a calorimeter. This consisted of a little cylindrical copper vessel immersed in water. At the bottom of the cylinder there was a graphite disc, and another graphite disc was placed quickly on the top of the carbon button, when it fell into the cylinder. The calorimeter was completely screened from any radiation from the arc. The loss of heat experienced by the button in falling must have been very small, the calorimeter being within 10cm. of the carbons, and owing to the impetus given to it the button traversed this short space filled as it was with the vapour of the arc very quickly.

The author found that the quantity of heat necessary to bring 1 gramme of carbon to the temperature of volatilisation from 0°C. was 1,600 gramme-degrees-centigrade. According to the determinations of Weber and Dewar some 300 calories are required to warm up 1 gramme of graphite from 0°C. to 1,000°C. There is, therefore, a balance of 1,300 calories. Assuming that above 1,000°C. the specific heat of graphite has the theoretical value of 0·52, these 1,300 calories represent 2,500°C., so that *the temperature of volatilisation of carbon works out at* 3,500°C.

In a note to this communication M. Berthelot remarks that M. Violle's experiments are of the utmost importance to chemists and physicists, and he points out that they are in agreement with some experiments carried out some years previously by M Violle and himself on explosive gaseous mixtures, when temperatures of 4,000°C. to 4,500°C. were observed. M. Berthelot points out that the volatilisation of carbon is not a purely physical phenomenon. Carbon in its native state is not comparable in constitution to the elements, such as oxygen, hydrogen, and nitrogen, with which it is associated in gaseous combinations. Carbon in its native state is a polymerised body. To reduce it to a gas in its monomolecular state we must restore the energy absorbed by this process of polymerisation—a chemical phenomenon—and also the energy which is required for the physical reduction of the monomolecular element into vapour. This consideration gives an idea of the great energy with which gaseous carbon intervenes in reactions carried out at high temperatures. A blow-pipe fed by cyanogen and oxygen in the proportions necessary to form oxide of carbon would give rise under constant pressure to a flame having a temperature of about 3,500°C., a temperature which could be surpassed by sudden combinations of the gases operated with in sufficiently large volumes.

ON THE MAGNETIC PROPERTIES OF OXYGEN AT VARIOUS TEMPERATURES.†

BY P. CURIE.

The author states that he has found that the coefficient of magnetisation of oxygen is constant for fields varying from 200 to 1,350 C.G.S. units. He has also verified the fact that by varying the pressure from 5 to 30 atmospheres, the coefficient of specific magnetisation, with reference to the unit of mass, does not sensibly vary. The ratio of the magnetisation coefficients of the same mass of oxygen and water (-145) at 20°C. is $10^6 k_{20} = 115$; the value ($-0{\cdot}79 \times 10^6$) being taken as the coefficient of magnetisation of water, k being the coefficient of specific magnetisation of oxygen.

The author carried out two series of temperature determinations. In one set he used a bulb of ordinary glass filled with oxygen at 5 atmospheres pressure. In the other set he used a bulb of hard glass filled with oxygen at 18 atmospheres pressure. This latter bulb was brought without accident to a temperature of 450°C., the pressure being then 45 atmospheres. It was found that the coefficent of variation of k with temperature increased as the temperature fell. The curve given by the formula—

$$10^6 C\, k_t = \frac{33700}{273+t} = \frac{33700}{T},$$

where t is the temperature, and T the absolute temperature, coincided accurately with the observations of the first series of experiments. The determinations of k in the second series were 1 per cent. to 2 per cent. too high between 200°C. and 350°C.

The law of the variation of k is, therefore, an extremely simple one: *Between 20°C. and 450°C. the coefficient of specific magnetisation of oxygen varies inversely as the absolute temperature.*

The author points out that this result is important to magnetic theory. Oxygen is of all magnetic bodies the most simple in molecular constitution. There is every ground for believing that the complete investigation of the properties of this body will give the clearest ideas as to the nature of magnetic phenomena.

The coefficient for air may be calculated by only taking the oxygen it contains into consideration. We have for the volume coefficient of air at one atmosphere pressure

$$10^6 \chi_t = \frac{2{,}760}{T^2}.$$

This formula may be used as a temperature correction in all magnetic determinations carried out in air, assuming that the composition of air does not vary with the temperature. This coefficient relating to a cubic centimetre of air rapidly decreases as the temperature rises. At 20°C. it makes a 4 per cent. correction necessary in the case of water; at 400°C. its value is five times less.

* From the *Comptes Rendus*, December 26, 1892, Vol. CXV., No. 26. Abstract.

† From the *Comptes Rendus*, December 26, 1892, Vol. CXV., No. 26, Abstract.

BOOKS, &c., RECEIVED.

"Manuel d'Électrologie Médicale." By G. Trouvé. (Paris: Octave Doin.) 800 pp., 8vo.

"Annuaire pour l'An 1893." (Paris: Gauthier-Villars et Fils.) 800 pp., 8vo.

"Index of the *Journal* of the Institution of Electrical Engineers." Vols. XI.—XX. 1882-1891. Edited by F. H. Webb. (London: E. and F. N. Spon.)

"Handbook of Regulations issued by the Royal Commission for the Chicago Exhibition." 1893. (London: William Clowes and Sons.) Fourth edition. 200 pp.

"Tips to Inventors." By R. Grimshaw, Ph.D. (New York: Practical Publishing Company.) 100 pp. Price $1.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 6th.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Paper to be read:—"The Theta-Phi Diagram of the Thermo-dynamics of Steam," by J. Macfarlane Gray.

SATURDAY, January 7th.

ROYAL INSTITUTION.

3 p.m. Juvenile Lecture. "Astronomy," by Sir Robert Ball, F.R.S.

TUESDAY, January 10th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion:—"Gas-Power for Electric Lighting," by J. Emerson Dowson, M.Inst.C.E. At this Meeting the Monthly Ballot for members will be taken.

THURSDAY, January 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be further discussed:—"Experimental Researches on Alternate Current Transformers," by Dr. J. A. Fleming, F.R.S.

FRIDAY, January 13th.

PHYSICAL SOCIETY.

5 p.m. Paper to be read: "Upon Science Teaching," by F. W. Sanderson, M.A.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Students' Meeting. Paper to be read:—"Description of the Design and Construction of a Road-way Bridge over the River Cam," by Edwin Hulme, Stud.Inst.C.E.

SOCIETY OF ARTS.

8 p.m. Howard Lecture I. "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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SPECIAL NOTICE.

With this Number is issued Gratis a Tabulated Statement showing the Central Lighting Stations of the United Kingdom in Operation and in Progress.

Next week will be issued (Gratis to Subscribers) a MAP, printed in colours, showing the Streets in the Metropolis in which Mains are actually laid for Private Lighting up to January, 1893, together with the areas allotted to the different Supply Companies. This Map will be similar to those previously issued as Supplements to "The Electrician."

1892.

Year after year, as this planet approaches a particular point in its orbit, civilised mankind proceeds with no little solemnity, and considerable sameness, to take stock of the events of the preceding three hundred and sixty-five days. Column after column is devoted to a chronicle, more or less dull, of the art, politics, coal trade, and what-not of such and such a twelvemonth. The unfailing recurrence of the phenomenon offers a tempting opportunity for the display of a little originality, which may take the shape of allowing the advent of a new year to pass by without the customary stock-taking. There are many customs which are more honoured in the breach than in the observance, but it seems to us that if people can really be induced to read these annual lucubrations, they serve a sufficiently useful purpose to warrant their periodic appearance. A clear idea of leading events is worth having, and it may frequently be gained by digesting some of these extremely hardy annuals.

So far as concerns electrical science, 1892 is remarkable neither for activity nor originality. On the first day of the year, a long life of scientific achievement was gracefully rewarded by the elevation of Sir WILLIAM THOMSON to the peerage; whilst the closing weeks witnessed the termination of the labours of the committee charged, by the Board of Trade, with the supremely important duty of settling the fundamental electrical standards. Appointed in December, 1890, "to consider whether any, and if so, what, steps

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CENTRAL LIGHTING STATIONS OF THE UNITED KINGDOM.

LONDON.

IN OPERATION.

(Italic figures denote TOTAL Horse-Power or TOTAL Kilowatts.)

Name of Company.	Address of Station.	Engineer.	System of Distribution.	Lamp Data. C'nnct'd (8 c.p. or equiv.	Lamp Data. Plant Capacity (8 c.p. lamps.)	Lamp Data. Max. Load (Lamp) observed	Area of District.* Square miles.	Distance of Farthest Lamp. Yards.	Pressure (volts). At Lamp.	Pressure (volts). At Station.	Meters. Number and Type.	Mains. Length. Miles.	Mains. System.	Boilers. Type.	Boilers. No.	Boilers. H.P.	Engines. Type.	Engines. No.	Engines. H.P.	Belts, Ropes or Coupled Direct.	Dynamos. Type.	Dynamos. No.	Dynamos. Kilowatts.	Price of Board of Trade Unit.	Price of Gas in District.	Remarks.
Chelsea Electricity Supply Company	Draycott-place ...	Percy Still ...	Secondary battery sub-stations with continuous current transformers	35,000	40,000	14,000	1·13	...	100	...	Aron and Ferranti	20	Callender's Bitumen Insulated cables in Callender-Webber conduits	B. and W.	...	...	Willans	...	...	Direct-coupled	Elwell-Parker	...	...	8d.	3/1	Supply direct from low-pressure machines for area contiguous to Central Station.
Electricity Supply Corporation	12, Maiden-lane, Strand	Hardman A. Earle	Three-wire	30,000	65,000	16,000	0·18	1,090	100-2	104-2	175; Aron (12 to 500 am.), Ferranti (10 to 150 am.)	17	Insulated cables in Callender-Webber conduits	B. & W.	6 1	156 250	Willans	5 3 2	200 136 85	Direct-coupled	Edison-Hopkinson	5 3 2	115 86 55	7d.	3/3	...
House-to-House Electric Light Supply Company	Richmond-road, West Brompton	Albert Gay (*Man.*)	Alternate current transformers	23,000	25,000	10,000	0·77	2,500	100	2,000	500 Shallenberger	26	India-rubber insulated cables in iron pipes	Babcock Lancashire	4 1	*900* ...	Fowler's horizontal.	5	*820*	Ropes	Lowrie-Hall	1 1	100 50	8d.	3/-	...
Kensington and Knightsbridge Electric Light Company	1. Chapel-place, Brompton; 2. Kensington-ct.	C. J. Barley[1] H. W. Miller[2]	Three-wire system with batteries	14,809[1] 31,293[2]	31,500[1] 49,500[2]	5,800[1] 8,700[2]	0·67	1,292[1] 1,820[2]	100	100·5	Aron and Ferranti	12½	Bare copper in Crompton conduits and Henley's cable in iron pipes	B. & W.[1] B. & W.[2]	3[1] 4[2]	360[1] 250[2]	Willans[1] Willans[2]	... ...	*700*[1] *1070*[2]	Direct	Crompt'n and Siemens	5 7	*381* *645*	8d.	3/1	...
London Electric Supply Corporation	Deptford	P. W. D'Alton	Alternate-current transformer sub-stations	60,000	90,000	35,000	3·37	9½ miles.	100	10,000 2,400	550; Ferranti, Frager, Shallenberger, Thompson, Borel	32 Trunk, 28 Distributing	Concentric (Ferranti and Siemens)	B. & W.	24	*12,000*	Hor. com. Corliss, vert. com. Corliss, & triple expans'n.	2 2	700 1500	Ropes	Ferranti	5	*4,200*	7d.	3/-	...
Metropolitan Electric Supply Company	1. Manchester-sq.; 2. Sardinia-st.; 3. Rathbone-pl.; 4. Amberley-rd, Paddington; 5. Whitehall-avenue	Frank Bailey	Alternate-current transformers	125000	...	...	4·6	...	100	1,000	Shallenberger, Aron, Ferranti, Teague, Thomson-Houston	...	Insulated cables in iron pipes	B. & W. Marine. Loco.	27 3 5	...	Willans, Westinghouse, Hornsby, and Allen.	...	...	Direct, ropes and belts	Parker, W'st'h'se, Kapp, Siemens, and Lat. Clark Muirhead and Co.	...	...	7¼d.	3/-	Continuous current at Whitehall. Special pressures supplied at lamps where required.
Notting Hill Electric Lighting Company	Victoria-gardens, Notting Hill	Geo. Schultz...	Low-pressure with secondary batteries	10,000	15,000	3,000	·69	780	100	102-3	Aron (150) and Ferranti (50)	8½	Bare copper in Crompton conduits	B. & W.	2	*700*	Willans	4	*560*	Direct	Crompt'n	4	*480*	8d.	3/-	...
St. James' and Pall Mall Electric Light Company	1. Duke-street; 2. Carnaby-st.	Sydney T. Dobson	Three-wire	48,000	40,000[6] 20,000[7]	24,800	·24	800	106	106-11	600; Aron and Ferranti	7½	Bare copper in iron troughs. Siemens armoured cables and Callender cable in bitumen concrete conduits	Loco.[6] Econ'mic[7]	6[6] 6[7]	*2400*[6] *1200*[7]	Willans	17	*3500*	Direct	Siemens & Clark-Muirhead	17	...	7d.	3/4	Distance of furthest lamp is 1,600 yards if only one station is at work.
St. Luke's (Chelsea) Electric Lighting Company	Manor-st., Chelsea	...	High pressure with batteries	5,000	30,000	...	...	...	...	...	Aron	...	...	B. & W.	...	...	Arm'gt'n & Sims	...	...	Belts	...	...	...	8d.	3/1	System now in process of reconstruction.
St. Pancras Vestry.....	Stanhope-street, St. Pancras	T. F. Baron...	Three-wire with batteries	24,000	20,000	...	4·1 (estimated)	1,700	110	...	Aron and Ferranti	5½	Bare copper	B. & W.	5	250	Willans	9	120	Direct	Kapp multipolar	9	85	6d.	3/-	Arc lighting engines, 2, 70 H.P. Arc Lighting dynamos, 2, 50 kilowatts.
Westminster Electric Supply Corporation	1. Davies-street; 2. Eccleston-place; 3. St. John's Wharf	Prof. Alex. B. W. Kennedy	Three-wire with batteries	48,900[3] 29,900[4] 19,000[5]	84,000[3] 42,000[4] 60,000[5]	18,000[3] 7,500[4] 7,250[5]	1·9	1,600	100	102-115	(1,200 Aron, 300 Ferranti, &c.)	97	Bare copper in conduits where possible, but more generally insulated cable in pipe or casing	Return tube.[3] Return tube[4] B. & W.[5]	6[3] 4[4] 5[5]	... ...	Willans[3] Willans[4] & Davey Paxman. Willans[5]	10[3] 4[4] 2[4] 8[5]	*1700*[3] *1000*[4] *200*[5]	...	Crompt'n & E.C. C.[3] Crompt'n & S'm'ns.[4] Goold'n & Mather & Platt[5]	10[3] 6[4] 8[5]	*890*[3] *450*[4] *630*[5]	7d.	3/-	Boilers each to evaporate 5,000 lb. water per hour.

* Exclusive of Parks and Open Spaces. [1] Chapel-place. [2] Kensington-court [3] Davies-street. [4] Eccleston-place. [5] St. John's Wharf. [6] Duke-street [7] Carnaby-street.

We have been unable to obtain detailed information with regard to the following central lighting stations, which, with the exception of the first, are for the most part small ones:—City of London, Bankside and Wool Quay (alt.-cur. trans., sub. sta.); Crystal Palace and District (con.-cur. trans.); Bournemouth (alt.-cur. trans.: 7,500 lights capacity); Bradford (low pressure with batteries: 15,000); Bray (alt.-cur. trans.); Carlow; Chagford (alt.-cur. trans., sub. stat.); Chatham (alt.-cur. trans.); Cambridge (alt. cur. trans: 6,000); Cowpen; Derby (low pressure with batteries: 500); Derby (Town Council); Eastbourne (alt.-cur. trans.); Hull (Town Council); Larne (alt.-cur trans: 4,000); Newcastle (2 stations, alt.-cur. trans); Nelson (Lancs); Thetford (low pressure with batteries: 1,000); Taunton (alt.-cur. trans.: 6,000); Waterford (alt.-cur. trans.: 1000); Weybridge (alt.-cur. trans.: 2,000); Woking (alt.-cur. trans.).

The following stations are **Projected**:—Accrington (low pressure with batteries, Town Council); Bolton (Town Council); Cardiff (Town Council); Heckmondwike (Local Board); Manchester (five-wire, Town Council); Nottingham (three-wire, Town Council); Richmond (low-pressure); Salford (alt. cur trans., Town Council); Whitehaven (Town Council); Wolverhampton (alt.-cur. trans., Town Council); Worcester, (alt.-cur. trans., Town Council).

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CENTRAL LIGHTING STATIONS OF THE UNITED KINGDOM.—PROVINCES.

IN OPERATION AND IN PROGRESS.

(Italic figures denote TOTAL Horse-Power or TOTAL Kilowatts.)

Address of Station.	Name of Company.	Engineer.	System of Distribution.	Lamp Data. C'nnct'd (8 c.p. or equiv.)	Lamp Data. Plant Capacity (8 c.p. lamps).	Lamp Data. Max. Load (Lamp) observed	Area of District.* Square miles.	Distance of Farthest Lamp. Yards.	Pressure (volts). At Lamp.	Pressure (volts). At Station.	Meters. Number and Type.	Mains. Length. Miles.	Mains. System.	Boilers. Type.	Boilers. No.	Boilers. H.P.	Engines. Type.	Engines. No.	Engines. H.P.	Belts, Ropes, or Coupled Direct.	Dynamos. Type.	Dynamos. No.	Dynamos. Kilowatts.	Price of Board of Trade Unit.	Price of Gas in District.	Remarks.
Bath	City of Bath Electric Lighting and Engineering Company	M. C. Olsson	Alternate current transformer	6,200	10,000	5,800	4	2,000	100	2,000	103; Westinghouse	40	Callender solid	B. & W.	4	150	Brush	4	150	Ropes and Belts	Mordey-Victoria	4	75	6d.	2/8	Also 4 50-light T.-H. machines.
Birmingham	Birmingham Electric Supply Company	J. C. Vaudrey (*Man. Dir.*)	Low-pressure, with batteries	17,000	24,000	...	...	...	...	...	...	...	Crompton culverts for feeding mains; Callender's solid system on the distributors	Lancashire	6	250	Vertical Willans	4 6	35 ...	Direct coupled	Crompton.	6	90	8d.	2/7	...
Blackpool	Blackpool Corporation	John Hesketh	Alternate current transformer	6,500	...	...	...	...	100 or 50	2,000	...	...	Silvertown insulated cables.	Lancashire	3	...	Horizont'l compound non-condensing	1 2 3	200 100 60	Ropes	...	1 2	100 50	...	...	Arcs 165. Three 55-arc lighters.
Brighton	Brighton Corporation	Arthur Wright (*Man.*)	Two-wire with batteries	11,000	10,000	...	...	...	115	...	Ferranti	...	Armoured cables	Lancashire	3	...	Willans	2 2	200 80	Direct	Goolden.	4	...	7d.	2/9	...
Brighton	Brighton and Hove Electric Light Company	G. J. Philpott	Alternate current transformer	16,000	...	...	...	...	...	...	Shallenberger	14	Overhead insulated cables	Fowler	...	...	Fowler	...	...	...	...	..	...	7d.& 8d.	2/9	...
*Bristol	Bristol Corporation	...	Alternate current transformer	...	20,000	...	...	...	...	...	...	3	...	L'nc'shire	7	...	Willans	...	...	Direct-coupled	Siemens	2 2	210 88	...	2/8 2/10	Also 90 arcs.
Buckingham	Buckingham Electric Light and Power Supply Company	Parr and Gillies	Two-wire with batteries	500	1,500	...	...	...	100	103	...	...	...	...	...	...	...	...	...	...	...	...	...	7d.	4/9	...
Chelmsford	Chelmsford Electric Lighting Company	Arthur H. Pott	Alternate current transformer	1,600	6,000	2,800	3·47	2½ (miles)	100	2,000	Ferranti, Shallenberger	...	Chiefly overhead (Silvertown and Henley)	Marine Loco. Lanc.	2 2 1	140 20 240	Willans	...	...	Belting and Direct	...	...	...	1/ -6d.	3/6 4/1	Arc lights in streets.
Dublin	Dublin Corporation	Mark Ruddle	Alternate current transformer	8,600	10,000	7,400	...	2,000	...	2,020	80; Shallenberger	9	Rubber cables in iron pipes	Babcock-Wilcox	4	*1400*	Coupled Compd.	3	*900*	Ropes	Elwell-Parker	3	*450*	7d.	3/6 4/0	80 arc lamps in streets, the plant consisting of 3 Brush dynamos & 3 high-speed engines.
Exeter	Exeter Electric Light Company	T. P. Wilmshurst	Alternate current transformer	5,500	7,000	4,200	...	1,800	100	2,000	48; Shallenberger	9	Fowler-Waring concentric armoured lead-covered	B. & W.	3	150	Fowler, comp. horizontal. Fowler, comp. horizontal. Westinghouse, triple expans'n.	2 1 2	140 90 25	Ropes	Mordey	2 1	75 50	7½d.	3/1	Also 2 30-lt. T.-H.; 35 arcs in operation.
Fareham	Fareham Electric Light Company, Fareham	Arthur Blake (*Sec.*)	Alternate current transformer	1,000	1,000	880	...	2,311	100	1,000	29 Shallenberger 2 Chamberlain-Hookham, 1 Thomson-Houston	16	Overhead insulated cables	Loco.	2	80	Compound Horizontal Girder Auto. Expansion	1	...	Belts	Th'mson-Houston	2	30	8d.	3/9	There are 21 1,200 c.p. T.H. arcs in the streets.
Galway	Galway Electric Light Company	J. E. Pearce...	Two-wire with batteries	1,070	1,500	630	12½	1,700	110	125	...	4	Underground & overhead	...	...	...	42in. Hercules. Turbines. 12ft. fall	2	...	Belts	Crompt'n & Statter	...	50	5d.	5/9	Charge for motors in day 3d. per B.T.U.
Glasgow	Glasgow Corporation	W. Arnot ...	Three-wire	...	12,000	...	...	...	100	115	Kelvin and Ferranti	...	Bare copper in cast-iron culverts, and cable in pipes	Steel (marine) type	5	...	Willans	2 2 3	80 150 250	Direct		7	...	7d.	2/9	...
Hastings and St. Leonards	Hastings and St. Leonards Electric Light Co.	E. T. Mercer	Alternate current transformer	4,000	...	...	...	3,520	100	2,000	Shallenberger	30	Underground	...	...	...	Brush	...	...	Ropes	Mordey-Victoria.	...	*250*	9d. 8d.	3/9	...
*Huddersfield	Huddersfield Corporation	A. B. Mountain	Alternate current transformer	...	10,000	...	...	...	100	2,000	...	...	Primary, Siemens concentric; Secondary, Callender's bitumen-covered single cables	B. & W.	4	*500*	Vertical cond'ns'g.	3	*500*	Ropes	Mordey-Victoria	3	*250*	6d.	2/9	...
*Hull	Hull Town Council	F. Harman Lewis	Three-wire with batteries	4,000	9,000	3,000	0·5	900	110	113	Ferranti	3	Bare copper on Crompton System where possible, otherwise rubber covered cable in iron pipes	Paxman's economic.	3	...	...	...	...	Direct-coupled	Siemens	2 2	115 45	7d.	2/10	Evaporative capacity of each boiler = 4001b. water per hr.
Keswick	Keswick Electric Light Company	J. R. Dixon...	Alternate current transformer	1,600	2,000	1,300	6	2 (miles)	100	2,000	None	4	Overhead cables	Galloway	...	230	Westinghouse.	...	50	Belts	Kapp	2	30	...	3/3	Contracts made with customers based on Gas Bills.
*Leeds	Yorkshire House-to-House Electricity Company	Harold Dickinson	Alternate current transformer	7,000 (applied for	7,500	...	33	5,000	100	2,000	Shallenberger	6	Lowrie-Hall	Lancashire	3	...	Comp'nd. C'nd'ns'g.	2 1	200 100	Ropes	Lowrie-Parker	...	*250*	8d.	2/2	B.T.U. discount 10% to 25% and 5% for cash. Gas less 5% for cash.
Liverpool	Liverpool Electric Supply Company	A. Bromley Holmes	Two-wire with batteries.	30,000	35,000	21,000	...	...	110	...	Hookham & Ferranti	...	Callender Solid System	Lancashire	13	300	Willans	14	200	Direct-coupled	Siemens, Crompton, Elwell-Parker	14	100	7½d.	3/0	...
Lynmouth	Lynmouth and Lynton Electric Light Company	F. Wallis.....	Alternate current transformer	...	...	1,200	...	...	...	2,000	...	...	...	...	...	...	Water-power	...	...	Direct-coupled	Mordey-Victoria	2	...	...	...	...
Leamington	Midland Electric Light and Power Company	F. W. E. Jones	Two-wire ..	3,500	10,000	2,000	1	1	113	...	Hookham's (new type)	...	...	Robey	...	...	Robey	...	...	Belts and Ropes	Hookham & Chamberlain	...	...	8d. 4d.	2/6 3/0	...
Northampton	Northampton Electric Light and Power Company	W. E. Heenan	Two-wire	4,000	7,000	2,600	...	900	104	104-7	60 Aron, Frager and Ferranti	2	...	Daniel Adamson	3	...	Scott & Hodgson	3	...	Ropes and direct-coupled	Crompton.	3	66	9d.	2/4	Discount of 10%.
Norwich	Messrs. Laurence, Scott & Co.	W. B. Sisling	Two-wire with batteries	1,300	1,500	1,100	¼	875	110	120 (max.)	Scott	2	Overhead cables	Locomotive	2	*100*	C'mp'nd under type	1	...	B'lts&dir'ct-coupled	"Norwich"	...	*40*	8d.to6d.	3/8	...
Ogmore Valley (2)	Ogmore Valley Electric Light and Power Company	...	Low pressure	700	2,500	...	...	...	...	...	...	28	Overhead cables	...	...	...	Tandem compound vertical Fowler compound. Robey compound	2 1 1	... 35 35	....	Wilson	6	12	...	...	To be erected, two 40-H.P. Pelton wheels. Output of engines is in N.H.P.
*Oldham	Oldham Town Council	S. W. Newington	Two-wire with batteries	...	2500 alight at one time.	...	...	1,100	105	...	...	2½	Bare copper in concrete culverts	Lancs.	2	...	Willans	4	*320*	Direct-coupled	Charles-w'rth Hall	4	*192*	...	2/4	...
Oxford	Oxford Electric Company	J. H. M'Lean	High-pressure continuous-current transformers, lowered to 100 volts for distribution	5,000	15,000	8,800	...	1,000 (from Cent. Switch Stn.)	100	1,000 (at Gen. Stat.)	Parker	L.T. Mains, 8 H.T. Mains, 7	L.T. mains, Callender double steel armoured mains, lead-covered, laid in earth; H.T. mains, Silvertown cables in iron pipes.	Loco.	3	200	Triple expan. sup. cond. marine	...	150	Belts	Parker	5	80	8d.	2/8	...
*Portsmouth	Portsmouth Corporation	..	Alternate current transformer	...	11,000	...	7½	2 miles	100	2,000	...	24 public & priv.	Concentric high-pressure feeders with separate conductors for low-pressure distribution	Lancs.	5	...	Horizontal. Turbo Generator. Vertical	2 1 4	320 270 50	Ropes	...	2 1 4	150 200 30	6d.	2/6	Also 160 Public Arc Lamps.
Preston	The National Electric Supply Company	F. F. Bennett	Three-wire	7,000	20,000	4,000	...	800	110	115	200; Aron, Ferranti, Frager, Thomson, Reckenzaun, Kelvin.	7	Bare Copper	Multitub'l'r, Lancashire.	5	250	Belliss open compound	8 2	100 50	Direct	Westminster	...	...	7d.	3/1¼	15 per cent. discount per B.T.U. if paid within 21 days.
Reading	Reading Electric Light Company	F. F. Yeatman	Alternate current transformer	770	700	...	...	...	100	2,000	Thomson-Houston	...	Overhead cables	...	...	...	...	1 3	50 25	Belts	Thomson-Houston	...	...	8d.	3/-	There are about 80 1,200 c.p. arc lamps supplied to shop, &c., the current being generated by one 18 and three 30-arc lighters.
Sheffield	Sheffield Electric Light and Power Company	W. Johnson (*Man. & Sec.*)	Alternate current transformer	...	6,000	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6d.	1/10 2/2	Station being re-arranged. Mains will be run under ground. Separate transformers on consumers' premises to be replaced by transformers in chambers under footways.
Southampton	Southampton Electric Light and Power Company	K. A. Scott-Moncrieff	Three-wire with batteries	2,500	2,700	1,300	...	785	100	105 (max.)	42 Aron and 18 Ferranti	1½ Distrb.	Crompton	Locomotive	1 1	20 40	Robey Willans	1 1	40 60	Belts and Direct	Crompt'n	2 1	33 38	10d.	2/10 3/4	B.T.U. (With rebate on sliding scale).

* Stations marked with an asterisk are in progress.

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should be taken for the provision of electrical standards," the committee held several sittings, and examined numerous representative witnesses. Its preliminary report was published in August, 1891, and on November 29th last its final report was signed. Before many more years, we may reasonably hope to see the legislative adoption of the same electrical standards of measurement all over the civilised world, England, America, Germany, and France leading the way. This may seem to some but a very peddling affair. We may, however, perhaps realise its intrinsic importance if we try to imagine the vexation of spirit which would be caused by the simultaneous existence of half-a-dozen different amperes, volts, and ohms; and the lamentable waste of brain tissue which would have been avoided had international standards been possible when European nations first began to think of evolving order out of the chaos of miles, toises, stunden, versts, pounds, livres, pfunde, and funts. In the domain of pure electrical research, the most striking work has been that carried out by Prof. DEWAR, in collaboration with Prof. FLEMING, on the electrical resistance of pure metals, alloys, and non-metals at the boiling point of oxygen, an investigation which showed not only that the specific resistance of perfectly pure metals tends to zero at absolute zero temperature, but revealed a remarkably delicate means of testing the purity of metallic substances. At the British Association, which met in Edinburgh in August, the average of the Papers was even below the not too high standard which obtains at these gatherings. Interesting discussions, however, took place upon the nomenclature of electrical units, and the desirability of establishing a national physical laboratory, a most appropriate subject in view of the presence at the meeting of Prof. VON HELMHOLTZ. The discussion disclosed the existence of a considerable diversity of opinion as to the utility of such an institution, and no two speakers could agree either as to the proper functions of such a national physical laboratory, or as to the expediency of soliciting Government support. Dr. LODGE, who opened the debate, made, it was generally admitted, a powerful and well-reasoned exhortation on behalf of the more scientific organisation of the Grand Army of Science, and for the delegation to a highly equipped central institution of investigations for which amateurs and busy professors have neither the time, the money, nor the apparatus.

At the Institution of Electrical Engineers the 1892 Session was opened by an address on "Electrotechnics" from Prof. AYRTON, an address which, with the exception of a single spirited attack upon "useless Greek," kept commendably clear of the ever-burning question of the relative value of a scientific and of a classical education. As to the speaker's heartfelt conviction on this point, however, there could be but little doubt, and, as we listened to his glowing eulogy of electrotechnics, a passage from an address on popular culture delivered some fifteen years before at Birmingham came irresistibly to mind. "I cannot help thinking," said the speaker on that occasion, "that one of the most narrow, and what will eventually be one of the most impoverishing, characteristics of our day is the excessive supremacy claimed for physical science. This is partly due, no doubt, to a most wholesome reaction against the excessive supremacy that has hitherto been claimed for literature, and held by literature, in our schools and universities. At the same time, it is well to remember that the historic sciences are making strides not unworthy of being compared with those of the physical sciences, and not only is there room for both, but any system is radically wrong which excludes or depresses either to the advantage of the other." Prof. AYRTON's Address was followed by a decidedly sensational experimental lecture by Mr. NIKOLA TESLA in the theatre of the Royal Institution, and later on by the interesting Paper of Messrs. GLADSTONE and HIBBERT, "On the cause of the changes of Electromotive Force in Secondary Batteries," in which they described a variety of experiments tending to prove their contention that it is to variations in the strength of the sulphuric acid that we must look for the main cause of the variations of the electromotive force of secondary batteries. The last paper of the year was a lengthy contribution from Dr. FLEMING, entitled: "Experimental Researches on Alternate Current Transformers," the discussion on which, after extending over two evenings, was adjourned until the 12th of this month. Both the composition of the Council, and the wholesale method of electing associates, have been called into question during the year, and there seems to be a widespread feeling that the quality as well as the quantity of the associates should be taken into consideration by the powers that be. Last, but not least, the year 1892 has seen the compilation of a compendious index to the volumes of the Institution Journal covering the period 1882-1891.

Electric lighting has during the twelvemonth just elapsed continued to progress, but its advance has been uneventful and the pace moderate. In the Metropolis the only new ground broken has been in the City, where the street arc lighting is now practically complete, and where some way has been made with the private lighting mains. The electric lighting business gives every indication of settling down to a prosy and, let us hope, prosperous middle age. New types of dynamos, new systems of distribution are at a discount, and the grim necessity of earning a dividend has concentrated all energies upon the effecting of minute economies and the encouragement of an even load by all manner of ingenious devices. The three-phase craze has died out, and the earthing of the middle wire of a three-wire system has taken its place as an excuse for mild polemics in the papers. Niagara has at last been harnessed, but now that the thing is done—or, rather, nearly done—crabbed critics are saying that the coal-fields of Lancashire, supplemented by a system of electric transmission, are, after all, superior as a source of cheap power to the Horse Shoe Falls. Not the least noteworthy of events has been the way in which the successive tests of Prof. EWING have removed the last doubts which have not unnaturally lingered in the minds of steady-going mechanical engineers as to the economy of the Parsons' turbine at high and low loads. The Crystal Palace Exhibition, which opened on the 9th January with the avowed intention of giving to electric lighting in 1892 an impetus similar to that afforded by the Exhibition of ten years before, resulted in a loss to the Crystal Palace Company and little profit to the electric lighting industry. In America, 1892 will be memorable in the annals of electricity for the amalgamation of the Edison and Thomson-Houston Companies under the name of the General Electric Company, with its natural sequel—a merciless attempt to crush the life out of all less powerful concerns, and thus secure a monopoly of the entire heavy electrical engineering business of the United States.

Municipal enterprise in the direction of electric lighting continues as vigorous as ever. Accrington, Blackpool, Stafford, and Worcester have all voted large sums to carry out municipal electrical supply schemes; the Vestry of Hampstead is determined to emulate the Vestry of St. Pancras, and Brighton has within the last few weeks decided to expend no less than £35,000 in extending its present system. The foundation-stone of a municipal electric lighting station was laid at Portsmouth in October, and just a month before the Dublin Corporation took over the electric light

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works from the contractors. Finally, Glasgow, after buying up the local company in a straightforward, if not too generous, manner, has also plunged into the fascinating trade of supplying electric energy. As to the local authorities who are "considering the matter," their name is Legion. The immediate disadvantages of "municipalisation" are purely social; meanwhile, until the inevitable results, good or bad, of this propensity begin to mature, electrical contractors may congratulate themselves on the prospect, which the trading mania of municipalities affords, of getting hard cash, and not shares, for work done. Up to the present, municipal management has fulfilled the prophecies neither of friends nor foes.

From the point of view of mileage in operation, electric traction has during 1892 gone perilously near to retrogression. The Side Overhead Trolley system, it is true, commenced work on the very last day of the year, but both at Croydon and at Barking accumulators cars have ceased to run, and at Birmingham they have involved a loss. The Central London Railway is still completely *in futuro*, and the Liverpool Overhead Railway has not, as yet, given us a taste of its quality. On the other side of the account may be set down the increasing receipts and decreasing cost per mile run of the trains on the City and South London Railway, and comfort may possibly be found in the exhilarating spectacle of no less than four important metropolitan electric railway schemes hung up in a state of suspended animation in the Legislature, not to mention one in receipt of the Royal Assent and two new schemes now in the sanguine stage of promotion. On the whole the year's record is not brilliant. The progress of electric traction in this country is undoubtedly slow, and the inactivity is due to the lack of demand by the public for rapid transit and to the reluctance of capitalists to finance it, rather than to any disinclination on the part of contractors to undertake the work.

The telegraph world this year is in the happy position of a country without a history. In submarine telegraphy the most noteworthy incidents have been the continued activity of the French, the laying of the Senegal-Pernambuco cable, and the decision of the Australasian Colonies to revert to a slightly higher tariff, *i.e.*, 4s. 9d. a word in lieu of 4s. In accepting a resolution, moved by Sir E. Birkbeck on April 26th, the Government pledged itself to take immediate steps to telegraphically connect the signal and life-boat stations around our coasts with one another and with the main system of the country, and to appoint a Royal Commission to inquire into the larger question of telegraphically connecting our outlying lighthouses and lightships with the shore. At the time of writing a large sum has already been spent on land-lines, and the Royal Commission, after an exhaustive inquiry, has issued an interim report. In telephony the past twelvemonth has been one of "alarums and excursions." Early in the year the London Chamber of Commerce began to stir, and by the end of March had got itself into an influential deputation, which waited on the Postmaster-General, who thereupon made a speech in the House of Commons announcing the advent of a new era of telephony, which new era subsequently became embodied in a Treasury Minute. The Government proposed to take over the telephone trunk wires from the National Telephone Company, and would in future assist that concern in its endeavours to provide the public with a good service. Apparently, this Arcadian picture was not to the liking of Dr. Cameron, for on March 29th he attempted to cut the telephone tangle by moving a resolution in favour of Government purchase. But the British Public, as represented by Her Majesty's faithful Commons, decided by a large majority to postpone the inevitable. Exactly three months later the New Telephone Company, the *raison d'être* of which had by this time become rather obscure, asked the public to subscribe the balance of the capital not taken up by the National Company. Finally, on December 10th, the lamb lay down with the lion, and the threatened telephone war to the knife passed away in a fizzle of financial Press congratulations. In America, Edison was, on May 3rd, granted a long-deferred patent, covering, it would seem, all telephones in which carbons are used. On October 19th, a more solid achievement was recorded, namely, the inauguration of the New York-Chicago telephone line, which, as the distance separating these two towns is about 1,000 miles, is by far the biggest thing of the kind in the world, so that its progenitors may rest content.

Electrical litigation has, as in former years, been rampant. On February 23rd, the action brought by Mr. Lane Fox against the Kensington and Knightsbridge Electric Lighting Company for alleged infringement of his distribution patent No. 3988 of 1878 came on for hearing before Mr. Justice A. L. Smith, the battle finally ending in the Appeal Court six months later when the patent was invalidated on the grounds of disconformity, insufficiency of description, and want of utility. *Requiescat in pace.* On November 2nd Dr. Hopkinson commenced his action against the St. James and Pall Mall Electric Light Company for infringing his three-wire patent No. 3576 of 1882, and Mr. Justice Romer's decision thereon is still pending. On December 13th the action brought by the National Telephone Company against Mr. Graff-Baker for disturbing the Leeds telephone circuits by the working of his electric cars came on for hearing before Mr. Justice Kekewich, and now stands adjourned until the 12th inst. On April 5th the Brush compound-winding patent No. 2003 of 1878 received its quietus in the House of Lords after a long career of uninterrupted misfortune in the Courts below. In his native land, *per contra*, Mr. Brush's claim to the invention of the pasted accumulator plate has again been sustained, as has Mr. Edison's incandescent lamp patent.

The death-roll of 1892 has been unusually heavy. The National Telephone Company lost its president, Mr. Leyland, at a moment when it could ill spare him, and the New Telephone Company was likewise deprived of its leader, the Duke of Marlborough, at an equally critical juncture; whilst the names of Van Depoele, Slattery, Eugene Cowles, Peter Willans, Edward Graves, Cyrus Field, Frederic Gisborne, and Werner von Siemens recall valuable services rendered to electric traction, distribution, metallurgy and engineering, telegraphy and science.

SELF-INDUCTION IN TELEGRAPHY AND TELEPHONY.

In the course of a very interesting Paper by the late Mr. Willoughby Smith on "The Working of Long Submarine Cables," read before the Society of Telegraph Engineers on February 12, 1879 (*Journal*, Vol. VIII.), after describing certain tests in which self-induction was deliberately introduced with the object of neutralising the capacity of a cable, he remarked:—"From the results of these and similar experiments, I was under the impression that by a judicious distribution of electro-magnets on subterranean lines, greater speed might be obtained." Once or twice since this date, electricians recognising that the great enemy of high-speed telegraphy in cables, or even in long land lines, was the retardation due to the capacity of the circuit, and that the effects of capacity are practically opposite to those of self-induction, have suggested, as Willoughby Smith had done, the use of induction coils for

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improving the working of such lines. On the other hand, since the presence of self-induction in telegraph instruments has given rise to a retardation of a totally different character, other electricians have resorted to every possible device for reducing this quantity to a minimum, especially in telephony. Mr. Oliver Heaviside has always contended that self-induction was useful rather than inimical to long telephone lines, but as no bad line was ever turned into a good line—as far as we have heard—under his auspices, his views were accepted only by a few students of his writings. He recurs to the subject in the course of his articles on Electromagnetic Theory this week.

Meanwhile, the practical application of self-induction in its *rôle* of a negative capacity has formed the subject of a patent which may turn out to be of considerable importance. Before proceeding to describe the methods by which it is proposed that this invention may be carried out in practice, a popular exposition of the two effects may be found useful by non-mathematical readers. A line having a considerable capacity may be compared to an elastic tube. When a current is sent into the former, or when a stream of water is suddenly forced into the latter, a great rush occurs at first, and this decreases at first rapidly and then gradually, until a steady flow is attained.

The phenomenon of retardation due to capacity is easily understood by the foregoing analogy. The liquid distends the elastic tube at first instead of passing along it. On the other hand, an analogy is to be found between self-induction and inertia; but it should be clearly borne in mind that it is only an analogy, and that to say that an electric current possesses inertia is likely to give rise to most erroneous ideas. A line having considerable self-induction, then, may be compared with a tube in which a liquid of considerable mass is set in motion. A stream of mercury suddenly forced along a tube under a given pressure will start more slowly than a stream of water in the same tube and under the same pressure, owing to the greater inertia of the mercury, but, as in the former analogy, after a certain time the flow will be steady. The one effect is to a large extent the reverse of the other. Analogy, however, ceases when we consider that the self-induction of a circuit depends rather on its shape and the presence of iron—in fact, on the surrounding medium—than on the nature of electricity, or of what we call an electric current.

The attempts which have hitherto been made to combine self-induction with capacity, so that the former, which can be artificially introduced and accurately adjusted, may neutralise the latter, which is inevitable, have been confined to the use of induction coils at ends of the line. Induction coils are in common use on ordinary telephone lines in connection with the transmitters for speaking, but so greatly do they impede the currents that in certain cases it has been customary to cut out the coil at the receiver while listening. The self-induction being either in the wrong place, unnecessary, or altogether out of proportion to the capacity, the improvement by cutting out the coil has strengthened the idea that self-induction is essentially disadvantageous. A moment's consideration will show that the capacity is evenly, or nearly evenly, distributed along a cable, but it is not quite so clear that the introduction of self-induction at the extremities of the line is of little use in cancelling the capacity. This, however, is the case, and the distribution of self-induction *along* a line is the essence of Patent No. 22,304 of 1891, by Prof. S. P. Thompson. The following abstract has been taken from the specification which bears the title "Improvements in Means for Use in or in connection with the Conveyance of Varying Electric Impulses, applicable to Electric Signalling for Telegraphic, Telephonic, or other Purposes":—

As lines and cables whether aërial, subterranean or submarine are now constructed, there is a practical limit to the distance to which signalling is possible with existing instruments: my invention will increase this distance. There is, also, for a line or cable of given length, as at present constructed, a limit to the rapidity at which signals can be transmitted by instruments of a given type: my invention will increase this rapidity of signalling. There is, moreover, for a line or cable of given length, as at present constructed, a limit to the kind of instrument that can be used to signal, high-speed instruments, harmonic telegraphs and telephones not being capable of being used on long cables or on very long lines. For example, the capacity of an Atlantic cable, which is about one-third microfarad per nautical mile, retards telegraphic signals so much that only a few words per minute can be transmitted. The distance to which rapid automatic signals can be sent through cables of this type is but a few score miles. Through very long cables of existing types, telephones, harmonic telegraphs and rapid automatic instruments cannot be used at all. It is known that the cause of the limitations mentioned above as found with cables and long lines of existing type is the presence throughout the length of the cable of electrostatic capacity. Such electrostatic capacity is in general not located at any one point, but is distributed more or less uniformly along the line or circuit. By this invention the effects of this distributed capacity are counter-balanced by applying distributed electro-magnetic induction. The invention consists in dividing the entire line into sections of preferably equal resistance, and between each section inserting an induction device capable of more or less completely neutralising the electrostatic charge of a portion of the line equal to one section. The electrostatic capacity distributed along the cable or line is thus balanced, as it were, in sections, each compensator so introduced into the line or cable exerting a neutralising effect on the capacity of the cable in the adjacent parts. Thus, for example, if a self-induction coil is of sufficient size and power to approximately neutralise the effects of electrostatic capacity of any cable for a distance of five miles on either side from the point where it is inserted, it will be expedient to treat that cable in sections, each of ten miles length, similar self-induction coils being inserted every ten miles along the cable. Self-induction or mutual induction coils for use as compensators should have not only a high time-constant but a high resistance relatively to that of the sections of cable which they are to compensate or connect. The essence of the sectioning of the cable is, that since retardation results from there being a capacity distributed along a great length, one should so modify the system that movements of electricity to effect the charges and discharges of the accumulations in the cable can take place over short lengths of circuit instead of having to flow in and out from the ends up to the places where the charge has accumulated.

The specification goes on to describe various methods of carrying this invention into practice, and, for the most part, relates to cables having two or more conductors. The simplest case consists of the use of a number of compensators arranged in parallel across the two conductors of a cable. These compensators consist of a wire of high resistance coiled round a core of well laminated iron (preferably composed of numerous fine wires insulated by rust or otherwise from each other) joining the two conductors. The coil is, of course (as well as the core), covered with insulated material, and its choking or self-inducing action, if it consists of a sufficient number of turns of the fine wire coiled near together, will cause sufficient resistance to prevent all but an insignificant quantity of the working charge to short circuit. In electric cables the induction coils must be further arranged so as not to form unwieldy enlargements of the cable, and are preferably long and narrow, and with the axes parallel to that of the cable.

The specification contains fourteen illustrations, showing various arrangements of choking coils, or of mutual induction, or transformer coils connected in series, or in parrallel with two or more conductors in a cable.

In some cases it may be practicable to use an uninsulated conductor in the place of one of the wires above referred to, but such an arrangement will usually be greatly inferior to the twin or multiple conductor system in which all the conductors are insulated. But in all cases it is necessary to bear in mind as an essential part of the invention that the compensators must be distributed through the length of the cable so as locally to counteract the effect of the static inductive capacity of the cable which is itself distributed over the whole length of the cable, and that the completeness of the counteraction will depend upon the compensators being sufficiently numerous thus locally to destroy the ill effect of the static induction. In other words, the cable must have compensators at sufficiently short distances to render it possible to practically neutralise, by means of the compensators, the effect of the static induction in the lengths of the cable between the compensators.

SUMMARY OF ELECTRICAL EVENTS FOR 1892.

JANUARY.

The Queen confers a peerage upon Sir William Thomson (Lord Kelvin) (1st).

Death of Sir George Biddell Airy, ex-Astronomer Royal.

Death of Mr. F. R. Leyland, president of the National Telephone Company (4th).

Opening of the Crystal Palace Electrical Exhibition (9th).

The Royal Academy of Science of Turin present Prof. Hertz with the Brescia premium of £500.

Inauguration of street electric lighting in St. Pancras.

Death of Mr. Alexander Watt (15th).

Presidential Address by Prof. Ayrton at the Institution of Electrical Engineers on "Electrotechnics" (28th).

Dividends declared: St. James' and Pall Mall Company, 8½ per cent.; Anglo-American Telegraph Company, 2⅝ per cent.; Hastings and St. Leonards-on-Sea Electric Light Company, 7½ per cent.; Newcastle-upon-Tyne Electric Supply Company, 4 per cent.

FEBRUARY.

Lecture by Mr. Nikola Tesla before the Institution of Electrical Engineers on "Experiments with Alternate Currents of High Potential and High Frequency" (3rd).

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The Glasgow Corporation finally decide to purchase Messrs. Mavor and Coulson's central station, business, and plant for £15,000.

The Tramways Committee of the Glasgow Town Council publish a statement showing the relative cost of tramway traction by horses, cable, and accumulators.

Publication of the Parliamentary estimates for the construction of the proposed metropolitan tubular electric railways.

Publication of the London County Council's Rules and Regulations affecting the use of the electric light in theatres and other places of entertainment.

Paper read before the Institution of Electrical Engineers by Mr. Alexander Siemens on "Some Experimental Investigations of Alternate Currents" (11th).

The "Sir William Siemens" Electrical Engineering Laboratory at King's College opened by Lord Kelvin (19th).

Mr. Nikola Tesla lectures before the Société Français de Physique and the Société Internationale des Électriciens (19th).

A widespread magnetic disturbance of unusual severity interrupts telegraphic communication all over Europe and the United States (13th-14th).

A special general meeting of the London Chamber of Commerce "to consider the general position of the commercial community in regard to the telephone service of London and the Telephone Bills now before Parliament."

Deputation appointed to wait on the Postmaster-General to "express the view of the Chamber as to the supreme importance of H.M. Government bringing a General Powers Bill into Parliament so as to afford facilities for the development of the telephone" (22nd).

The action for infringement of Patent No. 3,988 of 1878 brought by Mr. Lane Fox against the Kensington and Knightsbridge Electric Lighting Company comes before Mr. Justice A. L. Smith (23rd).

Dividend declared: Newcastle and District Electric Lighting Company, 5 per cent.; India Rubber, Gutta Percha and Telegraph Works Company, 12½ per cent.; Telegraph Construction and Maintenance Company, 20 per cent.; City of Bath Electric Lighting and Engineering Company, 4 per cent.; Keswick Electric Light Company, 3 per cent.

March.

Paper read before the Institution of Electrical Engineers on "Oil as an Insulator," by Prof. D. E. Hughes (10th).

Electric cooking demonstrations at the Crystal Palace Exhibition.

Interesting experimental lecture before the O. S. A. on "The Behaviour of Insulating Materials under the Action of High Potential Differences," by Messrs. H. B. and W. Fox Bourne (11th).

Official announcement that the Belgian Government propose to take over the telephonic system of that country on January 18th, 1893.

Tenders for the arc lighting (6,000 lamps) of the Chicago Exhibition opened. Only one offer, that of the Thomson-Houston Company, at the rate of $38½ per lamp. Tender peremptorily rejected (15th).

Bill placed before the French Chamber of Deputies authorising an expenditure of £160,000 on the telephone system of Paris.

Conclusion of the hearing of the action, "Lane Fox *v.* Kensington and Knightsbridge Electric Lighting Company," after having occupied the attention of the Court for fifteen days (18th).

Death of Mr. Charles J. Van Depoele (18th).

Deputation of the London Chamber of Commerce to the Postmaster-General to state the views of the commercial community on the state of the telephone system of the United Kingdom (21st).

Important speech by the Postmaster-General in the House of Commons announcing new policy on the part of the Post Office in regard to the Telephone Companies (21st).

Paper on "Load Diagrams of Electric Tramways and the Cost of Electric Traction," read before the Institution of Electrical Engineers by Mr. A. Reckenzaun (24th).

Dr. Cameron's motion in favour of the Government purchase of the telephones rejected by 58 votes in a House of 352 (29th).

Judgment given by Mr. Justice A. L. Smith in the Lane Fox *v.* Kensington and Knightsbridge Electric Lighting Company case, invalidating Mr. Lane Fox's distribution patent No. 3988 of 1878 (30th).

Dividends declared: Kensington and Knightsbridge Electric Lighting Company, 2 per cent.; Liverpool Electric Supply Company, 4½ per cent.; Direct Spanish Telegraph Company, 4½ per cent.

April.

Contracts for the arc lighting of the Chicago Exhibition settled on the basis of $20 per light; 5,000 lights to be supplied by the Thomson-Houston, Western Electric, and Standard Electric Companies (2nd).

Nine tenders sent in for furnishing the incandescent lighting of the Chicago Exhibition; some 85,000 lights required (2nd).

Judgment delivered by the House of Lords in the action of "King, Brown, and Co. *v.* Anglo-American Brush Electric Light Corporation." The decisions of the Scotch Courts, invalidating Brush's "compound-winding" patent, No. 2,003 of 1878, upheld (5th).

The Chancellor of the Exchequer announces a large reduction in the Patent Office fees (11th).

Price of the B.T.U. at Bradford reduced from 6d. to 5d.

Increase of the Chicago Exhibition Government grant from £25,000 to £60,000.

Glasgow Police Commissioners decide to erect 106 arc lights in the streets of Glasgow (11th).

Death of Mr. Eugene H. Cowles, one of the inventors of the Cowles electric process for the manufacture of aluminium (21st).

Acceptance by the Government of Sir E. Birkbeck's resolution *re* Coast Communication (26th).

Paper read before the Institution of Electrical Engineers on "The Light of the Electric Arc," by Mr. A. P. Trotter (28th).

Dividends declared: Indo-European Telegraph Company, 6 per cent.; Oriental Telephone Company, 2¼ per cent.; Submarine Cables Trust, 6 per cent.; Western and Brazilian Telegraph Company, 4 per cent.; Metropolitan Electric Supply Company, 2 per cent.; Eastern Extension Telegraph Company, 7 per cent.; Indo-European Telegraph Company, 10 per cent.; Great Northern Telegraph Company, 8·6 per cent.; Western Brazilian Telegraph Company, 4 per cent.

May.

Issue by the United States Patent Office of three telephone patents to Mr. T. A. Edison, apparently covering all telephones in which carbon is used (3rd).

First meeting of the Joint Committee of Lords and Commons appointed to inquire into the metropolitan electric railway schemes (9th).

Issue of a revised tariff by the National Telephone Company at Sheffield, which was subsequently withdrawn, owing to the hostility which it aroused.

Paper read before the Institution of Electrical Engineers, by Messrs. Gladstone and Hibbert, entitled "On the Cause of the Changes of Electromotive Force in Secondary Batteries" (12th).

Formal amalgamation of the Edison and Thomson-Houston Companies, under the title of the General Electric Company.

Report of the Joint Committee of Lords and Commons appointed to inquire into the various metropolitan electric railway schemes. Committee reported that they could see no reason why the schemes should not go forward; that the proposed lines would tend to relieve the streets of passenger traffic; that electricity was a suitable and efficient source of motive power (23rd).

Award of the Albert Medal of the Society of Arts to Mr. T. A. Edison, "in consideration of the distinguished services rendered by him to the progress of electric lighting, telegraphy, and the telephone."

Fatal accident to Mr. W. P. Willans (24th).

Paper on "Electrical Distribution by the Newcastle-on-Tyne Electric Supply Company," read before the Institution of Electrical Engineers by A. W. Heaviside and R. C. Jackson (26th).

Annual General Meeting of the Electrical Trade Section of the London Chamber of Commerce; election of Major Flood Page as Chairman, and of Messrs. Émile Garcke and Alexander Siemens as Vice-Chairmen; appointment of a Special Committee to deal with the telephone and traction question (27th).

Issue of a Treasury Minute setting forth the future policy of the State in regard to the telephones; introduction of a Bill for facilitating the carrying out of this programme.

First meeting of the Select Committee of the House of Commons appointed to consider the Electric Railway Bills (31st).

Dividends declared: Consolidated Telephone, Construction, and Maintenance Company, 3½ per cent.; Reuter's Telegram Company, 5 per cent.

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JUNE.

Remarkable lecture by Prof. Dewar at the Royal Institution upon the Magnetic Properties of Liquid Oxygen and Air (10th).

The Taunton Town Council decide by 10 votes to 5 to purchase the Taunton Electric Light Company's Works for £9,300.

Strike of telegraphists throughout the Spanish Peninsula.

The action "Lane Fox *v.* the Kensington and Knightsbridge Electric Lighting Company" comes before Appeal Court II. (Lords Justices Lindley, Lopes, and Kay) (27th).

Dividends declared: Electric and General Investment Company, 25 per cent.; Western Counties and South Wales Telephone Company, 1 per cent.; National Telephone Company, 6 per cent.; West African Telegraph Company, 4 per cent.

JULY.

Inauguration of the Tivoli hydro-electric station (4th).

Helmholtz gold medal conferred upon Lord Kelvin.

The Sawyer-Mann "flashing" patent upheld in the States.

Death of Mr. Cyrus Field (12th).

Widespread earth-current disturbances (16th-17th).

Public subscription to the New Telephone Company opened; the National Telephone Company subscribes one-third of the issue (29th).

Issue of a circular letter to the Electrical Trade Section asking the members to co-operate in sending a representative exhibit to Chicago. No response.

The accumulator cars on the Barking-road section of the North Metropolitan Tramway Company's system cease running (28th).

Issue of the London County Council's Bye-laws relating to Overhead Wires (29th).

Dividends declared:—Eastern Telegraph Company, 6½ per cent.; Edison-Swan United Electric Light Company, 7 per cent.; Electrical Power Storage Company, 6 per cent.; African Direct Telegraph Company, 4s. per share; Manchester Edison-Swan Company, 5 per cent.; Sheffield Telephone Exchange and Electric Light Company, 5 per cent.; Direct United States Cable Company, 3½ per cent.; Globe Telegraph and Trust Company, 4⅞ per cent.; Crompton and Company, 7 per cent.

AUGUST.

Opening of the British Association meeting at Edinburgh (3rd).

Judgment in the action "Lane Fox *v.* Kensington and Knightsbridge Electric Lighting Company" given by the Court of Appeal. The decision of Mr. Justice A. L. Smith, invalidating Mr. Lane Fox's patent No. 3,988 of 1878 on the grounds of disconformity between the provisional and final specifications, insufficiency of description and want of utility, upheld (10th).

The operation of the accumulator cars on the Bristol-road section of the Birmingham Central Tramways Company's system during 1891-92 results in a deficit of £1,679; largely due, however, to abnormal circumstances.

Publication by the Board of Trade of a memorandum stating that, until further experience of the behaviour of electricity meters in actual working has been gained, the Department does not propose to grant any certificates (18th).

Death of Mr. Frederic Newton Gisborne, superintendent of the Canadian Government Telegraph Service and one of the earliest pioneers of Atlantic cable promotion (30th).

Trial at Helsby of the "Brain" covered conduit system of electric traction (30th).

Dividends declared: Cuba Submarine Telegraph Company, 8 per cent.

SEPTEMBER.

Offer of a prize of 5,000fr. by Prof. Elihu Thomson for an investigation tending to the development of our knowledge of theoretical electricity.

Death of Dr. Proell, inventor of the well-known cut-off gear.

Board of Trade Report published showing that 24 Electric Lighting Orders were granted and confirmed during the 1892 Session (23rd).

The Dublin Corporation take over the Electric Lighting Works (28th).

Laying of the Senegal-Pernambuco cable.

Dividends declared: Brush Electrical Engineering Company, 6 per cent.

OCTOBER.

Publication in the *Philosophical Magazine* of an important Paper "On the Electrical Resistance of Pure Metals, Alloys, and Non-Metals at the Boiling Point of Oxygen," by Profs. Dewar and Fleming (1st).

The Accrington Town Council sanction the expenditure of £10,000 on an electric lighting scheme (3rd).

The Blackpool Town Council accept tenders to the amount of £18,709 for electrical plant (4th).

The United States Circuit Court of Appeal give judgment in the suit of Brush Electric Company *v.* Electrical Accumulator Company, upholding the Brush claims to the pasted plate for secondary batteries, but on a narrower basis than laid down in the orignal decision of Judge Coxe given on July 23, 1891 (4th).

The Leeds Corporation prolong the agreement with regard to the Roundhay Park Electric Tramway for twelve months.

Mr. Thomas Hodgkins, of Setanket (N.Y.), presents the Royal Institution with £20,000, to be applied in the promotion of scientific research.

A large number of electric traction "franchises" permitting the overhead trolley system granted by the New York Board o Aldermen.

The action brought by the Edison Electric Light Company against the United States Electric Lighting Company for infringement of the Edison incandescent lamp, U.S. patent No. 223,898 of 1880, decided by the United States Circuit Court of Appeals in favour of the Edison patent (4th).

The New York-Chicago telephone trunk wire opened for traffic (19th).

The Brighton Town Council decide to light the sea-front by electricity.

Laying of the foundation-stone of the Portsmouth municipal central lighting station (27th).

Dividends declared: Brazilian Submarine Telegraph Company, 6 per cent., with a bonus of 1s. per share.

NOVEMBER.

Commencement of the action for alleged infringement of the three-wire patent 3,576 of 1882, brought by Dr. John Hopkinson against the St. James' and Pall Mall Electric Light Company (2nd).

Publication of some important tests of the Parsons Steam Turbine by Prof. Ewing; steam consumption, 26·6lb. per E.H.P.H.

Presidential Address to the Junior Engineering Society on "The Cost of Electric Supply," by Dr. John Hopkinson (4th).

Death of Mr. Edward Graves, Engineer-in-Chief to the British Post Office Telegraphs (9th).

Expiry of the Cheesbrough (Sawyer-Mann) "flashing" patent, No. 4,847 of 1878 (28th).

Paper on "Experimental Researches on Alternate-Current Transformers," read before the Institution of Electrical Engineers, by Dr. J. A. Fleming (24th).

Issue of a Supplementary Report by the Board of Trade Electrical Standards Committee (29th).

Dividends declared: Swan United Electric Light Company, 10 per cent.

DECEMBER.

The Brighton Town Council vote £35,000 for extensions of the Municipal electric lighting system (1st).

The Stafford Town Council decide to borrow £20,000 for carrying out an electric lighting scheme (6th).

The Worcester Town Council decide to accept the tender of the Brush Company for £23,000 for the execution of an electric lighting scheme (6th).

Death of Dr. Werner von Siemens (6th).

Amalgamation of the National and New Telephone Companies (10th).

The Nottingham Town Council decide to adopt a low-pressure system with secondary batteries and continuous current transformers (12th).

The Yarmouth Town Council decide to apply for permission to borrow £15,000 for electric lighting purposes.

Opening of the action brought by the National Telephone Company against Mr. Graff Baker for alleged injury to their business by reason of telephonic disturbances caused by the working of his electric cars at Leeds (13th).

County Court decision at Ipswich that an Electricity Supply Company is bound to renew customers' lamps (14th).

Death of Mr. M. M. M. Slattery, inventor of the well-known Slattery Induction System of Electrical Distribution (14th).

The appeal against the decision giving the Edison Company practically the monopoly of the incandescent lamp business in the United States disallowed, with the limiting proviso that lamps must be supplied to would-be buyers.

The Hampstead Vestry decide to spend £25,000 on a central lighting station (16th).

Death of Mr. Thomas Hodgkins, of Setanket, Long Island, U.S.A., recent donor of £20,000 to the Royal Institution.

The Windsor Town Council summons the Windsor and Eton Electric Lighting Company for breaking up the streets without permission. Company fined (19th).

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The Electric Construction Corporation seek the assistance of the Electric and General Investment Company in obtaining further capital by the issue of £100,000 Six per Cent. Second Mortgage Debenture Bonds.

Woodhouse and Rawson United (Limited) declare a balance loss of £130,000 on the year's undertaking. A committee of consultation appointed. The Directors authorised to raise a sum not exceeding £20,000 on the security of the floating assets of the Company.

Opening of the South Staffordshire Electric Tramway (31st).

THE ELECTRIC RAILWAYS AND TRAMWAYS OF THE UNITED KINGDOM.

Place.	Length.	System.	Worked by.
In Operation—	Miles.		
Bessbrook—Newry..	3¼	Third Rail (Dr. E. Hopkinson)	Bessbrook and Newry Tramway Company.
Birmingham	3	Accumulator Cars	Birmingham Central Tramways Company
Blackpool	2	Holroyd - Smith's Conduit	Blackpool Corporation
Brighton	1	Third Rail (Volk)	Mr. Magnus Volk.
Carstairs	1¼	Contact by side rail (Anderson-Munro)	J. Monteith, Esq., of Carstairs (Private).
City and South London Railway (King William - street—Stockwell)	3¼	Third Rail (Dr. E. Hopkinson)	City and South London Railway Company.
Guernsey	2¾	Overhead (Siemens)	Guernsey Railway Company.
Leeds (Roundhay Park Line)	6	Thomson-Houston Overhead	Mr. Graff-Baker.
Portrush — Giant's Causeway	8	Third Rail (Siemens)	Giant's Causeway Electric Tramway Company.
Ryde	¾	Third Rail (Siemens)	Ryde Pier Company.
Southend Pier	1¼	Third Rail (Crompton)	Southend Corporation.
Walsall, Wednesbury, Bloxwich, and Darlaston	8	Overhead Side Trolley	South Staffordshire Tramways Company.
In Progress—			
Liverpool Overhead Railway	6¼	Third Rail	Electric Construction Corporation.
Stockwell and Clapham	1	Third Rail.....	City and South London Railway Company.
Projected—			
Barry Island	...	...	Barry Docks Railway Company.
Blackpool-Lytham..	...	...	...
Bolton	...	...	Bolton Corporation.
Bradford..... ...	...	Experimental.....	Mr. Holroyd-Smith.
Brecon	...	...	Brecon Corporation.
Brighton - Rottingdean	3	Accumulator Cars	Brighton and Rottingdean Seashore Electric Railway Company.
London—			
Central London Railway (City and Shepherd's Bush)	6½	...	Central London Railway Company.
City and South London Railway (Islington Extension)	2¾	...	City and South London Railway Company.
Edgware - road — Victoria	4½	...	...
Finsbury Park and City	3¼	...	Great Northern Railway Company.
Hampstead, St. Pancras and Charing Cross	5¼	...	...
Paddington - Clapham	4½	...	...
St. Leonards-Hythe	...	...	South Eastern Railway Company.
Southport.....	...	...	Corporation.
Waterloo — Baker-street	3	...	...
Waterloo—City ..	1½	...	South Western Railway Company.
Wellingborough and District Tramroads	2½	...	Wellingborough and District Tramways Company.
Wigan	5½	...	Wigan Corporation.

ELECTRIC LIGHTING NOTICES.

The following is a list, corrected up to date, of the Electric Lighting Notices for 1893. It will be seen that there are 18 notices as against 32 last year. Of these 18 notices, no less than 11, not including the London County Council's scheme for lighting the Embankment, which, being embodied in a Bill, does not come within the purview of the Board of Trade, are given by Local Authorities, who seem more determined than ever to retain their grasp on electrical enterprise.

ELECTRIC LIGHTING NOTICES.

THE METROPOLIS.

Districts.	Names of Applicants.
Hackney	Board of Works.
Hammersmith..	Vestry.
Islington.....	Vestry.
Islington (St. Mary).	Holloway Electricity Supply Company.
Islington	County of London Electric Lighting Company.
Poplar.....	Board of Works.

THE PROVINCES.

Towns.	Names of Applicants.
Altrincham and Bowdon.	Manchester Edison Swan Company.
Barnet.....	Local Board
Beckenham (Kent).	Local Board.
Bridgend...	Local Board.
Brighton.....	Brighton and Hove Electric Light Company.
Colchester	Corporation.
Eccles	Corporation.
Newcastle - on - Tyne.	Newcastle-on-Tyne Electric Supply Company.
Newmarket ...	British Electric Light Company.
Partick	Commissioners of Police.
Reading	Reading Electric Supply Company.
Taunton	Corporation.

NEW PUBLIC COMPANIES OF 1892.

The following are the more important limited liability electrical and engineering companies registered during the past year, together with their capital :—

Name of Company.	Capital.
Abell's Electrical Engineering Company..... ...	5,000
Adolphe Crosbie	£15,000
African Trans-Continental Telegraphs	140,000
Agricultural Machinery Company of France	80,000
Akester Electrical Syndicate.....	15,000
Albright and Wilson	400,000
Alwyn (L.)	2,000
American Insulated Wire Company.....	75,000
Anderson, Laverick, and Co....	10,000
Arcas Plating Company.....	80,000
Armstrong's Electric Light and Power Company	20,000
Assam-Bengal Railway Company.....	1,500,000
Association for the Protection of Telephone Subscribers.....	—
Askwith and Co.....	20,000
Astley (John) and Sons	3,000
Automatic Gem and Gold Extractor Syndicate...	1,000
Barrett (R.) and Son	100,000
Bates Steel Company..	350,000
Bickle and Co.	50,000
Birmingham Iron and Steel Steam Company.....	3,000
Black, Hawthorn and Co.	110,000
Blaiberg and Marson	25,000
Boardman's Electric Sun Lamp Patents.....	10,000
Bristol and Kingswood Engineering and Boiler Company	15,000
Bryncelyn Gas Light and Coke Company	1,500
Burglar and Fire Alarm Company	20,000
Cambridge Electric Supply Company	50,000
Capon, Heaton and Co.	20,000
Carbon Battery Company	10,000
Central Electrical Company	50,000
Central Engineering and Ship Repairing Company	9,000
Central Rail Traction Company	10,000
Channel Tubular Railway Preliminary Company	40,000
Chelmsford Electric Lighting Company	10,000
Chesterman (Jas.) and Co.....	75,000
Compagnie des Forces Electriques	—
Compound Motor Company	200
Corlett Electrical Engineering Company	10,000
Cropper (H. S.) and Co.....	15,000

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Name of Company.	Capital.
Cutting (R. C.) Douglass and Co.	20,000
Day's Gas Engine Company	60,000
Dibasic Iron and Steel (Pioneer) Company	200,000
Dominion Electrical Company	25,125
Dowie and Handyside	4,000
Drosophore Company	15,000
Edison-Bell Phonograph Corporation	60,000
Electric Clock Company	1,200
Electric Cycle Syndicate	3,000
Electric Fittings Hiring and Maintenance Company	200,500
Electric Lamp Company	4,000
Electric Lighting and General Development Syndicate	700
Electrical and General Contract Corporation	50,000
Electrical Coal Cutting Contract Corporation	402,000
Electrical Company	15,000
Electrical Installation Company	1,800
"Electrical Plant"	10,000
Electrical Wonder Company	10,000
Electro Alkali	160,000
Electro-Automatic Fire Extinguishing Company	12,500
Elieson Accumulator British Patent Syndicate	12,000
Elmore's American and Canadian Patent Copper Depositing Company	200,000
Elsner & Co	12,000
Engineering and General Contract Corporation	100,000
Engineering Exchange	10,000
"Eston" Arc Lamp Syndicate	25,000
Expanded Metal Company	125,000
Farmer (Sir James) and Sons	50,000
Fletcher, Russell & Co	150,000
Glauber Ferrite Syndicate	25,000
Globe Engineering Company	40,000
Gray (C. and E.)	5,000
Harfield and Co.	100,000
Harvie (W.) and Co.	30,000
Heatley and Gresham	10,000
Hicks, Hargreaves, and Co.	240,000
Hind and Lund	10,000
Hirst and Co.	5,000
Hockett	10,000
Holliday and Williams	3,000
Holloway Electricity Supply Company	2,000
Hope Jones Electric Organ Company	25,000
Hove Electric Lighting Company	40,000
Howell (J. C.)	25,000
Hull Tramways Company	25,000
Inventions Contract Syndicate	5,000
Jacquard Automatic Reading and Punching Machine Syndicate	150,000
Jordan (C) and Sons	30,000
Keighley Electrical Engineering Company	10,000
Kennedy Storage Battery Company	100,000
Landore Copper Company	3,000
Lansard (Emile) Syndicate	10,000
Lithanode and General Electric Company	100,000
London and Hampstead Battery Company	50,000
London and Suburban Messenger and General Agency Company	25,000
London Electric Manufacturing Company	10,000
London Electric Wire Company	50,000
London Health Electrical Institute	10,000
London Mica Importers	70,000
Longbottom (John) and Co.	2,000
Lynch and Company	25,000
Madras Electric Tramways Company	100,000
Mather and Platt	200,000
Maybury and Marston	50,000
Measures Brothers	100,000
Mein's Engine Company	3,500
Meiter Syndicate	156,000
Merryweather and Sons	110,200
Metal Reduction Company	100,000
Metropolitan Light Company	5,000
M'Onie, Harvey and Co.	35,000
Newall and Co.	10,000
New British Electrical Installation Contractors	25,000
New Electricity Supply Company of Croydon	40,000
New Electro-Metallurgical Syndicate	10,000
Newport Metal Stamping Company	3,000
Newton (J. W.) and Co.	10,000
North American Construction Company	100,000
Nottingham Machinists Company	30,000
Oakden and Sharpe	20,000
Oncken Patent Staveless Barrel Company	150,000
Ozone Syndicate	25,000
Pacific and European Telegraph Company	100,000
Payne-Gallwey, Pickering and Co.	20,000
Piggott (T.) and Co.	90,000
Pioneer Telephone Company	100,000
Pontypool Electric Light and Power Company	10,000
Pope (W.) and Son	12,000
Powditch (J. R.) and Co.	4,000
Princess Company	2,000
Railway Electric Reading Lamp Company	100,000
Rawdon Foundry Company	2,000
Reading Electric Supply Company	75,000
Regenerating Boiler Company	5,000
Renton, Gibbs and Co.	10,000
Richmond Electric Light and Power Company	50,000
Roots' Petroleum Motor Syndicate	2,000
Saunders (John)	8,000
Sax (J.) and Co.	20,000
Scarborough Electrical Supply Company	50,000
Schiele Union Engineering Company	12,000
Sea Fishing Company	10,000
Sheffield Electric Light and Power Company	98,000
Simpson (J.) and Co	250,000
Societé d'Électricité de la Méditerranée Souchier et Cie	fr.250,000
Solid Rolling Mills and Metal Works Co.	35,000
Sperryn, McDonald and Co.	5,000
Steedman (T. C.)	5,000
Stephante Flux Syndicate	5,000
Sykes (J.) Bros	100,000
Tavernier's French Patents	1,200
Tavy Iron and Engineering Works	10,000
Tawe Foundry and Engineering Company	2,000
Theatre Electrical and Specialities Production Company	5,000
Thompson, Ritchie and Co.	5,000
Tinkers	50,000
Titanic Steel Company	12,000
Trott Patent Valve and Engineering Company	50,000
United Electric Sewage and Chemical Syndicate	5,000
United Electric Tramways	30,000
United Kingdom Economic Gas Syndiacate.	10,000
Universal Arc Lamp Syndicate	3,000
Veale and Co.	10,000
Walsall Electrical Company	10,000
Weeks (W.) and Son	25,000
Western Counties Electric Light and Power Company	25,000
Wiggin (H.) and Co.	160,000
Young's Reversible Nut Lock Syndicate	12,500

PUBLIC COMPANIES WOUND UP, DISSOLVED, &c., IN 1892.

The following are amongst the limited liability companies which have been wound up during the past year, the asterisk denoting that the company was wound up by order of the Court :—

Anders, Elliot, and Chetham-Strode.
*Ateliers Hoster de St. Nicolas.
Blackpool Electric Tramway Company (line purchased by the Blackpool Corporation).
Caledonian Telephone Company (business taken over by the National Telephone Company, Limited).
City of We-tminster Electrical Syndicate (business taken over by the Westminster Electric Supply Corporation, Limited).
Collier Audible Telephone Syndicate (business taken over by the Collier-Marr Telephone and Electrical Manufacturing Company, Limited).
Eclipse Electric Lighting Syndicate.
Electric Date and Time Stamp Company.
Electric Tramcar Syndicate.
Electrical Assets Purchase Company.
*Froude-Hurrell Torpedo Company.
Grange Syndicate.
Henley Telegraph and Electric Construction Company.
Improved Galvanising Company.
*International Electric Syndicate.
Kensington Court Electric Lighting Company (business taken over by the Kensington and Knightsbridge Electric Lighting Company, Limited).
Keys' Electric Company (re-organised under the title of the Electrical Company, Limited).
MacMahon's Patent Electric Check System.
Maquay Syndicate.
Mining and General Electric Lamp Company (reconstructed as the Lithanode and General Electric Lamp Company, Limited).
Muir, Mavor and Coulson.
Mutual Telephone Company (business taken over by the New Telephone Company, Limited).
National Telegraph Works Company.
North-Eastern Telephone Company.
Pioneer Telephone Company (absorbed in the New Telephone Company, Limited).
*Poole and White.
Primary Syndicate.
Roper's Electrical Engineering Company.
Sheffield Telephone Exchange and Electric Light Company (business taken over by the National Telephone Company, Limited, and the Sheffield Electric Light Company, Limited).
South Staffordshire Electric Lighting Company.
Thomas Barraclough and Co.
Vaughan-Sherrin Electrical Engineering Company.
Western Counties and South Wales Telephone Company (business taken over by the National Telephone Company, Limited).

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The following companies have been dissolved or have ceased to exist, in most cases nothing having been done beyond registration, and no business commenced :—

Armstrong's Electric Light and Power Company.
Barry and Cardiff Electric Light and Power Supply.
Bath Electric Light Company.
Bournemouth Electricity Supply Company.
Bradford Mutual Electric Lighting Company.
Durand Electric, Petroleum, and Gas Engine and Manufacturing Company.
Electric Sewage Utilisation and Improvements Company.
Electro-Chemical Syndicate.
Elieson Electric Company.
Hanley Electricity Supply Company.
Johannesberg Electricity Supply Company.
Kidderminster Electric Light and Power Supply.
Morgan's Automatic Electric Signal System Syndicate.
Northern Counties Electric Light and Power Supply.
Regent Portable Electric Lamp and Lighting Company.
Sherrin Electric Power Generator Company.
Sunderland and District Electricity Supply Company.
Universal Electric Light and Power Trust Corporation.
Water Primary Battery Company.

The following changes in nomenclature have been made :—

Crystal Palace District Electric Supply Company, Limited (formerly the Electric Installation and Maintenance Company, Limited).
Islington and General Electric Supply, Limited (formerly the Camberwell and Islington Electric Light and Power Supply, Limited).
St. Luke, Chelsea, Electric Lighting Company, Limited (formerly the New Cadogan and Belgrave Electric Supply Company, Limited).

THE CENTRAL STATION AT MÜLHAUSEN.*

The central station at Mülhausen was designed by Messrs. Siemens and Halske, and was opened in March, 1888. Although small, the station is full of interest, and is a good example of a type much in favour nowadays.

The installation consists of :—

(*a*) Two boilers.
(*b*) Two steam-engines.
(*c*) Two direct-current dynamos coupled direct to the engine.
(*d*) Battery of accumulators.
(*e*) Underground cables.
(*f*) Switchboard.

(*a*) *The Boilers.*—Two Naeyer tubular boilers are used, having each the following proportions :—

Heating surface	2,100sq. ft.
Grate surface	47·4sq. ft.
Number of tubes	144
Length of tubes	13·12ft.
Interior diameter of tubes	3·86in.
Exterior ,, ,,	4·52in.
Weight of water	6·65 tons.
Working pressure	114lb. sq. in.

The boilers are fed by a pump, or by two ejectors, from a tank supplied by the water service mains of the town. The chimney, which is too large for the present boilers, affords ample margin for the extension of the station. It is 115ft. high, inside diameter at base is 6ft. 7¼in., and at the top 4ft. 11in.

(*b*) *The Engines.*—The engines are of the inverted cylinder compound-condensing type with the following principal dimensions :—

Diameter of high-pressure cylinders	15·35in.
,, low-pressure ,,	21·65in.
Stroke	15·75in.
Revolutions per minute	140 to 160
Indicated horse-power at 160 revolutions	180

The governor permits the revolutions to vary between 140 to 160 per minute by the addition of small weights.

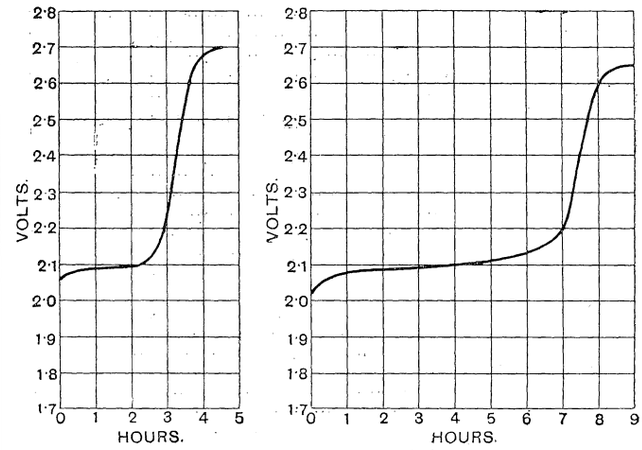
The pipe arrangements are so designed that should an accident occur during working to one of the steam pipes, the engines are not thrown idle, as there are two distinct sets of main steam pipes. Traps are fitted to the main steam pipes just before they enter the engines to insure the use of dry steam as far as possible. The exhaust may be thrown direct into the chimney should the condensers fail. The water for condensing purposes is drawn from a well close to the boilers, and runs to waste after passing through the condensers.

The engines are well and solidly built, and have been free from accident and overheating in the running parts, although they are very compact, and occupy a comparatively small space. Efficiency has, however, not been sacrificed, as during carefully-conducted trials the consumption of water, including cylinder jackets, was only 17·84lb. per indicated horse-power per hour. The cylinders are in two castings, bolted together with liners fitted in each cylinder, and jacketed throughout, except on the bottoms. The high-pressure cylinder is fitted with a piston valve and the low-pressure with an ordinary D slide valve. The cranks are at right angles, and counterbalanced with weights of a complete disc form. The crank shaft carries an overhung fly-wheel at the high-pressure cylinder end, and the dynamo is bolted direct on the bedplate at the low-pressure cylinder end, the shaft being supported beyond the dynamo by a moveable bracket carrying a spherical bearing.

(*c*) *The Dynamos.*—The dynamos are of the Siemens-Halske type, with armature in the form of a ring surrounding the magnets, which are six in number, and bolted direct on to the prolongation of the crank shaft. The armature is bolted direct on to the bedplate of the engine. This arrangement has among others the advantage of reducing to a minimum—

(1) The space occupied.
(2) The staff to look after the machine.
(3) The likelihood of stoppages on account of the means of transmission giving way.
(4) The initial price of the machines and their upkeep.

The brushes are so arranged that they can all be applied or taken off simultaneously by one simple movement, and their position can be altered at will. The periphery of the armature is carefully turned, and acts as commutator. The central rotating magnets produce a powerful magnetic field in close proximity to the armature. This being of a large diameter the circumferential velocity of the field is high, although the number of revolutions per minute is by no means excessive. It is this latter quality which enables the dynamo to be bolted direct on to the engine. Further, the lines of force are very advantageously placed to avoid leakage and so forth, and the difference of potential between two consecutive elements is so small that sparking at the brushes is entirely avoided.



FIGS. 1 and 2.—Tudor Accumulator. Voltage Curves (charging) of a 920 ampere-hour cell. (1) Current kept constant at 230 amperes. (2) Current kept constant at 115 amperes.

(*d*) *The Accumulators.*—To obtain greater security and economy in working, the station is fitted with three sets of accumulators of the Tudor type. There are two sets with a capacity of 645 ampere-hours, and another set with a capacity of 375 ampere-hours. The three together, giving out 145 E.H.P., during 3½ hours, this, together with the two machines at 180 H.P., gives a total of 505 I.H.P. To show the behaviour of these Tudor cells during charging and discharging we reproduce a curve (Fig. 1) of a cell with a capacity of 920 ampere-hours. The normal current of discharge is 276 amperes, and that of charging 230 amperes. Fig. 1 shows the variation in the pressure, the current being kept constant at 230 amperes during charging, which lasted for 4 hours 25 minutes. In Fig. 2 the charging current is kept constant at 115 amperes, the charging lasting 8 hours 40 minutes. The energy consumed is the same, practically, in both cases, but the pressure when charging with 115 amperes is naturally lower than when charging with 230 amperes. It is especially towards the end, however, that the difference becomes more marked. Fig. 3 shows the discharge with a constant current of 276 amperes, the useful capacity in this case being 920 ampere-hours. Fig. 4 was obtained with a constant discharge of 158 amperes, the useful capacity being 1,320 ampere hours. As the curves show, the volts descend from 2·6 to 1·9 in the first few minutes, and diminish insensibly to 1·83 volts, when they fall suddenly to almost nothing. In practice the pressure should never be allowed to descend below

* Abstract from the *Bulletin de la Société Industrielle de Mulhouse.*

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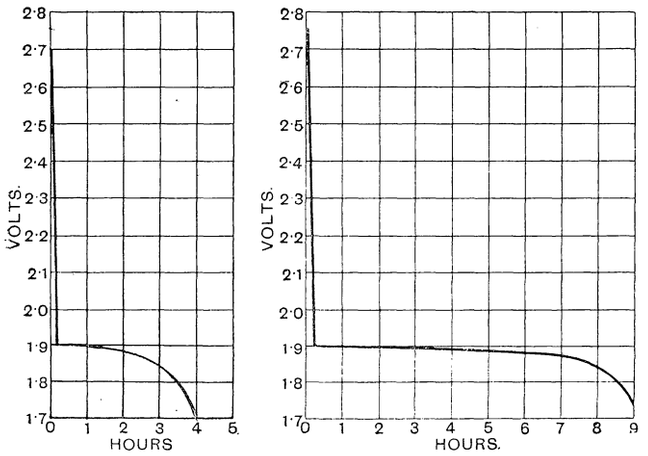
1·83 volts. It may be noted that the capacity of a cell augments if the discharge is slow.

(*e*) *The Conductors.*—The cables may be divided into three distinct categories, (*a*) main cables, (*b*) distributing cables, (*c*) branch cables.



FIGS. 3 and 4. Tudor Accumulator. Voltage Curves (Discharge). (3) Current kept constant at 276 amperes (920 ampere-hour cell). (4) Current kept constant at 158 amperes (1,320 ampere hour cell).

The main cables serve to lead the current to the various distributing centres, and the fall in potential in these mains does not exceed 5 volts. The distributing mains distribute the current locally, the loss in this section does not exceed 2 volts, and to these are attached the branch cables that serve the consumers. All the cables are of the Siemens concentric three-wire type. The mains are not run in any special conduits, but are simply buried in the earth at a depth of about 27in. The junction boxes are of cast iron, and filled with an insulating material that solidifies on cooling. The boxes are hermetically sealed with thick oil when closing them down.

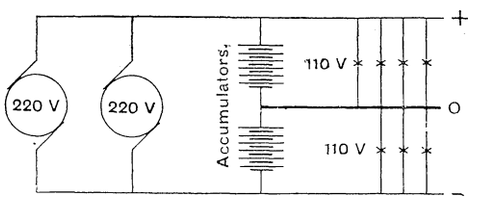


FIG. 5.—The Three-wire system at Mülhausen.

Fig. 5 shows, in a diagrammatic manner, the arrangement adopted in the Mülhausen installation. One of the principal advantages in the three-wire system is the cheapness of the conductors, which may be illustrated as follows :—

Taking first the ordinary two-wire system, let

I = Current in amperes.
L = Distance in metres to be traversed by the current.
T = Drop allowed (in volts).
C = Coefficient depending on the nature of the conductor.
S_1 = Section of one conductor.
S_2 = Total section of the two conductors.

Then $$S_1 = \frac{I L}{T C} \quad : \quad S_2 = 2 S_1 = \frac{2 I L}{T C} \quad . \quad . \quad . \quad . \quad (1)$$

Now, for the three-wire system with the same amount of energy we have double the pressure, and therefore half the current, that is I now becomes I/2 and T becomes 2 T while L and C remain unchanged.

$$\therefore S_1 = \frac{L\, I/2}{2\, T\, C} = \frac{I L}{4 T C}.$$

Since the section of the third conductor may be half the others, and denoting the section in the three-wire system by S_3, we have

$$S_3 = 2{\cdot}5\, S_2 = \frac{2{\cdot}5\, I\, L}{4\, T\, C} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Comparing (1) and (2)

$$\frac{S_2}{S_3} = \frac{\frac{2 I L}{T C}}{\frac{2{\cdot}5\, I L}{4 T C}} = \frac{8}{2{\cdot}5},$$

and $$S_3 = \frac{2{\cdot}5\, S_2}{8} = 0{\cdot}5125\, S_2,$$

which represents an economy of 68 per cent. for the three-wire system over the two-wire system in conductors alone.

The daily output of the Mülhausen central station may be divided into three distinct phases :—

(1) Energy supplied by the accumulators.

(2) Energy supplied by the dynamos and the charging of the accumulators.

(3) Energy supplied by both dynamos and accumulators.

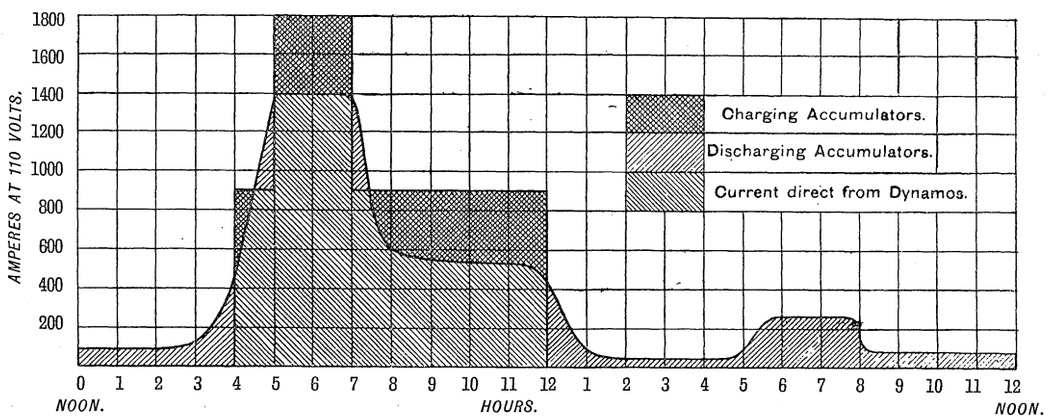


FIG. 6.—Mülhausen Central Station. Output Curve.

Fig. 6 gives the curve of output for a day in December, 1891, and shows that one dynamo alone was working from 4 to 5 and from 7 to midnight, while the two dynamos were at work between 5 and 7, the accumulators supplying the current for the rest of the time.

The advantages of the system are that the accumulators supply the current during the slack hours of the day, the engines only working during the busy hours of the afternoon when the cells are charged, which arrangement enables the engines to be run at their maximum power and efficiency. Further, the accumulators need next to no attention, and this enables the working staff to be greatly reduced, the staff in this particular case being only an engineer, an assistant, and a stoker, the engineer also assisting at any work that may be necessary on the mains.

(*f*) The switchboard is so designed that all the three different conditions above-named can be arranged for.

The price of the current is fixed at 0·96d. per ampere-hour* for lighting purposes, and 0·384d. per ampere-hour for motor purposes, which is equivalent to 0·48d. per 16-c.p. lamp per hour, and 2·59d. per electrical horse-power per hour. Aron meters are used throughout the system.

The actual number of lamps and other appliances supplied with current in July, 1892, were as follows :—7,765 incandescent lamps, 84 arc lamps, 4 1/10-H.P. motors, running ventilators, 13 1-H.P motors, 1 8-H.P. motor, 3 cigar lighters, 1 heating apparatus, 2 installations of portable accumulators for lighting carriages.

* [It appears from Fig. 5, though curiously enough it is not stated elsewhere in the article, that a pressure of 110 volts is used. The price of 0·96d. per ampere hour is equivalent, with 110 volts, to very nearly 8¾d. per kilowatt hour, and 0·384d per ampere hour is equivalent to 3½d.—ED. *E.*]

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THE USE OF A SHUNT WITH HIGH SELF-INDUCTION IN CABLE TELEGRAPHY.

A series of experiments have been lately carried out in the German State-Telegraph Office on the effect of the Godfroy system* of shunting the receiving end of a cable with a high self-induction, in order to neutralise capacity effects. The results are worthy of notice, as seen by the figures.

A ring of cable between Hamburg and Berlin was used, 600 kilometres long; resistance, 4,200 ohms; capacity, 150 microfarads; and was worked with Morse instruments and Siemens polarised relays. The coils of the relay, being in parallel, measured about 300 ohms. A large Siemens instrument was used at the receiving end between relay and earth to register the capacity current, and the diagrams are those furnished by this instrument. The battery contained 50 cells. The Fig. 1 shows the capacity current when the word "Berlin" was signalled. A coil of high-resistance (500 ohms) and large self-induction

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

(being sheathed with iron) was then placed as a shunt on each end of the cable. Figs. 3 and 4 show the discharge currents obtained under these circumstances from 50 and 100 cells respectively. It will be noted that in both cases the discharge current is reversed as regards Fig. 1, owing to the high back electromotive force of the shunt-circuit. If this resistance is replaced by one of no self-induction, the discharge is as in Fig. 2, as might be anticipated.

It is obvious that since the reversal of the discharge current can be so effected, it is possible by a suitable adjustment of the self-induction to practically neutralise it. The shunt was therefore made of 250 ohms resistance and smaller self-induction, and a resistance of similar amount but wound non-inductively was added to it, so as to keep the resistance the same as before. The curves (Figs. 5 and 6) show the results obtained with 50 and 100 cells; it will be noticed that the capacity current is practically eliminated.

The high self-induction shunt therefore protects the receiving relay from the effect of the discharge current and therefore also from alterations of magnetic condition, so that the use of a relay is much facilitated.

* For other articles on this and similar devices, see *The Electrician* Vol. XXVI., p. 241, December 26, 1890; also Vol. XXVII., p. 303, July 17, 1891.

THE CABLE STEAMER "GREAT NORTHERN."

This steamer, which is owned by the Eastern and South African Telegraph Company, ran her official trials in Hartlepool Bay recently. The results obtained both on the trial and in the run up to London which followed, were most satisfactory. The "Great Northern" is an iron vessel, built twenty-two years ago by Messrs. Denton, Gray, and Co., and engined by Messrs. Thomas Richardson and Sons, of Hartlepool. When the question recently arose as to new boilers, the ship was found to be in such a good state of preservation that the Company decided to renovate and fit her with the most modern machinery. Messrs. Richardson and Sons obtained the contract for the work, and under the personal superintendence of Mr. P. L. Isaac, the Company's engineer, the ship has been fitted out in a most efficient manner. The old compound engines have been replaced by a set of triple expansion engines of the most approved type, and one single-ended boiler working at a pressure of 160lb. per sq. inch. The diameters of the cylinders are 17in., 28in., and 46in. by 33in. stroke, and although working on three cranks no more space is taken up in the ship than with the old engines. The high-pressure and intermediate-pressure cylinders are steam jacketted and fitted with Morison's circulating receiver, the casings being drained by means of pulsator drain traps. The engine room fittings include Morison's evaporator and feed heater, Edmiston's feed-water filter, Drysdale's centrifugal pump, Worthington's feed pump, and the boiler is fitted with Thompson's circulator. The boiler is fitted with three Morison's suspension furnaces arranged to work with Howden's system of forced draught, the air being supplied by one of Chandler's engines and fans, supplied by Messrs. Bumsted and Chandler, of Hednesford. By employing one boiler only at 160lb. pressure instead of two working at 65lb. each, the side bunkers have been considerably enlarged, and the amount of coal now carried will thus be double that under the old arrangement. A new steam and hand-steering gear, by Messrs. Clarke, Chapman, and Co., has been fitted, and works a new rudder. Very powerful cable engines, by Messrs. Johnson and Phillips, combining separate picking up and paying-out gears have been fitted, the bow gear having three powerful sheaves made of wrought and cast steel to the Company's own design, and similar to those of the Eastern Company's steamers "Chiltern" and "John Pender." A new cable tank has been added aft, making the number four. These tanks are capable of taking 532 knots of deep-sea cable, a large quantity for a vessel that is essentially for cable repairing.

The electric light plant on the "Great Northern" consists of two sets of combined direct-driven dynamos, one for 80 lights and the other for 200 lights of 16 c.p. A 20in. search light of Admiralty pattern has been fitted on the upper bridge. The light-plant and search light have been supplied by Messrs. Clarke, Chapman, and Co., of Gateshead. The deck-houses have been extended so as to give extra room to the testing and chart rooms. The vessel is provided with a 28ft. steam cutter, with compound engines, one of eight recently supplied to vessels of the Eastern and other telegraph companies. The "Great Northern" is thus practically as good as a new vessel, and up to Lloyd's requirements for a new iron vessel of her size and class. The extensive alterations and additions to the ship, including new deck-houses and cabins, have been carried out by Messrs. Irvine and Co., and the whole of the work, both in connection with the hull and machinery, has been supervised by Mr. G. Beckwith, marine engineer to the Company.

CORRESPONDENCE.

EARTHING THE MIDDLE WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My letter in *The Electrician* of November 25th last on the Regent Street Fire, and incidently upon earthing electric light mains, appears to have attracted a good deal of notice in your columns and elsewhere. My remarks upon earthing—which referred solely to public supplies upon a large scale, and more particularly to those on a "three-wire system"—were somewhat brief and imperfect; hence a certain amount of misapprehension exists as to the main point of my contention. Mr. J. Sayers, for instance, in his letter deprecating wilful earthing, bases his argument upon the *ideal* of a separate conductor system of wiring, viz., *no earth*, and fails to see that those conditions in the instances I am referring to have no existence in fact. It is not a question of double *versus* single insulation, for we have no double insulation. It is not even a question of permitting "earth," for we are already earthed

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and hopelessly so. I have known lamps to be lighted and metals fused by means of the leakage in our mains. Shocks to the person have been experienced when incautiously handling portions of the system, and testing instruments have been damaged in consequence of the prevailing "earth."

Tests have occasionally revealed its presence on both sides, but invariably greater on one than on the other; and it is reported that one large supply company, after expending much time and labour in futile attempts to rid their system of this "earth," have given up the task as hopeless.

Under these circumstances, the only question for consideration is, whether it is better to put up with this irregular earthing of our installations through the mains, or adopt some means of controlling and regulating it. Earthing the centre naturally suggests itself as the solution of the difficulty, and although that means deliberately sacrificing one insulated side, it will, at the same time, reduce *two dangerous sides* to one. Whatever complications attend earthing the centre conductor already exist in a magnified degree, and, while wilful earthing cannot make matters worse than they now are, it should relieve us of some of our present troubles.

Let us take a typical case. I inspect an installation off a well-known supply on the three-wire system of distribution, and soon become aware of an earth on a main. Taking a couple of incandescent lamps, and connecting them in series with one pole and a convenient gas pipe, they are lighted brilliantly! This tells me not only that an *outer* is earthed, but that I have 200 as against 100 volts difference of potential to deal with. Now, I know very well that if I could but confine that earth to the middle wire I should reduce that difference of potential by one-half, and as we are now solely concerned with insulation, it is unnecessary to insist upon the advantage of 100 as against 200 volts when safety is the principal factor.

As to the probable effect upon the cable itself, or injury by electrolytic action, I cannot do better than refer your readers to *The Electrician* of November 11th last, in which there is a translation of a letter to the *Elektrotechnische Zeitschrift* by Ph. Seubel giving the results of three years' experience of systematic earthing upon a large scale.

Mr. Chamen's letter is of importance as coming from one connected with a well-known supply company, and I am glad to find myself in accord with him on this important question. At the same time I must take exception to his estimate of the value of cut-outs under the conditions assumed. If fuses act in all cases of leakage to earth, then it matters little whether we are earthed or not, intentionally or otherwise. But the danger we have most to fear is the incipient leak of considerable duration, which, while insufficiently pronounced to reveal itself by blowing the fuse, is, nevertheless, capable of igniting combustible material in its track. It may be urged that wilful earthing would render such faults more serious. Perhaps so, but would it not at the same time enhance the value of our cut-outs?

Mr. Andrews not unnaturally chimes in with his concentric system as the way out of our difficulties. Well, if earthing becomes a necessity, few, I should imagine, will be found to dispute the advantage of having the *live wire* shielded and protected by the harmless outer return; and if *no earth* is a *sine quâ non* of our existing system of wiring, then, surely, that system can be regarded only as a temporary expedient.

In discussing this question of earthing, one is handicapped at the outset with the confusion that exists in certain quarters between *earthing* a system and the use of an *earth return*. *The Review* (Insurance, not Electrical), for instance—whose Editor laughs to scorn the idea of earthing the middle wire—gravely recommends Mr. Human to carefully study the evidence in a legal case now before Mr. Justice Kekewich, in which the sole point at issue is the use, or abuse, of an earth return.

It is not so much the present as the future we have to fear. As houses are added on, so will our difficulties increase, and this varying and shifting drag upon our insulation must tell its tale in the long run.

In advocating systematic earthing I am simply recognising the impossibility of maintaining both sides of a large system of supply free from "earth," and the advisability of effecting a compromise with nature by conceding one pole.—Yours, &c.,

H. Human.

Guardian Fire Office, 11, Lombard-street, E.C.

METHOD OF CHARGING FOR AN ELECTRICITY SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I thank Professor Garnett for pointing out another possibility of my meter system. It must not be lost sight of, however, that it is the short duration of the maximum load that forces electricity supply companies to charge a high price per unit, and that if for any reason the duration of maximum load is increased the price per unit can be decreased. A three days' London fog will enormously swell the receipts of a supply company charging at a uniform rate, but what about the customer when his electricity bill comes in? and how many are deterred from adopting the electric light by what he says about its expense. With a differential charge, electric lighting would often cost less than gas in the case of a long fog, and still bring in a good return to the supply company. It is those consumers who, in ordinary weather, only require current from, say an hour before sunset till 8 o'clock in the evening—that is about 500 hours per annum—who run up both the capital and running expenses of the supply companies.

At these hours I propose that the higher charge should be made. If, through a fog or otherwise, the duration of the heavy load is increased the company's capital expenses are not increased at all and its running expenses very little, while its earnings are very much increased, so that it can well afford to charge at the lower rate. Those customers who only want supply after 8 o'clock at night when the main shop and dressing for dinner load is off, can evidently be supplied at the lower rate with profit to the supply company. Churches, public halls, theatres, &c., will practically come under this head. With the maximum demand arrangement proposed by Profs. Hopkinson and Kennedy and Mr. Wright, these places would be charged so heavily that they would keep to gas in many cases or go in for their own plant.

Then as regards power the system I propose gives the strongest possible incentive to such users as small printers, grinders, cabinet makers, &c., to arrange their work so that they do not use power after the lighting load comes on. Larger manufacturers, who cannot do this, will find it pay them to run their works by electricity from the mains in the summer time only, and use their gas or steam engines in the winter; when they could use their electric motor as a dynamo to do their lighting at the time when supply of current is expensive.

Nearly all manufacturers have engines much too large for them, so as to have ample reserve, they say; this tells very much in favour of electric power, the difference between the efficiency of an electric motor running lightly loaded and a gas or steam engine running lightly loaded being of course immensely in favour of the former. This brings in the question of such places being able to suddenly call upon the supply company for a large current because of a breakdown in their own plant. It is obvious that a building requiring some hundreds of amperes could not be suddenly switched on to the supply mains without seriously interfering with neighbouring supply. This is surely sufficient ground for a supply company refusing to so arrange its connections that this could be done without notice, and more than this, the spirit of the supply clauses in the Provisional Order is certainly against a supply company being bound to keep reserve plant and mains lying idle for any special reason without being paid for it.—Yours, &c.,

W. H. Scott.

SUB-STATION TRANSFORMER SWITCHES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In several recent specifications for alternate-current central stations, transformers for sub-stations have been specified to have changing switches, either automatic or otherwise,

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to enable the connections of these sub-station transformers to be altered at small loads so as to increase their efficiency. This is generally done by dividing the primary and secondary into two parts which are put in parallel for large loads, and in series for small, the change generally being arranged to occur at about one-fourth or one-third load.

The effect of this is at small loads to increase the copper resistances to four times their original amount. On the other hand the iron losses will be only about one-third of their original amount, as there are double the number of turns in the primary and secondary when the parts are coupled in series; therefore B is one-half, and since the hysteresis varies as $B^{1\cdot6}$ and $\frac{1}{2}^{1\cdot6}$ is very nearly one-third, we will have only one-third of the iron losses.

The question is what increase of efficiency this causes with average load and whether it is commensurable with the extra cost, complication, and risk of breakdown. In order to investigate this I will take as an example a sub-station with the 15-unit Ferranti transformer, of which the losses are given in Dr. Fleming's admirable Paper. In it "The total power taken up in the transformer varies between 210 watts and 525 watts." Therefore the constant iron losses are 210 watts and at full load the copper loss is 315 watts. If the connections of the transformer are changed, as proposed, the iron losses will be reduced to 70 watts.

If we take the average load to be one-tenth of full load, which is about what is generally obtained in central station practice, there are various ways in which the load may come on, which will cause the efficiency to vary slightly. First, we may have one-tenth load on all the time. Here the connections of the transformer will be in series, and to simplify the calculations we will take the losses during ten hours, in which there will be an output of one hour's full load—that is, of 15,000 watt hours. Here we will have a loss in the iron of $10 \times 70 = 700$; and in the copper 126 watt-hours, or a total of 826. The efficiency, therefore, will be $15{,}000/15{,}826 = 94{\cdot}8$ per cent. Secondly, if the change of connections is made at one-third load, we may have just over one-third load for three hours, and no load for the remaining seven hours. During these three hours the coils will be in parallel, and the iron losses will be 630, the copper losses 105, or a total of 735 watt-hours. In the remaining seven hours there will be no appreciable copper loss, but the iron losses will be 490 watt-hours, making a grand total of 1,225 during the 10 hours. The efficiency will be 92·4 per cent. Thirdly, we may have no load for nine hours, and full load for one hour. Here the total loss will be 1,065 watts, and the efficiency 93·4 per cent.

In practice it is the second and third cases or intermediate ones that we have to deal with, and therefore we may say that with this transformer with moveable connections we will have at one-tenth average load an efficiency of about 93 per cent. Now if the connections remain unaltered the whole time, what will be the efficiencies? First, if one-tenth load is on the whole time, the iron loss will be $10 \times 210 = 2{,}100$ watt-hours, and the copper loss will be 31, or a total of 2,131 watt-hours, giving an efficiency of 87·5 per cent. Secondly, if full load is on for one hour and no load for nine hours, the iron losses will be 2,100 as before, but the copper loss will be 315, or a total of 2,415 watt-hours, giving an efficiency of 86·1 per cent. Therefore we may say that with this transformer with fixed connections we will have at one-tenth average load an efficiency of about 87 per cent.

Thus, by having changing connections, we gain at one-tenth average load about 6 per cent. in efficiency. If the average load is less we gain more, if more we gain less, but in central stations one-tenth load is somewhere about the average load on the transformers. The question is, is this 6 per cent. worth the great extra cost, complication, and risk of breakdown? In cases where automatic switches are used there is the risk of their failing to act properly, in which case a serious breakdown may occur; the transformer may be burned out, or if it is protected by fuses they may go, and in any case the light will fail. The same may occur if the switch is worked by hand—a sudden fog comes on when the coils are in series, and either the transformer may be burned out or the fuses go.

Of course, with transformers in which the iron losses are large, such changing switches may be worth using, but with modern transformers of close on 90 per cent. efficiency at one-tenth load the game does not seem to be worth the candle.—Yours, &c.,

GERALD STONEY.

Newcastle-on-Tyne, December 31, 1892.

PARSONS' STEAM TURBINE DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The observations made by Mr. Tesla about my high-speed alternator, in the interesting letter which you published on the 23rd inst., do not call for reply; but there is an incidental remark about Parsons' Steam Turbine which my experience does not at all bear out. Mr. Tesla argues that the steam turbine is not suited for use with continuous-current dynamos, "as the commutators must be a source of some loss and trouble on account of the very great speed." I am sure Mr. Tesla will be glad to know that, in fact, this difficulty does not occur. The exceptionally high speed has not prevented the commutators of the steam turbine dynamos which I have seen from taking a dark polish and running with as complete a freedom from wear and sparking as one observes in the best examples of dynamos driven at ordinary speeds.—Yours, &c.,

Cambridge, Dec. 31, 1892. J. A. EWING.

GILBERTIANA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Thompson has shifted his ground and has taken up a new position, from which he apparently thinks he can throw more mud at Messrs. Wiley and Sons, with safety to himself. He would now have us believe that the epithets he hurled at them referred only to the *manner* in which their American edition of Ruskin was produced, and not, by any means, to the fact that such an edition was produced at all. Probably Prof. Thompson has never seen the edition in question, and knows nothing of its actual merits or demerits; but these have absolutely nothing to do with the matters under discussion, which are his unqualified abuse of Messrs. Wiley and Sons, and his attempt to discredit the translation of Gilbert which they are about to publish. Besides, in his letter of December 30th, Prof. Thompson stultifies himself: he calls Messrs. Wiley and Sons "highwaymen." A highwayman is a robber on the highway, a felon who robs with violence as distinguished from the thief who steals only in sneaking fashion. When the profession was in vogue it mattered little whether the "gentleman of the road" was in broadcloth or in rags; whether he threatened his clients with polite words and a pistol or with oaths and a bludgeon; the robbery was the only point of interest, not the manner in which it was effected. According to Prof. Thompson, Messrs. Wiley and Sons are a "notorious house," a firm who "have earned for themselves an evil notoriety by their pirated editions of Ruskin's works"; they are a "tainted source" and "literary highwaymen." And having thus bespattered a firm of repute Prof. Thompson warns everyone that "the alleged American translation" may well be ignored because of the publishers' imprint it will bear. I am glad Prof. Thompson speaks well of Mr. Mottelay in spite of his effort to boycott his work, for though the forthcoming translation is "an underhand way to an attempt to depreciate the careful work that has been going on for three years by the Editing Committee of the Club," yet Mr. Mottelay is not the "man to lend his name" to it. Again, in his later letter Prof. Thompson still believes Mr. Mottelay "to be an honourable man," and says that "this translation will not make a grain of difference to us." Why, then, does he attempt to cast discredit on it by vilifying the publishers? As to some other points in his letter of December 30th, I am sorry that I cannot explain to Prof. Thompson why Mr. Mottelay did not return to extend his acquaintance, and become enrolled among the members of the Gilbert Club. We are all of us apt to miss the golden opportunities of our lives. Prof. Thompson makes me speak of "astonishing inaccuracies" in my letter

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published by you on December 23rd; neither word quoted occurs in my letter, either combined or separated. Nor did I suggest directly or indirectly that Mr. Mottelay intended to "pirate" (what a favourite expression!) the Gilbert Club translation, nor that he had ever seen it; and I made no reference whatever to the "big show at Chicago," if by that Prof. Thompson means the Columbian Exposition.

This loose way of making absolutely unfounded statements and baseless accusations throws light on the cause that led Prof. Thompson to try and damage the reputation of Messrs. Wiley and Sons, a cause which he vainly seeks in his last letter to obscure by suggesting entirely new and previously unsuspected reasons.

It will probably be quite unnecessary for me to trouble you again on this matter, as Messrs. Wiley will now have had time to take such steps as they consider desirable.—Yours, &c.,

London, Jan. 3, 1893. JAMES DREDGE.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS ACCEPTED.—On the recommendation of the Electric Lighting Committee, the Derby Corporation has accepted the tender of Mr. Vernon for the building of the electric lighting premises, the amount of the tender being £6,324. 17s. 5d.

CHANGE OF ADDRESS.—Messrs. Slingo and Brooker, electrical engineers, have removed from Solon New-road, Clapham, to 65, Chelsham-road, Clapham, S.W.

MESSRS. CROMPTON AND COMPANY (LIMITED).—The new catalogue and price list of dynamos, generators, and motors manufactured by this firm, has just reached us. Illustrations are given of standard types of the well-known machines manufactured by the Company, including the patent four-pole drum-wound dynamo, combined with a Willans engine of 200 i.-h.-p. Included in the catalogue are notes and data relating to the machines which will be of service to local authorities and other probable users. On examining the prices we find that reductions have been made in almost all cases. Messrs. Crompton have in preparation a complete catalogue of the various manufactures for which the firm is justly celebrated.

CROMPTON-HOWELL ELECTRICAL STORAGE COMPANY (LIMITED).—This firm send us a long list of installations at which Crompton-Howell batteries are in use. The list includes nearly 3,000 cells of various sizes, a large quantity having been sold to the leading electrical manufacturing companies, the Corporations of Glasgow, Hull, and Oldham, the McGill University at Montreal, H.M. dockyards, and to central lighting stations at Oporto, Hove, and Pretoria. The Company has been fortunate during the past year in having had no trouble with regard to renewals or repairs of their batteries.

PORTABLE ELECTRIC LAMPS.—The example set by the London General Omnibus Company, in providing their ticket inspectors with small electric lamps, to enable them to inspect the tickets *en route*, is to be followed by the Liverpool Omnibus Companies. There is also some talk of the metropolitan police being supplied with a small lamp, in place of the old-fashioned bullseye, and several of the railway companies have under consideration the supply of the lamps to their inspectors.

MESSRS. CAMPBELL, MACMASTER, AND CO.—Mr. D. Campbell, of Botolph House, has taken into partnership Mr. Archibald J. Macmaster, and the style of the firm will now be Messrs. Campbell, Macmaster, and Co. The firm are agents for a number of well-known houses in the North of England and Scotland.

MESSRS. PATERSON AND COOPER.—This firm report a fair share of work for the past year. In ship lighting, which is a speciality, plants have been supplied to the Allan Company, the Clyde Shipping Company, the General Steam Navigation Company, the North of Scotland, Orkney and Shetland Steam Navigation Company, to the training ship "Shaftesbury," and to a number of other steamers, and the firm have still in hand plants for the "Polynesian," "Princess Beatrice," and the "Matin." A number of direct driving sets and other ship lighting plant has been supplied to vessels built abroad, as well as to vessels wired by other firms. In installation work Messrs. Paterson and Cooper have been busy, and in the manufacturing department a fair average has been maintained. In measuring instruments the firm have received large orders from abroad, and the output of arc lamps, switch boards, and general electrical apparatus has been well maintained.

ELECTRO-MEDICAL APPARATUS COMPANY.—This Company has now completed its installation at Trafalgar Chambers, W.C. The apparatus and treatment rooms have been fitted with Edison-Swan lamps and with wall plugs for connecting the apparatus when required. A lamp and counterweight with pulley are suspended over the operating chair, and a special lamp is also at hand for the examination or treatment of patients. The managers of the Company have designed a special arrangement with the L. K. current controller, enabling the light circuit, to be used for treatment with safety and convenience. The portion of the current used reaches the patient through the shunt-circuit and can be regulated from 1 to 1,000,000 amperes by means of an adjustable resistance. Another arrangement, which is now complete, is a set of coils of insulators for treatment by Lawrence's modification of Tesla's "Unipolar" method. There is also a bath room, provided with an electric bath and douche, and electro-gymnastic apparatus.

MR. G. WILSON.—This gentleman has recently been consulted with regard to the electric lighting of Ogmore Valley, and has supplied a large portion of the plant required for the installation. The electric light and power business in the neighbourhood of Aberdare has increased to such an extent as to necessitate Mr. Wilson building new premises, and he reports that the outlook for the new year is bright.

MESSRS A. HALL AND CO.—This firm has secured the contract for lighting Nannau Hall, the seat of Mr. J. Vaughan, near Dolgelly, Wales. The generating station is to be about a mile from the mansion, and the motive power will be water. Included in the installation are the parish church parsonage and schools. The same firm have recently concluded the lighting of Dolgelly by electricity, the motive power in this case also being water, the plant consisting of two horizontal turbines of 67 H.P. The electric light has been a success in the district, most of the hotels and shops and many of the private residences being lighted by that illuminant.

MILLING MACHINES.—We have received from Mr. H. F. L. Orcutt a well-illustrated catalogue of Messrs. Ludw. Loewe and Co.'s machine tools and other special machinery, including cutting-off, spindle-centring, and boring machines. Their milling machines are made in great variety; the simpler patterns appear to be well-adapted for jig or quantity work. Several "universal" milling machines are offered, and these are equipped with numerous attachments, adjustments, feeds, and other ingenious devices.

AWARD.—Messrs. Woodhouse and Rawson United (Limited) have received a silver medal for their display of electric light fittings at the Kimberley Exhibition.

CALENDARS FOR 1893.—The Western Union Telegraph Company issue a useful calendar blotting book showing the routes of the Company's cables, and giving a list of the receiving offices in Great Britain.——Messrs. W. H. Willcox and Co. send us a useful date remembrancer, which, in addition to serving as a calendar for the year 1893, gives illustrations of the various specialities of the firm.——Bell's Asbestos Company issue a hanging calendar for the year, which is made the medium for a number of illustrations of the Company's manufacturers.

ACTON.—Skating on the large lake adjoining Captain Ronald Scott's residence at Acton has been much facilitated by the aid of an electric search light, which Captain Scott has placed in a position of vantage, enabling the skaters to proceed with their enjoyment notwithstanding the fog or the darkness of the night.

ARBROATH.—At a cost of over £2,000, Mr. F. C. Fletcher has introduced the electric light at his Letham Grange estate at Arbroath. The installation is extended to the mansion house, stables, riding schools, dairy, and in fact to every building on the estate, with the exception of the small houses for the workmen. A Babcock-Wilcox boiler is used to drive a 12-H.P. engine. The dynamo is of the Victoria compound self-regulating type, and the installation includes 52 L-type E.P.S. cells.

BUXTON.—At the last meeting of the Local Board a short report was read from the Electric Light Committee on the subject of the electric lighting of the town. The Committee reported that they had accepted the offer of a firm to supply an estimate of the cost of an installation for 2,000 lights "free of cost," and it having been decided by the Board to obtain this offer in writing, the further consideration of the matter was postponed. The offer of Messrs. Hammond and Co. to send their representative to lecture on the subject of the electric light was agreed to, and it was further agreed to make a charge of 3d. for the front seats at the lecture in aid of the Free Library!

CAIRO.—The Compagnie Centrale d'Eclairage par le Gaz has signed a contract with the Egyptian Government for an experimental lighting of Cairo by electricity.

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CAPE TOWN.—The arrangements are now complete for the lighting of Cape Town by electricity. Messrs. Siemens and Halske, who have secured the contract for the plant, machinery, and apparatus, are, we understand, to run the works for twelve months before the Town Council take over any responsibility. The plant will come from Berlin, and it is anticipated that the installation will be complete about the end of 1895.

DOUGLAS, ISLE OF MAN.—A new pleasure resort is to be shortly established in Douglas at Villa Marina, which is to include a large pavilion for dancing and variety entertainments, to be 150ft. long by 60ft. wide. The electric light is to be adopted, and the fittings and decorations are to be on an elaborate scale.

DUBLIN.—At the weekly committee meeting of the Irish Cattle Traders' Association, attention was called to the fact that many of the largest shippers of live stock were greatly inconvenienced owing to the want of facilities for veterinary inspection by the electric light, and the President of the Association informed the Committee that the Privy Council two years ago had given opportunity for veterinary inspection by the electric light, but that only one of the shipping companies had promised to take advantage of this permission. The Committee considered the matter of the greatest importance to the cattle trade, and it was ultimately left over for further consideration.

DUDLEY.—At the last meeting of the Town Council the Clerk reported that applications had been made from Messrs. Siemens Brothers and Co. (Limited) and the Brush Electrical Engineering Company (Limited) to tender for the lighting of the town by electricity.

DUNDALK.—At the last meeting of the Town Commissioners the question of obtaining a renewal of the electric lighting licence, which expires in July next, came up for discussion. The further consideration of the matter was left over till the next meeting.

DUNDEE.—The Harbour Trustees have under consideration the question of introducing the electric light to the docks and harbour, and also the running of electric cars from the West Station to the Cattle Depôt. The trustees' proposal has been remitted to the Urgency Committee for consideration, and this body will shortly report on the question.——It has been finally decided to prepare the necessary specifications for the lighting of the Town Hall and City Chambers by electricity.——The Property Committee of the Council have decided to defer the introduction of the electric light into the Guildhall until the effect of the Town Hall installation has been demonstrated. Altogether, electric lighting business in Dundee is brisk.

EDINBURGH.—A sum of £145 has been paid to the members of the deputation recently appointed to inspect the chief central electric lighting stations throughout the country. This sum includes £20 to the expert who accompanied the deputation.

FALMOUTH.—The Lighting Committee of the Local Authority have received communications in respect to the lighting of the town by the electric light, and this information has been distributed amongst the members of the committee, who will shortly prepare a report on the subject.

FULHAM.—It is announced that a proposal will shortly be made asking the Fulham Vestry to apply for an electric lighting Provisional Order.

HALIFAX.—The *Bradford Observer* states that there is a disposition on the part of the Halifax Corporation to appoint an electrical engineer at a salary of about £200 a year.

MANCHESTER.—Preparations are in progress for lighting the Town Hall at Manchester by electricity. There are at present no less than 3,000 gas burners employed in lighting the building, which consumes about 8,000ft. of gas per annum. The electric current to be supplied will, in addition to the interior lighting, also light the arc lamps on the outside of the building.

RAILWAY STATION AND DEPOT LIGHTING.—The Midland Railway Company, in addition to possessing the record for numerous improvements in railway service, have taken advantage of the recent improvements in electric lighting machinery and apparatus to instal the electric light in all their large stations and goods depôts throughout the country. At Sheffield, where the Company's wicker goods station is undergoing re-modelling, an extensive lighting installation is part of the work.

NELSON.—Mr. James Barton, of Blackburn, has just completed the electric lighting of the Borough of Nelson for the Corporation of that town. This is, we believe, the only Corporation in Lancashire which has itself undertaken the lighting of its district by the electric light.

RATING OF BLAST FURNACES.—The appeal by the Dowlais Iron Company against the assessment of their new furnaces at Cardiff is to be withdrawn, the result of a compromise arrived at at a conference of the Assessment Committee and the representatives of the Company, by which the new assessment is reduced by about 50 per cent.

RUNCORN.—The Board of Commissioners at Runcorn had under discussion yesterday the advisability of introducing the electric light into the public streets of the district.

SALFORD.—The arrangements for the installation of the electric light in the centre portion of the Borough of Salford are being pushed forward, and the plans are now ready.

SHREWSBURY.—The seventh annual industrial exhibition in connection with the Parish of St. Michael's, Shrewsbury, was held last week, and was a great success. At the meeting of the organisers Messrs. Lea, Sons, and Co. were accorded a vote of thanks for the assistance rendered in making the exhibition a success by the installation of the electric light. The firm exhibited a number of examples of hammered metal work.

TAUNTON.—The Board of Trade have granted the electric lighting licence applied for by the Town Council. At the last meeting of the Corporation, the report of Sir T. W. Blomefield and Major P. Cardew, which deals *in extenso* with the objections raised to the licence being granted, and to the views expressed by electrical experts on the subject, was read.

WEDNESBURY.—At the Town Council meeting this week on the question of making additions to the gas lighting of the town, Alderman Williams asked the Council to take into consideration the necessity for introducing the electric light into the district.

WREXHAM.—Further progress in the negotiations between the Town Council and the Wrexham District Electric Supply Company (Limited) is stopped owing to the illness of the Chairman of the Company.

PATENT RECORD.

The following list of applications for patents and specifications has been compiled for this journal by MR. J. C. CHAPMAN, *patent and registration agent, Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any available information may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

December 6, 1892.

22,346. J. D. MILLER. Glasgow. Improvements in telephonic switching apparatus.

22,355. A. GRAY. London. Improvements in the manufacture of electro-printing surfaces.

22,375. W. P. THOMPSON. Liverpool Improvements in the method of welding or working metals electrically. (C. L. Coffin, United States.)

December 7, 1892.

22,422. N. KHEM. Derby. An improved automatic electrical call apparatus principally for use in telephone circuits.

22,473. C. E. L. BROWN. London. Improvements in dynamo-electric machines.

December 8, 1892.

22,534. P. E. SINGER. London. Improvements in musical instruments operated by electricity.

22,589. W. M. MORDEY. London. Improvements in electric switches.

December 9, 1892.

22,615. M. B. FIELD. Glasgow. Improvements in electric current meters.

22,639. H. KROEKER. London. Improvements in glass vessels for accumulators.

22,657. J. G. LORRAIN. London. A new or improved electric accumulator. (M. Dumont, France.)

December 10, 1892.

22,699. P. E. SINGER. London. Improvements in musical instruments actuated by electricity.

22,719. W. GEIPEL. Lambeth. Improvements in street boxes used in the underground distribution of electricity.

December 12, 1892.

22,760. J. A. HEAP. London. Improvements in the method of, and apparatus for, electrolysing aqueous solutions of salts.

22,804. G. J. SPALDING and R. L. HAWKINS. London. Improvements in electric hair and skin brushes.

22,826. W. P. THOMPSON. Liverpool. Improvements in, or relating to, the construction of electric accumulators. (The Suddeutsche Elektricitäts-Gesellschaft, Raab and Bastians, Commandit Gesellschaft, Germany.)

22,837. G. S. HOOKER. London. A combined knocker and electric bell contact.

22,838. C. A. DAY. London. Improvements in long-distance telephones. (C. M. Haynes, United States.)

22,854. H. PIDOT. London. A new or improved electric arc lamp. (P. Archat, France.)

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December 13, 1892.

22,858. G. DAVENPORT. London. An improved electric arc lamp.
22,889. A. FRITH and G. Y. ASHWELL. Manchester. Improvements in electrical fittings; also applicable to other purposes.
22,914. W. L. WISE. London. Improvements in printing telegraphs. (C. L. Buckingham, United States.)
22,915. W. L. WISE. London. Improvements in printing telegraphs. (C. L. Buckingham, United States.)
22,923. S. Z. DE FERRANTI. Liverpool. Improvements in, or relating to, cables.
22,925. R. H. COURTENAY. London. Improvements in long distance telephonic transmitters of and receivers of sound.
22,931. W. L. WISE. London. Improvements in printing telegraphs. (C. L. Buckingham, United States).
22,947. W. LOWRIE. London. A new or improved method of utilising waste energy in water supply systems for generating electricity.
22,950. R. HADDAN. London. An improved galvanic dry battery or cell, and a composition for use in such cells. (R. Gabarro, Spain.)
22,951. R. E. B. CROMPTON. London. Improvements in switch boards for use in the distribution of electrical energy.
22,958. W. R. GARTON and J. C. DANIELS. London. Improvements in lightning arresters.

December 14, 1892.

22,987. P. M. JUSTICE. London. Improvements in secondary battery plates or elements, and in the process of preparing same. (W. W. Griscom, United States.)
23,007. W. WALKER and F. R. WILKINS. Birmingham. Improvements in galvanic batteries.
23,022. A. GRAHAM. London. An improved loud-speaking telephone.
23,023. T. PUSKAS. London. An improved loud-speaking telephone.
23,039. W. VON WINKLER and J. FEKL. Improvements in electrical connections or means for supplying current to electric motors.

December 15, 1892.

23,051. E. A. MITCHELL and G. T. TUGWELL. Kent. Improvements in galvanic dry cells.
23,054. J. W. DAVIS. Wolverhampton. Improvements in medical and other electric induction cells.
23,057. F. KING and W. P. MENDHAM. Bristol. Improvements in fittings for use in electric light installations.
23,061. W. H. STURGE. Birmingham. Improvements in, or connected with, portable electric lamp fittings.
23,068. A. ROSS, T. WHARMBY, and R. S. HAMPSON. Manchester. Improvements in mechanical and electrical interlocking of railway signals, signal or other levers, and block telegraph instruments, commonly called lock and block.
23,086. R. D. SMILLIE. Glasgow. Improved arrangement for communicating by telephone between several stations.
23,101. C. A. J. H. SCHROEDER and H. E. R. SCHROEDER. London. New primary batteries.
23,113. M. VON DOLIVO-DOBROWOLSKY and the COMPANY ALLGEMEINE ELEKTRICITATS GESELLSCHAFT. London. Apparatus for determining differences between the phases of two electric alternating currents of like number of alternations.

December 16, 1892.

23,158. P. E. SINGER. London. Improvements in electrical meters.
23,159. A. R. G. BEAL. Holyhead. Electro-mechanical depth indicator.
23,185. W. FIELDER and H. NEWMARCH. London. Improvements in, and connected with, alarm clocks and electric sound signalling appliances.
23,218. J. WAGNER. London. An electric mechanism or device for operating valves.
23,231. P. SCHARF. London. Method of effecting in electric glow lamps an air-tight union between entering wires, made of non-precious metal and the glass globe.
23,232. J. Y. JOHNSON. London. Improvements in, and relating to, secondary or storage batteries. (A. M. Michel, France.)

December 17, 1892.

23,269. J. PERRY, M. B. FIELD, and L. J. STEELE. London. Varying price electric supply meter.
23,290. E. ARNOLD. London. Improvements in alternate current motors for single and polyphase electric currents.
23,295. Sir D. L. SALOMONS, Bart. Tunbridge Wells. An improved centrifugal device for opening or closing an electric circuit.
23,314. G. F. COX. Thornton Heath. The automatic electric fire alarm.

December 19, 1892.

23,317. G. HIGTON. Derby. Improvements in thermometers and electrical connections therewith.
23,321. L. B. MILLER and M. W. WOODS. London. Heating liquids by electricity.
23,352. E. D. TAYLOR. London. Improved electrically operated locks.
23,361. A. HEIL. London. Improvements in writing-telegraphic instruments.
23,370. W. F. TAYLOR and P. F. BARNES. Croydon. Improvements in incandescent electric lamps.
23,385. H. W. MILLER. London. Improvements in electricity meters.

December 20, 1892.

23,409. G. A. WASHBURN. London. Improvements in storage batteries.
23,421. B. J. B. MILLS. London. Improvements in sockets for incandescent electric lamps. (J. Hutchinson, United States.)

SPECIFICATIONS PUBLISHED

All Specifications price 8d.

1891.

18,597. ANDREOLI. Electrolysis.
21,363. PERAL. Electric lift.
22,597. FRASER and KELSON. Supports for telephone receiving instruments.

1892.

1,141. VOGT. Dry electrical elements.
1,216. KORTEN. Electric cut-outs.
1,464. JENNER. Holders for incandescent electric lamps.
1,552. GOFFIN. Telephone transmitters.
1,637. ANDERS and KÖTTGEN. Telephones.
1,734. VON PEICHL. Electric compasses, &c.
2,163. CROMPTON. Electric measuring apparatus.
4,709. YORKE. Electric wiring.
8,493. WHITEHEAD. Telephone transmitter.
11,104. HAMMARLUND. Telephonic apparatus.
14,785. BRYSON. Electric despatch system.
15,813. THOMPSON. Junction for electric mains.
15,999. NEWTON (Barrett). Electrical circuits and cables.
16,262. FAURE. Electrolytical decomposition of alkaline chlorides.
16,561. MESTON. Electric motors, &c.
17,224. THOMPSON (Coffin). Electrically heating and working metal.
17,526. KLERITJ. Magnetic water gauge.
18,116. MATHIESEN. Electric arc lamps.
19,146. LAKE (Johns-Pratt Company). Electrical insulators.
19,160. THOMPSON (Benjamin). Telephone receivers.
19,602. BLACKBURN. Electric switches.

COMPANIES' MEETINGS.

Gulcher (New) Electric Light and Power Company (Limited).

The fifth ordinary general meeting of this Company was held at Winchester House, E.C., on Thursday, the 22nd ult., Mr. D. de Castro presiding.

The SECRETARY read the notice convening the meeting, and the minutes of the previous meeting, the latter of which were confirmed.

The CHAIRMAN, in the course of his remarks, said that the shareholders had doubtless all received and carefully criticised the report and balance-sheet, and also doubtless expected him to address them in pessimistic terms. On the contrary, however, he rose to address them in the highest spirits, as he considered the position of the Company was never better than at the present time. In the report for 1891 he stated that the whole of the profits resulting from his journey to New Zealand would amount to about £3,000, but in place of this amount he was pleased to say the actual result was £4,800. With regard to the manufacturing account, this showed a loss of £6,000, which fact was, *prima facie*, very depressing, but was not so bad as it looked and was largely the result of the fact that, owing to the Chairman's absence from London, the Company had engaged in unprofitable work. He ascribed this chiefly to the fact that they were only now in a position to produce a dynamo cheap enough to compete in the open market. Their machines were good, but were costly and had not been a manufacturing success, the result being that they had accumulated a heavy stock of these good machines, which they hoped eventually to dispose of. The Directors had accordingly depreciated the value of the stock by more than £2,000, thus reducing the actual manufacturing loss to about £4,000. A portion of this sum was due to the writing down of the value of the lease of their factory, which had arrived at within an appreciable distance of its termination; therefore, more than £3,000 of the £5,000 carried over from profit and loss account was due to the above exceptional circumstances. He would now tell them why he felt more hopeful for the future. By a rearrangement of their managerial staff, resulting in an improved organisation, they expected a saving of £500 per annum, which was a considerable item. The Directors had agreed to waive £500 of the annual fees hitherto paid to them, and this latter reduction would take effect as from June 30th last. They had secured a contract in New Zealand exceeding the amount of the whole of the business hitherto done in any preceding year, and from that contract he expected to make a substantial profit—sufficient, in fact, to wipe out the larger portion of their last year's loss. The Directors had arrived at the conclusion that it was most advisable for the Company to devote itself to the manufacture of central station plant. He was pleased to say that a friend had recommended the tender of the Gülcher Company for a large central station, and that the Directors anticipated securing the contract. The result of their Genoese business had been that the Gülcher dynamos had completely distanced the German machines put down to work against them.

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Elmore's Copper Depositing Company (Limited).

The third annual ordinary general meeting of this Company was held on the 30th inst., at the Great Northern Railway Hotel, Leeds, Mr. J. Jepson Atkinson presiding.

The CHAIRMAN, in moving the adoption of the report and balance-sheet, said that a word of explanation was necessary as to why they were holding their general meeting this year at Leeds, rather than in London, where these meetings had hitherto been held. Some shareholders had thought that they had adopted that locale in order to avoid meeting the members of the Company; but he need hardly say that that was certainly not the case, as they had, he thought, approximately, as many shareholders in the north as in the south. But in Leeds the Board wished to emphasise the fact that the Company was a Leeds industry; that its offices were at Leeds; and that the Board meetings were, and had been for some time, held at the works, in order that the Directors might be personally and immediately conversant with what was being done. Therefore, it was only appropriate that their general meetings should be held there, so that their shareholders might have an opportunity of seeing their property and works, and of forming an opinion for themselves of their position and prospects. As they were aware, the accounts submitted to the meeting were for the year ended June 30th last—a period which, as mentioned in the report, was chiefly occupied in completing the machinery and plant. The last six months of that period were disappointing to himself, as well as the rest of them, everyone having sincerely thought that every difficulty was overcome at the end of 1891, when the shareholders last met. However, he frankly admitted that he shared the meeting's disappointment in regard to the working of the Company for the period in question, but he wished to point out what appeared to him to be a very satisfactory feature in the accounts, namely, that they showed a profit derived from the Company's trading to the extent of nearly £800, notwithstanding that the output for the whole year under consideration did not reach more than 5 per cent. of what the plant was laid down to turn out. They might, therefore, easily calculate that if so small an output brought in so large a profit as that, after meeting the whole expenses properly chargeable to the trading account, then, with an output of 15 to 20 tons a week, a much larger profit would result, and it was in these, the most productive sources, from which they anticipated large orders and large profits, such as the manufacture of steam-pipes, that had not yet been entered upon by the Company, although they were taking immediate steps to accept orders for those, and the meeting might take it from him that their steam-pipes, in point of satisfaction to their customers and profit to the Company, would leave nothing to be desired. The Directors had taken no fees since the Company was reconstructed, and would not do so until the shareholders had received a dividend. He wished very strongly to impress upon the shareholders that, notwithstanding the many vexatious difficulties which they had had to overcome, and the long delay in realising some of their anticipations, yet the Elmore process, as an electro-metallurgical operation, was perfectly successful. They continued to receive a large number of repeat orders, and their customers were perfectly satisfied with their deliveries; and they must not for one moment think that the process was a failure, as they were perfectly certain that, in the course of the coming year, they could prove every statement they had made as to its success. In palliation of the Company's difficulties, the Chairman said he would like to refer shareholders to such companies as the Bessemer Steel Company, Bruner, Mond, and Co., the Crecender Tube Company, and others which at present were a great success, but which, in the early stages of their development, presented the same grounds for disappointment as the Elmore Company at present did. Nevertheless, they ultimately achieved remarkable success by dint of hard work and perseverance, and the Company, having a perfectly sound monopoly in their hands, were determined, by the same means, to secure a similar success, and their confidence in this respect could not be better seen than by an inspection of the shareholders registers, which would show that the Directors and officials of the Company and their immediate friends held a very large proportion of the Company's share capital. Since the reconstruction, on June 30th last, two practical commercial gentlemen had joined the Board, and one of them, after investigating the process, had invested something like £20,000 in the concern. These gentlemen were now present, and they meant to work and make the concern a success. He (the Chairman) had done all the dirty work of the Company, and had had all the anxiety and trouble from the beginning; but he had stuck to his shares, and he meant to continue to do so. He believed there was no question about the prices they could get for the work. The only thing was that there had been delay, and on this subject he hoped shareholders would question Mr. Elmore before the close of the meeting. He hoped that in a very short time they would thank him for sticking to the concern. He concluded by formally moving the adoption of the report and accounts.

Mr. W. GOODE JOHNSON seconded the motion.

Mr. HAWKYARD thought that the fact that one of the Directors had invested £20,000, after due investigation, showed confidence in the concern.

Mr. SQUIRE, a London shareholder, observed that last year shareholders hoped for a dividend, and were shown a copper pipe. This year again they hoped for a dividend, and were shown some copper pots.

The CHAIRMAN: These will produce the dividend.

Mr. SQUIRE said he could not help thinking the Directors were easily satisfied. Practically, instead of making a profit, they had made a loss.

The CHAIRMAN: That is on only 50 tons.

Mr. SQUIRE, further alluding to the suggestion that the mechanical part of the principle would not work, complained of the want of details supplied to the shareholders, and said he thought the time had arrived when they should be taken into confidence, and told exactly what the prospects were likely to be. He proposed an amendment—

"*That a small committee of shareholders should be appointed to look into the condition and prospects of the Company, and report to a meeting to be held that day two months.*"

Mr. PRITCHARD seconded the amendment.

A SHAREHOLDER thought it perfectly absurd that so much money should have been swallowed up to produce £700 trading profit.

Mr. W. G. JOHNSON said that, as a new Director, he was not responsible for the past promises, and he did not intend to be. Some shareholders had already had a large dividend; but if he had been a member of the Board that dividend would not have been declared: he should have used it for working capital and completing the plant, which had not been completed to this day. The concern has never had a chance yet. No one has declared it a failure. If vigorously worked, it can do all that is claimed for it, and more. With regard to Mr. Elmore, continued Mr. Johnson, that gentleman was singularly sanguine. He did not think that Mr. Elmore ever made any promises or anything which he did not thoroughly believe in.

Mr. HAYS appealed to Mr. Squire to withdraw his amendment. They had, he maintained, an excellent Committee in Messrs. Johnson and Hooley. So far, these gentlemen were satisfied, and had backed their opinion by putting money into the concern. Hitherto the payment of dividends was a monstrous mistake. The money ought to have been husbanded, and applied for completion of the plant. Unfortunately, there had been in London an element which, for his part, he had always viewed with disfavour.

Mr. HOOLEY observed that their plant was calculated to turn out 20 tons per week, and if they could secure this amount of employment for the plant, a handsome profit would result.

Mr. SQUIRE said that after the appeal that had been made to him he would consent to withdraw the amendment on one condition, that he should be allowed to make an investigation on his own account.

With the consent of the seconder of the amendment, it was unanimously agreed that it should be withdrawn.

Mr. ELMORE, jun., replying to a statement that the Company's land had been flooded, pointed out that there was no land in the neighbourhood of Leeds that had not been so flooded, the flood experienced during the past year being the greatest known for thirty years. With regard to the mechanical difficulties that had been referred to, it was easy to understand that machinery might be required, and could not be procured because capital was not forthcoming to justify the expenditure.

Mr. HOOLEY repeated that, at the end of six months, he would be able to make a satisfactory report to the shareholders. He had more money in the concern than many shareholders that complained. What they had really been suffering from in the past had been want of capital.

The report and accounts were adopted, and Mr. J. T. Cooper and Mr. William Elmore, retiring directors, were re-elected, as were the auditors, Messrs. Price, Waterhouse and Co.

Elmore's Wire Manufacturing Company (Limited).

The second annual ordinary meeting of the shareholders of this Company was held after the close of the above meeting, and was also presided over by Mr. J. Jepson Atkinson. It was of a formal character.

The CHAIRMAN formally moved the adoption of the Directors' report and accounts, which was seconded by Mr. Hays.

A SHAREHOLDER said he would like to know when the wire works were to be in operation.

The CHAIRMAN explained that fairly good progress had been made, and that in all probability the wire works would be in full working order in a week's time.

Another SHAREHOLDER observed that he thought it had been understood that there were orders in hand as far back as two years ago.

The CHAIRMAN: So we had.

SHAREHOLDER: Then why were they not executed?

Mr. HAYS: Because we had not sufficient money.

Mr. JOHNSON: What applied to the former company applies equally to this—it was largely in want of funds.

The CHAIRMAN, in reply to a question from a shareholder, said that it was calculated that the works would produce from 30 to 40 tons. The plant laid down was contemplated to produce 35 tons. He had every possible reason to believe that the initial difficulties having been overcome, and that the Wire Company, like the Copper Company, would more than realise all that had been predicted of it.

The report and accounts were adopted.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322 *&c., &c.*]

COMPAGNIE D'ECLAIRAGE ELECTRIQUE DU SECTEUR DE LA RIVE GAUCHE DE PARIS.—Under this title a Company has been formed by M. Naze at Paris for the exploitation of the concession granted him for the electric lighting of the left bank of the Seine, comprising the 5th, 6th, 7th, 13th and 14th, and portions of the 4th and 15th arrondissements. The capital of the Company is 8 million francs, divided into 16,000 shares of 500 francs each

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DALZIEL'S ATLANTIC TELEGRAM COMPANY (LIMITED).—This Company was registered on December 29th with a capital of £25,000 in 250 shares of £100 each. The objects are: to carry on the business of agents for any telegraph or cable company, for the collection, transmission and delivery of telegraphic messages of a private or commercial character, for which the full tariff charges or rates have been paid and which are not intended for publication in newspapers or journals of any description, or for public or private circulation in any manner; to construct, improve, maintain or aid in, or subscribe towards the construction, maintenance and improvement of any buildings, telegraph or telephone lines or cables and works of all kinds which may be necessary or convenient for the purposes of the Company; and to accept, purchase, hold and sell shares or stock in any company or undertaking, any of whose objects are similar to, or connected in any way with, any of the objects of this Company, or such as may be calculated to promote or advance the interests of the Company. The first Directors are Davison Dalziel, W. C. Hallett, H. V. Huggins, H. F. Jackson and Major John E. Jameson.

J. E. HOPKINSON AND CO. (LIMITED).—This Company has been registered with a capital of £20,000 in £1 shares, to take over the business of J. E. Hopkinson and Co., at 15, Walbrook, London, E.C., as manufacturers of and dealers in india-rubber, gutta-percha, asbestos, caoutchouc, substitutes for india-rubber, &c.

A. RANSOME AND CO. (LIMITED).—This Company was registered on December 28, 1892, with a capital of £59,000 in £10 shares, to carry on at the Stanley Works, King's-road, Chelsea, S.W., and at the Battersea Works, the business of mechanical and electrical engineers, tool makers, brass founders, metal workers, boiler makers, machinists, metallurgists, electricians, &c.

NEW JERSEY METAL REFINING WORKS (LIMITED).—This Company was registered on December 29, 1892, with a capital of £50,000 in £10 shares, to carry on the business of metal extractors, smelters, refiners, chemical manufacturers, &c., carried on by a Company called the New Jersey Extraction Works (Limited), U.S.A.

ROGER DAWSON (LIMITED).—This Company was registered on the 3rd inst., with a capital of £15,000, in £1 shares. The objects are to acquire by purchase from Alfred Roger Dawson the business of an electric light engineer and contractor, until recently carried on by him in partnership with Alwyn Rashleigh Phipps, under the style or firm of Rashleigh, Phipps and Dawson, and now carried on by A. Roger Dawson alone, as sole owner thereof; with a view to such acquisition, to enter into and carry into effect an agreement expressed to be made between A. Roger Dawson of the first part, Arthur R. Cobbett of the second part, Charles E. Tomlin of the third part, John H. Jenks of the fourth part, and the above-named Company of the fifth part, to carry on the business of civil, mechanical, and electrical engineers and contractors, coppersmiths, brass-workers, braziers, platina-smiths, metal founders, general metal workers, &c.; to contract for the lighting of any public or private place or property by the electric or other light; to establish centres from which light, heat, or power may be distributed; to acquire the right to manufacture or use and put up telephones, telegraphs, phonographs, and all electrical apparatus now known or that may be invented, including all wires or appliances, for connecting electrical or other apparatus at a distance with other electrical or other apparatus, and including the formation of electrical or other exchanges or centres; and to carry on any business connected with the supply of electric light, heat, or motive power, or with telegraphic or telephonic communication, or any other business that may be conducive to the interests of the Company. The subscribers are:—

	Shares.
Alfred R. Dawson, St. Margaret's, Weybridge, Surrey, electrical engineer	1
A. Rathbone Cobbett, Woburn Chase, Addlestone, Surrey	1
Charles E. Tomlin, Kingsdown, Streatham Park, Surrey	1
Frederic H. P. Berlyn, Elm House, Brixton-road, Brixton, London, S.W., electrical engineer	1
Percy J. Dawson, Palace-road, Streatham Hill, Surrey	1
Arthur Hicks, Palace-road, Streatham Hill, Surrey, civil engineer	1
Neville Hicks, Oakfield, Streatham Hill, Surrey	1

TRIPLE-GRIP PULLEY AND POWER SAVING APPLIANCES COMPANY (LIMITED).—This Company has been registered with a capital of £5,000 in £1 shares, to acquire an invention patented by C. T. J. Vautin, relating to an improved fibre pulley, or rim, for covering the periphery of pulleys.

CAMBRIDGE ELECTRIC SUPPLY COMPANY (LIMITED).—The statutory return of this Company, made up to September 28, 1892, has been filed; 1,631 shares, of a total of £50,000 in £10 shares, have been taken up, and £6 per share called, resulting in the payment of £6,822, leaving £2,964 in arrears.

CARBON ELECTRIC (LIMITED).—The statutory return of this Company, made up to November 25, 1891, was filed on December 29, 1892. The Company was registered on April 15, 1891, with a capital of £20,000, divided into 3,000 preference and 1,000 deferred shares of £5 each, to carry on the business of manufacturers of carbon rods and plates for electrical purposes, carried on by H. J. Chappell at his works in Devonshire. The capital has since been changed to £20,000, divided into 2,100 preference and 1,900 deferred shares of £5 each. At the time of making up, seven shares were taken up, no calls having been made. The first annual return, made up to November 25, 1892, and filed on December 29, 1892, discloses the same state of things, the original signatories to the Memorandum of Association being the only shareholders.

CANTERBURY ELECTRICITY SUPPLY COMPANY (LIMITED).
CARDIFF ELECTRICITY SUPPLY COMPANY (LIMITED).
LOUGHBOROUGH ELECTRICITY SUPPLY COMPANY (LIMITED).
MANCHESTER ELECTRICITY SUPPLY COMPANY (LIMITED).
PENZANCE ELECTRICITY SUPPLY COMPANY (LIMITED).
WESTON-SUPER-MARE ELECTRICITY SUPPLY COMPANY (LIMITED).
WEYMOUTH ELECTRICITY SUPPLY COMPANY (LIMITED).

With reference to the above-named Companies (each of which has a capital of £100 in £1 shares), the Brush Electrical Engineering Company (Limited) states, in reply to circulars from the Registration Office, that these Companies were registered in order that application might be made in the name of local companies for Provisional Electric Lighting Orders in the various towns. It goes on to say that, "although these applications were unsuccessful, and the Companies cannot, strictly speaking, be said to be carrying on business at the present time, we are nevertheless in negotiation with the corporations of the various towns, which may ultimately result in our undertaking, through local companies, the establishment of central electric lighting stations, and in this event the Companies in question would be made use of. In view of these negotiations, therefore, and pending their settlement, we would prefer to keep the Companies alive for the present."

CHAGFORD AND DEVON ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to May 1, 1892, has been filed. The Company was registered on November 18, 1890; 724 shares were taken up at the time of the making up, of which 400 were issued as fully paid. Upon the remaining shares the full amounts have been called, and all calls paid.

CHARLES CHURCHILL AND COMPANY (LIMITED).—The annual return of this Company, made up to December 13, 1892, has been filed. The Company was registered on October 21, 1889, with a capital of £6,000, divided into 140 preference shares of £25 each and 50 ordinary shares of £50. At the time of making up 103 preference and 40 ordinary shares were taken up, of which 50 preference and 40 ordinary shares were issued as fully paid. Upon the remaining 53 preference shares the full amounts have been called, resulting in the payment of £1,325.

CROSSLEY TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to October 6, 1892, has been filed. The Company was registered on July 11, 1884, with a capital of £100,000, divided into 5,000 "A" shares, 12,500 "B" shares, and 2,500 "C" shares of £5 each, to carry on the business carried on by the late Louis J. Crossley, John F. Harrison and Walter Emmott under the style of "The Crossley Telephone Company," and to carry on the business of a telegraph, telephone and electric lighting, heating and motive power supplying and generating company in all or any of their respective branches, and also of a general electric apparatus construction and maintenance company. At the time of making up, 607 "A," 120 "B," and 350 "C" shares were taken up. The full amounts called and all calls (£5,385) paid.

HOVE ELECTRIC LIGHTING COMPANY (LIMITED).—The statutory return of this Company, made up to December 5, 1892, has been filed; 1,667 shares, of £5 each, of a total of £40,000, in £5 shares, have been taken up and £4 per share called. The calls paid (including £101 payment in full) amount to £6,645, and £124 remains unpaid. Amongst the principal subscribers are Messrs Crompton and Co. (Limited), and W. T. Henley's Telegraph Works Company (Limited).

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended January 1st were £966, as against £878 for the corresponding period of last year, being an increase of £88. The total receipts for half-year amount to £22,550, against £20,335 in the corresponding period of 1891, being an increase of £2,215.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the month of December were £2,092, against £2,180 for the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of December amounted to £59,776 and to £55,830 in the corresponding period of last year, an increase of £3,946.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of December, 1892, amounted to £42,295, and to £38,898 in the corresponding period of 1891, or an increase of £3,397.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for December amounted to £20,800, and from January 1st to December 31st to £266,400. In the corresponding months of 1891 and 1890 the amounts were £282,600 and £280,000 respectively.

NOTTING HILL ELECTRIC LIGHTING COMPANY (LIMITED).—Application has been made to the Stock Exchange Committee to allow the vendors' shares, Nos. 8 to 141, to be quoted in the official list.

SOCIETE ELECTRO-MECANIQUE.—The capital of this recently-founded Parisian Company has been raised from 300,000 frs. to 1,000,000 frs., divided into 2,000 shares of 500 frs. each, of which 300, fully paid, have been allotted to the Compagnie Continentale Edison, and 300 to the Société Weyher at Richemond and the Société Jean-Jacques Heilmann et Cie.

SOCIETE FRANCAISE DES TELEGRAPHES SOUS-MARINS.—At a recent meeting of this Company in Paris, MM. Léauté, Lefaivre, Vidal, Contre-

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Amiral Caubet, and Ronget were elected Directors in the place of MM. J. Lair, E. Clerc, J. Kulp, E. May, A. Sienkiewicz, A. Vuigneer, R. Wallut and P. Wallerstein.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Dec. 30, 1892, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,252.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended December 31st were £2,708, as compared with £2,371 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, Dec. 28.	Price Wednesday, Jan. 4.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 28. Highest.	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	50 51	51 52	4 16 2	Jan., Apr., July, Oct.	50¾	50⅜
£2,876,140	Stock	25/0	Do. Preferred	91 92	92½ 93½	5 12 4	" "	93	92
£2,876,140	Stock	5/0	Do. Deferred	10¼ 10⅜	10½ 11	.. ..	" "	10⅜	..
£250,000	100	4%	African Direct, Telegraph 4% Debentures xd	100 103	99 102	3 18 5	January and July	101	100
130,000	£10	3/0	Brazilian Submarine	10¾ 11¼	11 11½	5 13 1	Mar., June, Oct., Dec.	11	..
£68,200	£100	5%	Do. 5 per Cent. Bonds	101 104	101 104	4 16 2	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906) xd	106 110	104 108	4 12 7	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175 180	175 180	3 17 9	Jan., Apr., July, Oct.	176½	..
16,000	10	8/0	Cuba Submarine	11½ 12½	11½ 12½	6 19 2	February and August	..	..
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	" "	..	..
12,981	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2 3	5 6 8	April and October	2½	2⅜
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11¼ 11⅝	11¼ 11½	6 1 9	Jan., Apr., July, Oct.	11⅝	11⅜
400,000	10	2/6	Eastern	14⅝ 14⅝	14¾ 15	4 6 8	" "	15	14¾
70,000	10	6%	Do. 6 per Cent. Preference	16 16½	16 16½	3 5 5	" "	..	..
£1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109 112	109 112	3 11 5	May and November	110	..
£200,000	100	5%	Do. 5 per Cent. Debentures 1899 xd	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension xd	14¾ 15	14¾ 15	4 13 4	Jan., Apr., July, Oct.	15	14¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	111¼	110
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900.. xd	104 107	102 105	4 15 2	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor Deb.,190(xd	103 106	101 104	4 16 2	" "	105	102
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	103 106	3 15 6	February & August	..	..
180,227	10	1/9	Globe Telegraph and Trust	9¾ 10	9⅝ 10	4 15 0	Jan., Apr., July, Oct.	9⅞	9⅝
180,042	10	6%	Do. 6 per Cent. Preference	14⅝ 15¼	15 15½	3 18 8	" "	15⅝	15⅛
150,000	10	5/0	Great Northern xd	19¼ 19¾	19 19½	4 7 2	Jan., April, and July	..	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104 107	104 107	4 13 6	March & September	107	..
17,000	25	12/6	Indo-European	44 46	44 46	5 8 8	May and November	45¾	..
88,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108 111	108 111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October	..	..
8,381	£100 Cert.	30 0	Submarine Cables Trust 6%	116 120	116 120	5 0 0	" "	..	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	..	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	.. ..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902 xd	104 108	100 104	7 13 10	June and December	102	..
88,321	10	6d.	West India and Panama	1⅛ 1⅜	1⅛ 1⅜	.. ..	" "	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10 10½	10 10½	5 14 3	May and November	10½	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8 9	8 9	6 13 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917 xd	105 108	103 106	4 14 4	June and December	..	..
64,242	15	3/0	Western and Brazilian	7 7¼	7¼ 7⅜	5 16 2	" "	..	..
33,129	7½	3 0	Do 5 per Cent. Cumulative Preferred	5¼ 5¾	5½ 6	6 5 0	" "	6	5¾
33,129	7½	4/6	Do. 5 per Cent. Deferred	1½ 2	1¾ 2¼	.. ..	" "	..	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106 109	106 109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106 109	106 109	5 10 1	" "	109	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	.. ..	..	..	..
224,880	1a/0	1½d.	Consolidated Telephone Const. & Maintenance	15/16 15/16	15/16 15/16	7 16 5	May and November	..	..
220,000	£1	4⅜d.	Oriental (11s. paid)	15/16 15/16	15/16 15/16	7 18 2	Yearly	..	..
454,747	5	2/6	National	4¾ 5	4¾ 5	6 0 0	June and December	4 15/16	..
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 15	14 15	4 0 0	" "	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13¾ 14½	13¾ 14½	4 4 3	" "	..	..
90,950	5	6¾d.	Do. 5% Non-Cumulative 3rd Pref (£3 paid)	4¼ 4½	4¼ 4½	.. ..	.. ..	..	..
726 477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.) xd	112 114	111 113	3 19 8	January and July	114	111
48,000	£10	..	New Telephone, Limited (£4 paid)	4¾ 5	4¾ 5	.. ..	.. ..	..	..
58,000	5	1/0	United River Plate	2¾ 3¼	2¾ 3¼	.. ..	January and July	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock xd	90 100	90 100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	10¼ 10⅜	10½ 11	.. ..	..	..	..
20,000	£10	..	Do. 6 per Cent. Preference	5 5½	5¼ 5½	10 18 2	..	5½	..
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	5 5¼	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	.. ..	1½ 2⅛	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	.. ..	5 5½	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	.. ..	6 6½	..	January and July	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	3 1/16 3 1/16	3⅜ 3⅝	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5 1/16 5 1/16	5 1/16 5 1/16	..	March	..	..
111,000	5	..	London Electric Supply	5/16 3/8	.. ..	..	..	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6¾ 7¼	..	..	6⅞	..
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	104½	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	..	..	..	..
18,680	£5	2/6	St. James' and Pall Mall	7¾ 8¼	7¾ 8¼	..	..	8	..
7,900	£5	7%	Do. 7% Preference	8¼ 8⅝	8¼ 8⅝	4 0 0	..	..	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 10 0	..	5 1/16	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/9⅜	Brush Electrical Engineering	3 3¼	3 3½	.. ..	..	3½	..
33,996	2	6%	Do. 6 per Cent. Preference	2⅜ 2⅝	2½ 2½	4 16 0	..	2⅝	2⅝
£125,000	Stock	..	Do. 4½ per Cent. Debentures	.. ..	100 102	..	..	101½	..
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares xd	5 5½	5 5½	6 7 3	January and July	..	..
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid) xd	.. ..	1¾ 2¼	..	..	..	..
45,000	10	12/0	Electric Construction	2 2½	2½ 2⅝	..	..	2⅝	2⅝
70,000	2	10/0	Elmore's Patent Copper Depositing	⅝ ⅝	⅝ ⅝	..	..	13/16	13/16
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21¾ 22½	21½ 22⅝	5 11 1	February & August	22⅛	21⅞
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/9 4/3	3/9 4/3	..	..	..	..
78,949	5	4/2½	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	3½	3½
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July	46¼	45½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894 xd	103 106	101 104	4 16 2	January and July	..	..
..	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	¾ 1¼	..	..	..	..
..	£5	8%	Do. Preference (fully paid)	.. ..	.. ..	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	.. ..	.. ..	..	..	..	..
600,000	Stock	½%	Do. Stock	35 38	36 38	1 6 3	..	..	..

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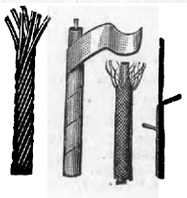

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Fire and other Reserve Funds, including Balance of Profit and Loss	2,981,078	0	0
Life and Annuity Funds	4,546,577	0	0
Total Invested Funds, 31st December, 1891	£7,894,357	0	0

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1881 ...	Life Funds	£2,737,858	...	Total Funds	£4,673,299
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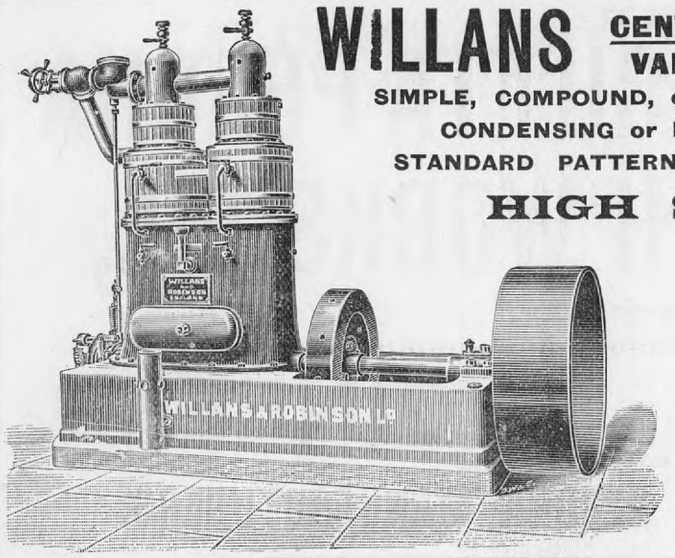

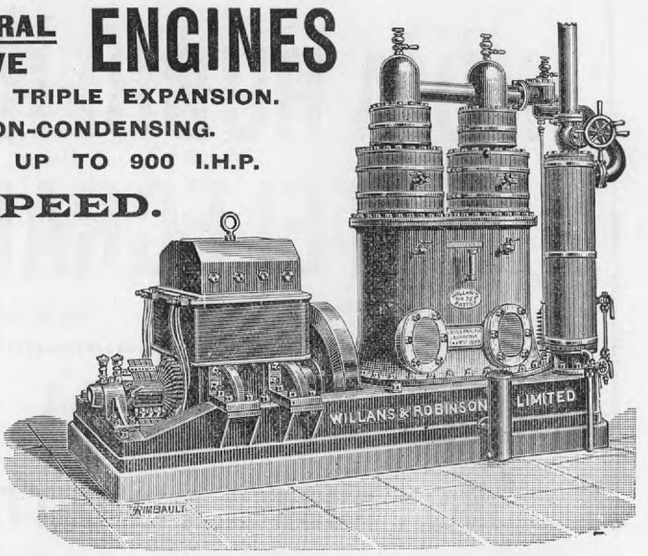

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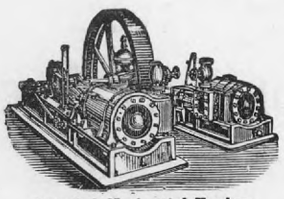
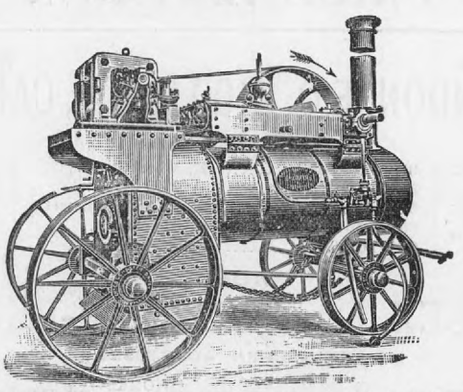
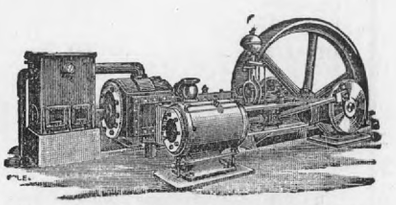


Coupled Horizontal Engine, 40 to 200 H.P. nom.



Improved Portable Steam Engine, with Dynamo attached, forming a portable electric light plant. Single cylinder, 4 to 12 h.-p.; double cylinder, 8 to 25 h.-p.; compound, 8 to 30 h.-p. nominal.

TELEGRAPHIC ADDRESS:
"PAXMAN COLCHESTER."



Horizontal High Pressure Coupled Compound Engine. 12 to 100 H.P. nom.

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THE ELECTRICIAN:

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NOTES.

Though full particulars are not yet obtainable as to the Royal Commissioners' interim recommendations for establishing electrical communication between certain points on the coast and adjacent lightships and rock lighthouses, the fact that the Committee is making useful progress will be welcome news to most of our readers, and, we believe, to the public at large. We cannot doubt the success of the experiments, now that they are being seriously taken in hand. It may be hoped that one of the first points to be dealt with will be the Goodwin Sands, where, as may be seen in our Notes column this week, great expense was incurred on an unnecessary enterprise a few days ago, for want of intercommunication between the several lightships in that ill-fated region.

A common sequel to the remark that electricity is in its infancy is, that the day will come when electricity will be generated direct from coal. The waste involved by the intervention of the steam-engine, with the clumsy modes of raising steam and the clumsier ways of utilising it, are apparent to anyone who looks into the calorific values of fuel. One day a pyromagnetic generator claims to rank as a step in this direction, and, on the next, an improved thermopile is put forward with more pretentious promises. The principle of the one is so obscure and the action of the other is so complex, that the public, with that reverence for science as a thing they cannot understand—with a mental attitude, in fact, which to-day takes the place once satisfied by superstition—hope for much, expect less, and passing on to the next nine days' wonder, forget to be disappointed. Mean while, under their very noses, and, indeed, appealing through those gates of knowledge, gas-engines are running, and without dignifying them by the name of internally fired engines or endothermic generators, it is well known that they are beating the steam-engine, both in fuel consumption and in general economy. The important Paper by Mr. J. E. Dowson, of which we print an abstract in another column, makes a careful comparison between the performance of gas and of steam-engines for electric lighting. Our friends the gas journals are fond of accusing electrical engineers of prophesying that gas will be abolished. We have often heard of this prophet, but have never met him; the fear was evidently father to the thought. At the same time, Mr. Dowson offers a much more economical fuel than town gas, and it is to be hoped that some central stations in this country may be induced, at all events, to try a supplementary gas plant or two for day loads or for emergency use.

We alluded, in our issue of December 9th, to some experiments by Mr. Campbell Swinton, in which he succeeded in bringing an ordinary glow lamp to normal incandescence by means of a high-frequency current passed through the body. Mr. Swinton made the important suggestion that, owing to the crowding of the current to the surface of the filament, the resistance of the lamp became excessive; so that the lamp, instead of taking a current of a third of an ampere at one hundred volts, perhaps received the usual thirty watts by means of a very minute current at a potential of some thousands of volts. Prof. Elihu Thomson fully confirms this explanation in his letter, which will be found in our Correspondence Columns. That there was a considerable difference of potential between the lamp terminals was indeed proved by the fact that when it was lit in this way, sparks often passed between them.

Mr. Swinton has made another interesting experiment. When a wire was used to lead the current to the lamp, in place of the human body, the lamp was over-incandesced, so that the body clearly offers considerable impedance to the passage of high-frequency currents. This was further proved by again inserting the body in the circuit, and bringing the thumbs of the two hands together. Sparks about a quarter of an inch in length were found to pass between the two thumbs, and, when these occurred, the lamp glowed with increased brightness. These sparks, moreover, indicate a fact of considerable importance, since they show that the human body can withstand, without danger or inconvenience, a potential corresponding with a spark of a quarter of an inch in length, or about ten thousand volts. It has been often supposed that the human body acts like a condenser with regard to the passage of alternate currents. But this cannot be the case, for if so, the impedance offered to high frequency currents would be very small, and the application of ordinary voltages would be fatal.

In the *Philosophical Magazine* this month there is an article by Mr. Fernando Sanford, of Palo Alto, California, which is entitled "A Necessary Modification of Ohm's Law." The writer measured the resistance of a copper wire when surrounded by various gaseous and liquid dielectrics, and

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found that its resistance altered considerably, sometimes by as much as 25 parts in 10,000. There is evidence that the measurements have been made with much care; but, for all that, the experiments given do not at all warrant the sweeping conclusion that the resistance of a metallic conductor varies with the dielectric surrounding it. An electrical resistance is one of those physical quantities which can be measured with extreme accuracy, and it is perhaps the quantity which has been most often measured. It is quite incredible that an alteration of the magnitude asserted can have escaped detection in face of so many years' use of the Wheatstone Bridge.

Not only is resistance the electrical quantity, any variation of which can most easily be detected, but Ohm's law is the law in which electricians rightly have more confidence than in any other. Before it is permissible to call a modification of it "necessary," it is clearly incumbent on the experimenter to show that in no other way can his observations be explained. But Mr. Sanford has not attempted this. According to him, "it seems clear that hereafter Ohm's law will have to be so modified as to take account of the dielectric surrounding a conductor, as well as the nature and temperature of the conductor itself." Apparently Mr. Sanford, by thus alluding to temperature, seems unaware that Ohm's law is only supposed to apply to a body whose physical state is kept unchanged, and that when the temperature alters, the resistance changes, not because Ohm's law ceases to be true, but because the body has a temperature coefficient.

It appears to us likely that the explanation of Mr. Sanford's results is to be found simply in the temperature of the wire. He finds that the resistance of the wire for the same temperature varies according to the dielectric in which it is placed. But the temperature he measures is not the temperature of the wire, but that of the dielectric in which the bulb of the thermometer is placed. The wire is thin, only one millimetre in diameter, but it seems a great assumption to suppose that the temperature of the wire is the same as that of the dielectric whatever the latter may be. The alteration in resistance, which is in most cases very much less than 25 parts in 10,000, or one quarter per cent., is immense if it is supposed to be due to an alteration in Ohm s law; but if it is merely due to change of temperature in a copper wire it corresponds at the utmost with little more than half of a degree centigrade. The wire is, of course, being heated by the current, and a slight change of temperature would necessarily result from change of emissivity owing to the different thermal properties of the various dielectrics used. The method described in the Paper, which might more appropriately have been entitled "Some Curious Discrepancies in Resistance Tests," may eventually be useful in investigations on emissivity.

In the December number of the *Journal de Physique* will be found an article on the Theory of Dimensions, written by M. Henri Abraham. To anyone interested in this subject, his Paper will prove well worthy of study. It is a clear and concise exposition of the difficulties met with in the theory of dimensions, and is enriched with a complete list of the various Papers, nearly sixty in number, which have been written on this subject since the original one appeared in Fourier's "Traité de la Chaleur." The main contention of M. Abraham is that, in determining the dimensions of any quantity, no relation ought to be considered which involves the physical properties of matter. To put this view in its simplest way, it may, for example, be said that to connect the dimensions of the unit of mass with those of the unit of length, simply because the mass of a cubic centimetre of water is one gramme, is quite unjustifiable. To conclude from this fact that the dimensions of a gramme mass are the same as the cube of a length, would be wrong, owing to the fact that the physical properties of a unit volume of water have been ignored. The proposition advanced by M. Abraham is not a new one, but, carried out logically, it leads to the result that it is impossible, either in the electrostatic or electro-magnetic systems of units, to completely express the dimensions of the various electrical quantities in terms of only the units of length, mass, and time.

Havre.—An electric tramway concession has just been granted to a M. Pierre Burton.

Electric Railway Enterprise in France.—According to *L'Electricien* a scheme is on foot for running an electric railway from Besançon to the Swiss frontier, 40 miles off.

Brighton.—At the last meeting of the Town Council the new tariff for electricity consumers was announced. (See Mr. Arthur Wright's letter to *The Electrician*, December 23, p. 221.)

Halifax.—At its last meeting the Town Council decided to take steps for supplying electricity under its Provisional Order of last year, and that an electrical engineer should be appointed at a salary of £200 per annum.

Cardiff.—The Electric Lighting Committee reported at the last meeting of the Town Council that the Town Clerk had been authorised to apply to the Local Government Board to sanction the borrowing by the Corporation of the sum of £32,500, for the purpose of erecting an electric lighting station. The minutes were adopted.

Cable Interruptions and Repairs:

	Interrupted.	Repaired.
Mozambique-Laurenço Marques ...	Nov. 24, 1892	Jan. 11, 1893.

Cables actually interrupted.	Date of Interruption.
Cayenne-Vizeu	September 24, 1892
Senegal-Pernambuco	December 27, 1892

The Eastern Telegraph Company notify that submarine telegraph communication is restored to the Cape of Good Hope and South Africa.

Presentation to Mr. H. J. Vose.—Mr. H. J. Vose, who has recently been appointed to the post of Superintending Engineer, Post Office Telegraphs, for the South Wales District, was on Thursday, the 5th instant, presented with a very handsome dining-room clock by his late colleagues of the Engineer-in-Chief's Office, General Post Office. The presentation was made by Mr. J. Hookey, Assistant Engineer-in-Chief, and Mr. Vose, in a few well-chosen words, thanked him and the donors generally for the gift.

Howard Lectures.—The first of a course of Howard Lectures, by Prof. W. Cawthorne Unwin, on "The Generation of Power at Central Stations, and its Distribution," will be delivered this evening at the Society of Arts. The course will consist of

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six lectures, to be delivered on Friday evenings up till February 17th. The lecturer will deal with the commercially available sources of mechanical energy, and the method of distributing it, treating in the last three lectures the hydraulic distribution of power, the transmission of power by compressed air, and the distribution of mechanical energy by electricity.

Crompton-Howell Batteries for an American Central Station.—"It has been a source of astonishment to foreign engineers," says the *Electrical World* of New York in its issue of December 24th, "that the use of secondary batteries in central station work has been entirely neglected in the United States. We are glad to announce that during the coming week one of the Edison stations in this city will connect a secondary battery plant to its mains. The batteries are of the Crompton-Howell type. The experience with this pioneer plant will be watched with great interest, and may lead to considerable re-modelling in our continuous-current central station practice."

The Indian Government and the Australasian Cable Rates.—The Indian Government has yielded to the remonstrances addressed by the official representatives of the Australian colonies to the Secretary of State for India recently, and have consented to abandon their intention of increasing the transit charge on cable messages from England to Australia which pass over the India land lines from 35 to 50 centimes per word. The Indian Government considered that, as the charge for cable messages to Australia and *vice versâ* has been increased from 4s. to 4s. 9d. per word, they were justified in increasing the land rate by 15 centimes. Now, however, they will adhere to the old rate of 35 centimes so long as the cable tariff remains at 4s. 9d.

Manchester.—The Municipal Electric Light Station, which is now nearly ready, promises to be second to none in the country. Its dimensions are 210ft. by 80ft., and 40ft. high. The engine-house is a fine building, lined with glazed brick throughout. The gantries have been erected for the electric travelling cranes along each of the two bays; the massive concrete foundations are in, and the bed bolts and belt racewells formed, preparatory to setting the engines and dynamos, which are all ready for delivery. The beds are built and the boilers are ready for fixing immediately upon completion of the large overhead tank, which is well advanced. The chimney, 240ft. in height, is finished. The economiser house is in progress, and such a proportion of the street mains and feeders have been laid as shortly to warrant the issue of forms of application for service connections. The demand is likely to be great from the commencement.

Automatic Electric Railway Signals.—In his report on the Thirsk disaster, Major Marindin remarks that it is well known that there are in existence several combinations of electrical and mechanical appliances, the use of one of which, so long as everything was maintained in good order, would make it impossible for such an accident to occur, unless a driver were to run deliberately past fixed signals. Although the mistakes made by signalmen are remarkably few, considering the enormous number of train-signalling operations performed daily, Major Marindin thinks it is the duty of all railway companies to adopt, upon their important lines at any rate, some safety appliance which will prevent a mistake made by one signalman from causing an accident. Devices of the kind have been in general use for some years upon three lines of railway, and in partial use upon others, both in the United Kingdom and abroad, and have been found satisfactory.

The Electric Transmission of Power from Coal Fields.—"We believe the electrical transmission of power from the coal fields to the metropolis," says *Industries*, in concluding its running commentary on Mr. Thwaite's recent Paper, "will be in practical working order before very many years. The chief difficulty in the scheme is to get the capital. There is no reason why Mr. Thwaite should not begin by transmitting the power to manufacturing towns where the load factor will be better than in the metropolis. The power can be used for lighting purposes and driving motors first, and it may come in for other purposes later. A striking feature about this scheme is that the fuel forms an exceedingly small fraction of the cost of the power. This shows that power gained from a waterfall is not necessarily sensibly cheaper than that taken from coal where it is cheap. Comparing this scheme with that connected with Niagara, while the Niagara scheme has a certain advantage in the way of water, the English scheme has a much more solid advantage in having its customers alreading existing close to the central station."

The Liverpool Overhead Railway.—A trial run over this line was made on Saturday last. The train consisted of two carriages, and the passengers included Sir A. B. Forwood (chairman of the Company) Mr. Todd (of the Electrical Construction Corporation), and others. The proceedings were under the direction of Mr. S. B. Cottrell, general manager and resident engineer of the Company. The train ran to Bramley Moore Dock, where the generating station is situated. There are four horizontal compound 400 I.H.P. engines, built by Messrs. John Musgrave and Sons, each driving an Elwell-Parker dynamo; these are supplied with steam by six Lancashire boilers, also built by Messrs. John Musgrave and Son, and fitted with Vicar's mechanical stokers, in addition to which there is an arrangement of mechanical coal bunkers, by which all handling of coal is entirely obviated, the coal being dropped into them from the high level coal railway. The current is carried north and south along the railway by a steel conductor placed on porcelain insulators, supported upon cross timbers between the rails on each line. A feature on the railway is Timmis's system of automatic signals, electrically worked by the trains themselves.

Electric Transmission of Power in Sweden.—An important power transmission installation, says our Scandinavian Correspondent, has been decided upon at the large Gröngesberg mining concern in Sweden. It will be used for the raising of ore and water, and will be carried out during the present year by the Swedish Electric Company. The five steam-engines, which have hitherto been used at different places, will be exchanged for five electric motors of the same power; and, in addition, there will be an electric light installation, comprising in the first instance 30 arc and 150 incandescent lamps. The power station will be at the Hällsjön, where four 100 H.P. turbines will be laid down. As the waterfall is of considerable height, the electric generators will be placed on the same axle, so that no belting or transmission will be necessary. The high-pressure current from the transformers is carried along 4mm. and 3mm. conductors to the mines, where the pressure is reduced. The distance from Hällsjön to Björnberget is six miles; here a certain amount of energy is used for light and power. From Björnberget it is about two miles to the first Gröngesberg central station, where another portion of the power is used; and from there it is some 600 yards to the second Gröngesberg station; and, finally, there is a stretch of one mile to Lomberget, where the balance of the power is absorbed. The installation will be the largest in Scandinavia, and the first of its kind in the district.

Hanley.—A special meeting of the Town Council was held last week, upon special requisition, to consider the position of the Council with regard to the Electric Lighting Provisional Order, and to pass such resolutions thereon as might be deemed advisable. The Corporation, as we have already stated, have obtained an Order, and have entered into a contract with the Brush Company, and a few weeks ago a Local Government Board Inquiry was held with respect to the application by the Town Council for sanction to borrow £21,000 required to carry out the scheme. The conveners of this meeting stated that they had been led into voting for the scheme by the belief that there was no alternative. They now pointed out that under clause 59 of the Order the Corporation was authorised to transfer the powers. The Mayor said that the resolution was out of order until the Council had rescinded a resolution passed on December 10, 1889, not to entrust any further powers for artificial lighting within the borough in the hands of any company, and a resolution of September 16, 1892, accepting the tender of the Brush Company. Those resolutions could not be rescinded without notice. But besides all this, the town clerk had obtained the opinion of the standing counsel of the Municipal Corporations Association, who stated that the Corporation had entered into a contract with the Brush Company, and would be still bound by that contract

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whether the resolution was rescinded or not. Notice was then given of intention to move the rescinding of the resolutions mentioned by the Mayor. Finally, however, it was moved and carried by 15 votes to 8 that the Council decline to reopen the question of the Electric Lighting Provisional Order.

Fashion in Engineering.—On December 16th last, in an article on "A Ballistic Galvanometer," allusion was made to those "causeless *nuances*" which distinguish the electrical machinery and apparatus of America from that made nearer home. In its issue of December 30, 1892, our able contemporary, the *Engineer*, holds forth on this very text, but referring more particularly to steam-engines; and the reasons it gives for these apparently fortuitous differences are worth noting. "It is surely an interesting question," says our contemporary, "Why does this difference exist? It seems certain that the design, or the peculiarities of design of the American engine, confer no special advantages on it, either from a maker's or a user's point of view. We think that the answer must be sought in the men who make and use steam-engines. There is a wide difference between an Englishman and an American. There is a difference in speech, in modes of life, in methods of thought; and what the man is, that will his engine be. It is, in short, a race difference, an ethnological difference, and that in its turn is a result of climate and surroundings. This may seem at first sight a curious and almost esoteric kind of speculation, but the moment the idea has been mastered we find ourselves in possession of a key to much that is, without it, perplexing to a degree. The engine itself, the machine, is neither better nor worse for being made on English or on American lines, and it assumes certain characteristics in the States, and certain different characteristics in this country, simply because the designers cannot help it; and a noteworthy thing is that English engineers who settle in the United States very soon give up their notions and adopt American ideas, while American draughtsmen in this country take up English ideas; and when this does not occur with the first generation, as is sometimes, although rarely, the case, it invariably does in the second generation."

The Pacific Cable Scheme.—The Canadian Government having decided to ask the Imperial authorities to appoint a Commission to inquire into the feasibility of the scheme for a Pacific cable, a representative of Reuter's Agency called upon the various Agents-General of the Australasian Colonies to ascertain their views on the subject, and what support was likely to be forthcoming from their respective Governments in this connection. Sir Andrew Clarke, the Acting Agent-General for Victoria, said he should strongly urge his Government not to entertain any idea of granting a subsidy for the purpose. From a strategical point of view the cable would have no importance whatever, and would be no practical help in time of war. The existing cables to Australia adequately carried all the traffic. He would favour the scheme, however, on the principle of letting "dog eat dog." Sir Saul Samuel, Agent-General for New South Wales, preferred to express no opinion. Mr. Westby Perceval, Agent-General for New Zealand, stated that, although in receipt of no instructions from his Government, he would favour the proposal of an alternative cable to Great Britain which would run entirely through British territory. He would, however, add that the present communication was sufficient for the traffic. Sir James Garrick, Agent-General for Queensland, believed his Government would look very favourably upon the scheme. Sir John Bray, Agent-General for South Australia, on the other hand, expressed the opinion that most of the Australian Governments would not be prepared to go to any expense for an alternative cable, the existing one meeting all requirements. Sir Edward Braddon, Agent-General for Tasmania, stated that he could not say what position his Government would take up in the matter.

Edinburgh.—The peripatetic tendencies of Electric Lighting Committees not unnaturally afford considerable amusement to the gas interest, and in a recent issue the Scotch correspondent of the *Journal of Gas Lighting* mingles didactics with merriment in adverting to the doings of the Edinburgh Committee. The following is a brief abstract of these remarks. The argument that because electrical engineers are inclined to be reticent, *ergo* they are immoral and the electrical industry is in a bad way, while comforting to gas engineers, is somewhat elliptical:—

> Mystery deepens as one comes to know more of that famous deputation from the Edinburgh Town Council to the Electric Lighting Works of the South. The deputation are in the throes of preparing their report. What is the difficulty? They have received information which they are not permitted to make use of. In some of the works which they visited they were admitted upon sufferance—the condition being imposed that they would not publish certain things which were communicated to them. I have hitherto regarded the electric lighting enterprise as one in which there was a great amount of solidarity; but this incident throws a side-light upon the doings of the fraternity who are engaged in it, and shows them to be each fighting fiercely "for his own hand." A brotherhood which is so veiled does not convey to an outsider the impression that they are engaged in an industry of a very healthful nature. I understand that the deputation are not to recommend any particular system, but are to lay before the Council the information they have received, and ask power to call in a superior expert to advise them which to adopt. The deputation seem to have gone into their work with vigour, for they not only looked at works, but interviewed customers as to their experiences. What is of interest at present is that, before starting, they seem to have been aware that they would not voluntarily receive all the assistance which they desired, and to have taken means to ensure that they would not be thwarted. The incident illustrates, on the one hand, the futility of sending deputations from public bodies to inquire into private businesess; and, on the other, the unsettled and unsatisfactory position of the electric lighting industry, when, while making a show of being frank and open, subterfuge has to be resorted to by its exponents. It also shows that electric lighting has not, in the course of its history of about twenty years, become one of the public agencies in civilisation, but is still matter of individual speculation both on its scientific and on its financial side. It is so far from having been tried and found efficient, that its promoters shrink from allowing it to be tested openly; and those who adopt it, have really to take a leap in the dark.

The Need of Coast Communication.—An instance of the amount of expense and time which would be saved by telegraphic communication with lightships occurred at Ramsgate only on Monday last. Shortly before one o'clock signal guns were heard at sea, and almost immediately the "Gull" lightship began making the usual signals for assistance from the shore. These were replied to from Ramsgate Pier, and the harbour tug "Aid," with the lifeboat "Bradford," proceeded to sea. The lugger "Champion" also put off, and the Broadstairs, Deal, and Walmer lifeboats all responded to the call, together with two other tugs. The weather was very thick, but there was no sea on. The Ramsgate tug "Aid," on arriving at the "Gull" lightship, learned that the lightsmen there had heard guns, which they believed to be signals proceeding from the East Goodwin lightship, and they had at once passed them on to Ramsgate. The tug and lifeboat then made for the other side of the Goodwin Sands, keeping a good look-out meanwhile for a wreck. On reaching the East Goodwin lightship the lightsmen there stated that no signals had been made by them. After cruising about, the tug and lifeboat returned to Ramsgate between four and five o'clock, having discovered no traces of a vessel in distress. The lugger "Champion" was equally unsuccessful. As the cost of the Ramsgate tug and lifeboat going to sea is alone about £20, and other lifeboats and tugs are also often engaged on a fruitless errand, owing to false alarms or mistaken signals, the matter is an important one.—A public meeting was held on Tuesday evening last at Ramsgate, to urge the Government speedily to carry out the proposed electric communication between lightships and the shore to prevent such loss of life as resulted in the recent wreck of the "Dilsberg" on the Longsand. The Mayor of Ramsgate presided, supported by Mr. E. J. Hobbs, the promoter of a scheme of electric communication with lightships. Mr. Hobbs proposed a resolution to the effect that the Government be petitioned to investigate the facts connected with the wreck of the "Dilsberg" on the Longsand on December 9th last with a view to ascertaining whether the disaster might not have been averted had electric or telephonic communication as experimentally provided in 1885 and 1886 now existed. The resolution was carried unanimously. After other speeches had been made, the Rev. T. Hancocks moved that the Government be requested to establish an effective system of telegraphic or telephonic communication between lightships, lighthouses, and the shore, that the loss of life and property at present existing might be prevented. This resolution was also adopted.

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NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 186.)

24. The Maintenance of Home and Continental Cables.—There are altogether 101 telegraph cables, in all 882 miles, in and about the British Isles, by which the most important outlying islands are connected with the mainland, and various rivers, estuaries, bays, and arms of the sea crossed. Besides these the English Government own two cables to Holland (219 miles) and one to Germany (232 miles), and have a joint ownership in five cables to France (195 miles), one from Jersey to France (16 miles), two to Belgium (108 miles), and one to Germany (211 miles). There are also two cables owned by the German Government, one to Lowestoft (226 miles), and one to Ireland (847 miles). These cables, amounting to 2,936 nautical miles, are kept in repair by H.M. telegraph ships, the "Monarch" and the "Lady Carmichael," expenses of maintenance being borne by owners and shared by joint owners. It is of the latter vessel that this paragraph is mainly descriptive, the illustration (Fig. 86) being from a photograph taken by Mr. W. R. Culley, chief electrician on board, and of the Government Depôt at Dover, to whom the writer is indebted for valuable information on the work of these ships. This vessel originally belonged to the Submarine Telegraph Company, who owned the two Belgian and four French cables. Since the English Government purchased this vessel, about four years ago, and with the respective Governments effected a joint purchase of the above cables, she has continued to keep them in repair, but when not so engaged is often employed on other lines. The mileage given above is considerably more if measured in miles of copper conductor, many of the cables enumerated being multiple, with from two to seven cores. The cores of all such cables are laid or stranded together with a lay of about 12ft., served with yarn and then sheathed; but on repair work, when a splice is made the cores are jointed so that the conductors lie parallel, not made up in a strand as they existed before, which takes much more time to do. It is, however, necessary to strand them when a splice is made in the London-Paris telephone cable (between Dover and Sangatte), the joints in the cores of this cable being made so that the four conductors are stranded in the proper lay of 12ft., as the good working of the telephones at each end depends upon the neutralisation of induction by twisting the wires. The landline wires, for the same purpose, are fixed so that they make a complete turn round each other every fourth pole.

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The "Lady Carmichael" is a trim little paddle steamer, with a displacement of about 760 tons, at a mean draught of 10ft., and measuring 167ft. by 27ft. by 12ft. deep. The action of the paddles on the water in giving an *immediate* effect one way or the other is greatly appreciated. When a sudden stoppage is required the blades of a propeller have not the same resisting surface to check the momentum of the ship, and cannot make such way per revolution astern as ahead, whereas paddles are equally as good. With disconnecting paddles, as fitted to this ship, either of which can be thrown out of gear in an instant, very quick turns and movements can be made, and the experience gained is that for shallow water and in strong tides there is nothing to beat it. Drawing as she does less than two fathoms of water, this vessel is very useful for repairs close in shore.

On the outside of the ship, just below the bow baulks, are fixed narrow footboards or platforms, one on each side, which the men engaged in putting stoppers on the cable stand upon while so engaged, being held up under the arms by a bowline. All work is done from the bows, one sheave only being fitted. The cable gear was constructed at the Thames Iron Works Company to the designs of Mr. W. B. Esson, and is driven direct by a pair of inclined cylinders, the same as that on the Great Northern Company's ships. The first-motion shaft (at the top in Fig. 87), carries the crank disc, four excentric sheaves (two for each valve, with links for reversing), and a pinion of 14in. diameter, gearing into one of 22in. on the intermediate shaft, the relative speeds of the shafts being inversely as their diameters. A pinion of 12in. diameter on the intermediate shaft drives the drum spur wheel of 6ft. 4in. diameter, reducing the speed further in the proportion of $6\frac{1}{3}$:1, or a total reduction of speed in the proportion of 10:1. With this reduction the gear lifts ten tons at the bows, but as there is no other purchase arranged with a reduction of, say, 20:1 or 30:1, the maximum strain is limited to the above weight. With heavy multiple cables, especially when buried, the strain in picking up often reaches 30 tons, and to meet this strain a steam winch is called into requisition, the barrel of which is driven with a slow motion by a worm, allowing the engines to keep their speed and perform their full work per minute.

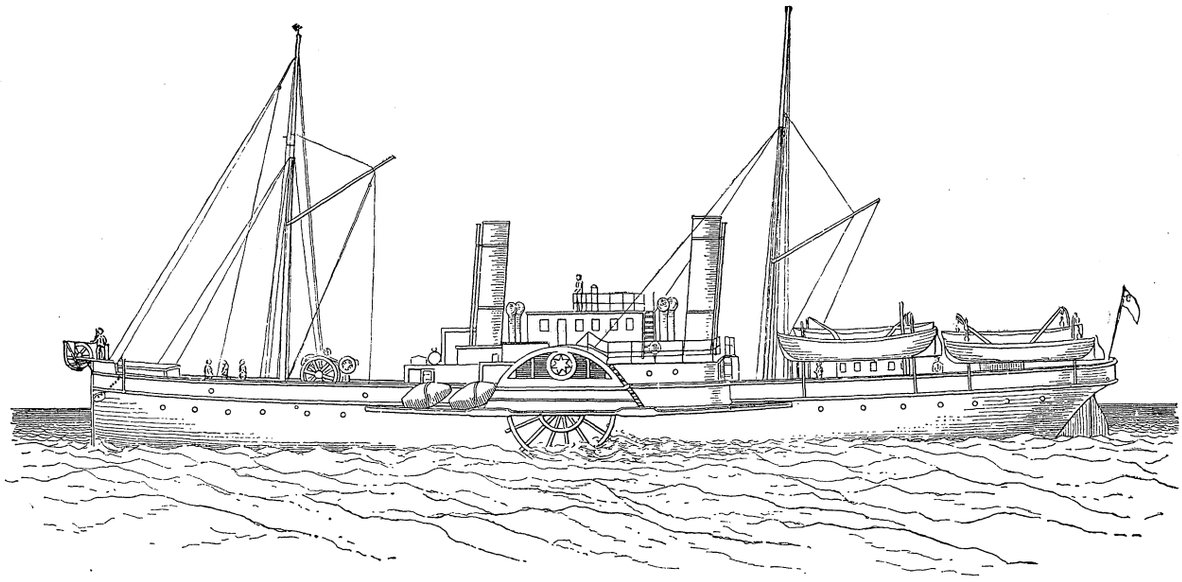

FIG. 86.—H.M. Telegraph Ship "Lady Carmichael."

For paying-out, the pinion driving drum is thrown out of gear, and the drum used with the brake. When up to buoy the drum is required for picking up buoyed end, so the turns of cable are taken off it, first removing the forward knife. Before taking the turns off, a little slack is payed out, and then the end stoppered at bows. When removed from drum the cable is laid over two forks on standards in line from bows to tank. This keeps it in a convenient position, and clear of the

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gear, and the drum and gear are then at liberty for picking up buoyed end. Steam steering gear is fitted, the wheel-house being on bridge deck level. A neat part of this gear is the arrangement for setting the limit to which it pulls over the

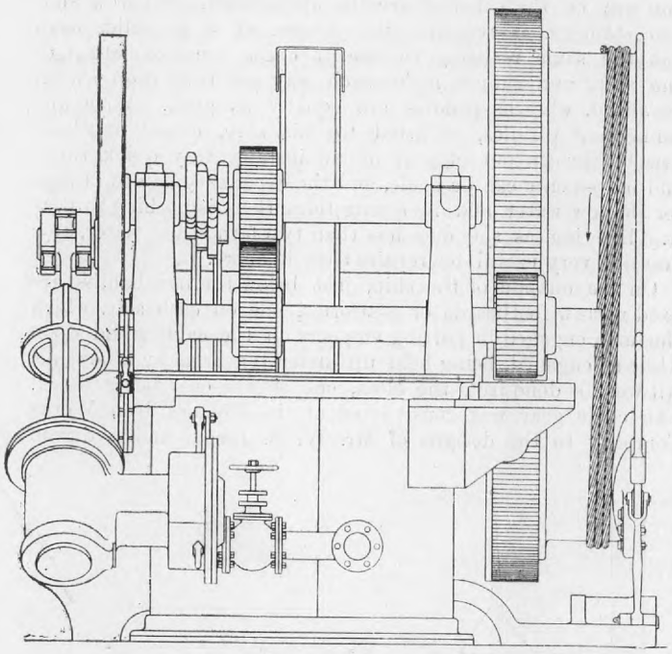

FIG. 87.—End View of Cable Gear.

rudder either way. The engine is by this device stopped when it has shifted the rudder by a predetermined amount, and the wear and jar produced in spinning the wheel a little too far, and going hard over, is prevented.

The chart room is on the same deck, and contains a large store of charts with the routes of the various cables round the British Isles, and positions where repairs or changes of route and splices have been made. One of the most remarkable of these is that showing the course of the London-Paris telephone cable laid by the "Monarch" early last year. Met by heavy weather soon after leaving the French coast, she was unable to continue paying out cable in the proper course; and not wishing to cut it, ran before the storm, paying all out and buoying the end. When the weather subsided, she picked it up and relaid it, but not in a straight course.

This cable, which was manufactured by Messrs. Siemens Brothers, under the supervision of the Post Office Engineers, contains four separate conductors, two for each circuit. After stranding the cores the whole is served with tanned hemp, and the outer sheath is of 16 galvanised iron wires, each 0·28in. thick, with a breaking stress of 3,500lbs. The sheathing wires are protected by a coating of gas-tar and silica. The insulation of the copper conductors is made up entirely of solid gutta-percha to 300lb. per knot, no Chatterton's compound being used. The shore ends of this cable do not differ from the main portion—that is, the sheathing is the same throughout, and, indeed, unless the ground is very bad, it is quite unnecessary to increase the size of the sheathing wires for the shore ends of multiple cables. The weight of each conductor is 160lb., and resistance about $7\frac{1}{2}$ ohms per knot; while the cores have a capacity of 0·3045 microfarads, and 2,000 megohms per knot at 75° F.

The testing room on the "Lady Carmichael" is remarkable for the very few instruments used. Instead of a couple of reflecting galvanometers and a mirror there is only one Morse instrument, and a simple compass card galvanometer. The latter stands on a small table mounted on gimbals, and is found quite sensitive enough for all the tests required, as everything is done by the bridge, in which method the needle is balanced to zero. The loop test is frequently in use, so many of the cables being multiple with spare insulated conductors to use as returns for the metallic circuit. In localising faults in single cables, and breaks in multiple and single core cables, when no insulated return conductor is available, it is found that the well-known "polar" tests of Mr. Lumsden (chief electrician to the "Monarch") are more to be relied upon than any other methods. These tests are fully described in "Kempe's Testing" and "Culley's Telegraphy." The Mance test is seldom used except as a check, and faults of high resistance are rare except in multiple cables, in which case they are readily localised by the loop. Insulation of cables after repair is proved on the bridge. On the wall is fixed a terminal board with six insulated terminals leading to cable in tank and six to bows, so as to be prepared for multiple cables. Battery commutators are also fixed for changing battery power, the cells used being Leclanché. As far as testing is concerned this completes the entire kit; while for speaking to shore, the distance being comparatively short, the Morse instrument is all that is required. A smart repair was effected on one of the Channel cables by this vessel on November 25, 1891. Leaving Dover Harbour at 4.45 a.m. for South Foreland, she proceeded to the position of break, 12 miles out, grappled for the two ends, and had the circuits through at 6.45 p.m., arriving back at Dover at 9.30 p.m. same day. The distance steamed was 32 miles in all, and the time from leaving to her return to harbour $16\frac{3}{4}$ hours, and this with four extra large joints to make.

While referring above to the cables to Belgium and France kept in repair by this vessel, it may be of interest to note

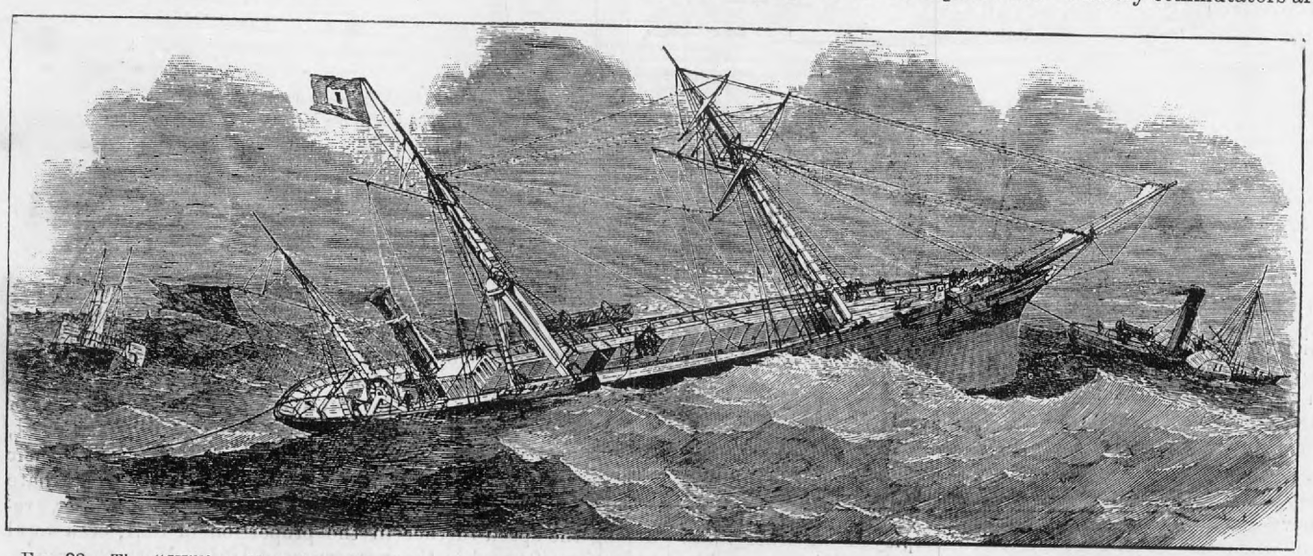

FIG. 88.—The "William Hutt" Laying Cable to Belgium in 1853. (This Illustration is reproduced from the *Illustrated London News* of May 14th, 1853, by kind permission of the Editor.)

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that two very old cables are amongst their number, and still in first-class working order. One is that referred to in the last paragraph (23), viz., the multiple cable of four cores laid in 1851 between Dover and Calais, the first sheathed cable ever laid. Since that date so many repairs have been effected that only a very short length of the original cable remains, but the line, as a means of communication, has remained intact. The other is the Belgium cable from South Foreland to Middlekerke, near Ostend, laid in 1853, which was laid by the screw steamer "William Hutt," the illustration (Fig. 88) of this early cable ship so engaged being reproduced from that in the *Illustrated London News* of May 14th of that year. It is a six-core cable, and cost £471 per mile, more than double what a similar one would now. It took over three months to manufacture this length of 70 miles, and the rate of coiling into the steamer's hold from the factory was only one mile per hour. Cable can now be coiled into tanks on board, a distance of 200 yards from the factory, at a speed of over 5½ miles per hour, as instanced by the "Silvertown," in which vessel, on one occasion in 1882, were coiled 2,370 knots for the Central and South American line, in 22 days, the greatest length coiled in twelve hours being 65 knots; while on another occasion, in 1887, she took aboard 64½ knots in eleven hours twenty minutes.

The "William Hutt," commanded by Mr. Palmer, of Gateshead, who built her, was towed during her expedition and accompanied by two vessels of the English and one of the Belgian Navy, the former marking out the course by buoys. Shore ends were landed by fishing boats. On the English coast, the "William Hutt" being anchored 500 yards from shore, 200 yards of shore end was first coiled into a large boat, and as this boat rowed to shore six other boats in turn supported cable as it was handed out from ship. (Buoys or barrels are used instead of boats now.) On the first boat reaching shore, the 200 yards were uncoiled from it and hauled up the beach by forty men, the end being connected to a speaking instrument for communicating with ship. The whole fleet of fishing boats was towed across to the Belgian coast to assist in landing the shore end there. This cable was manufactured by Messrs. R. S. Newall and Co. to the specification of Messrs. Wollaston and Crampton, engineers, and was laid under the direction of the above-named firm.

(To be continued.)

THE IMPEDANCE OF BRANCHED CIRCUITS.

BY ALEX. RUSSELL.

The ordinary algebraical formula for giving the solution of this problem is complicated and unsuitable for arithmetical calculation. The impedance can, however, be calculated graphically without much difficulty, and the method is instructive, as the final figure shows at a glance the relative phases of the various currents. A geometrical solution for the case of

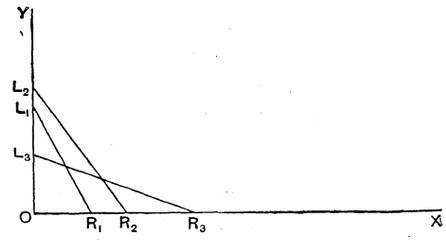

FIG. 1.—Impedances and Angles of Lag.

two inductive circuits in parallel is given by Dr. Fleming in the "Alternate Current Transformer," Vol. I. The drawback to this method is that the equivalent resistances and impedances are all given in different scales.

The current in the branch (R_1, L_1) must then

$$= \frac{E}{\{R_1^2 + p^2 L_1^2\}^{\frac{1}{2}}} \cos(p t - \alpha), \quad \ldots \quad (1),$$

where $$\tan \alpha = \frac{p L_1}{R_1}.$$

If C_1 be the maximum value of the current in this branch, then $$C_1\{R_1^2 + p^2 L_1^2\}^{\frac{1}{2}} = E. \quad \ldots \quad (2).$$

Now, the instantaneous value of the current before division is equal to the sum of the currents after division. We know, therefore, that the main current follows the harmonic law, and that its value is found by a theorem which is exactly analogous to the method in statics of compounding forces into a single resultant by the polygon of forces.

In order to get lines proportional in length to the currents we have first to construct lines equal to the impedances, $\{R_1^2 + p^2 L_1^2\}^{\frac{1}{2}}$. . . . Draw two lines (Fig. 1), O X, O Y, at right angles to one another, and measure lengths $O R_1 = R_1$ . . ., $O L_1 = p L_1$ . . ., and join L_1, R_1. . . . Then the lengths of the lines $L_1 R_1$, . . . give the impedances of the various coils, and the angles α, β . . . give the lag of the currents in the coils behind the applied E.M.F.

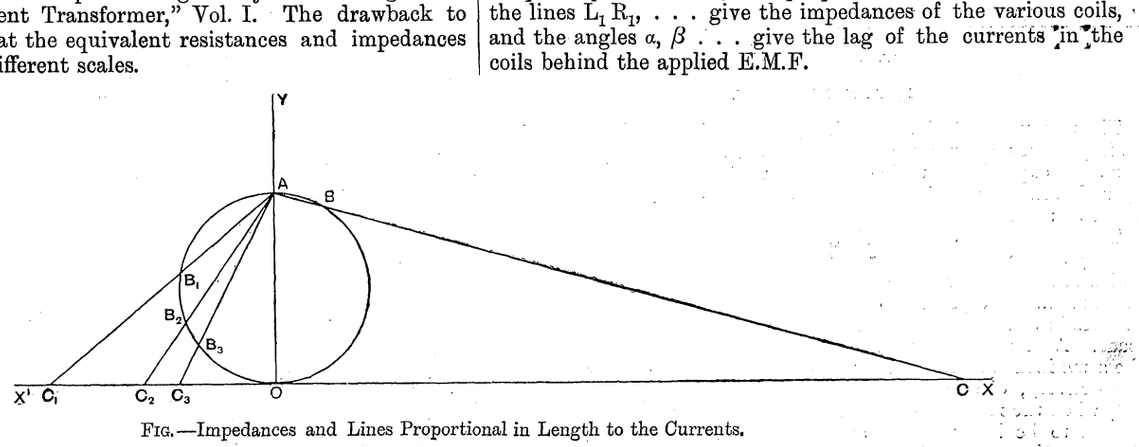

FIG.—Impedances and Lines Proportional in Length to the Currents.

We suppose that there is no appreciable mutual induction between the coils, that their coefficients of self-induction are constant, and that the applied E.M.F. follows the harmonic law.

Let the coils, which are all placed in parallel, have resistances R_1, R_2, . . . and coefficients of self-induction L_1, L_2, . . . and let the applied E.M.F. be E cos $p t$, where p is equal to 2π multiplied by the frequency of the $\sim$.

In Fig. 2 take any point A in O Y, and on O A as diameter describe a circle, O A being greater than the largest impedance. Draw chords $A B_1$, $A B_2$ . . . equal in length to $L_1 R_1$, $L_2 R_2$ . . ., and produce these lines to meet X X¹ in C_1, C_2. . . . Now, from (2)

$$C_1 . A B_1 = C_2 . A B_2 = \ldots = E$$

and $$A C_1 . A B_1 = A C_2 . A B_2 = \ldots = O A^2$$

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It follows that A C_1, A C_2 . . . are proportional to the currents in the coils.

Now (Fig. 3), make the angles C_1 O E, C_2 O E. . . . equal to α, β . . . , and measure lengths O C_1, O C_2 . . . equal to A C_1, A C_2 . . . (in Fig. 2). From C_1 draw C_1 D parallel and equal to O C_2, and from D draw D C parallel and equal to O C_3, and so on if there are more than three branches; join O C. Then O C is proportional to the current before sub-division. The

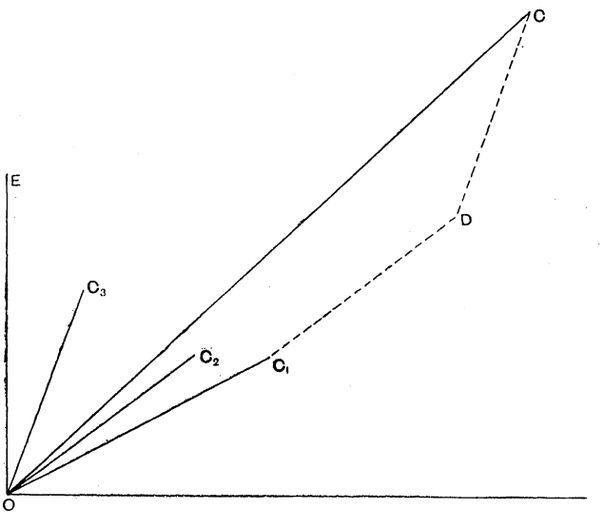

FIG. 3.—Phases and Magnitudes of the various Currents.

lag of the current O C behind the E.M.F. is obviously the angle C O E, and the difference of phase between the various currents can be measured from the figure. To get the joint impedance, make A C (Fig. 2) equal to O C (Fig. 3), and let it cut the circle in B. Then the length of A B is the resultant impedance. From the formula given by Lord Rayleigh (*Phil. Mag.*, 1886), we see that

$$\frac{1}{A\,B^2}=\left(\frac{R_1}{R_1^2+p^2L_1^2}+\ \ldots\ \right)^2+p^2\left(\frac{L_1}{R_1^2+p^2L_1^2}+\ \ldots\ \right)^2,$$

which suggests other geometrical methods for calculating A B.

The above method is also applicable to cases where there are condensers in the circuit, by considering a condenser as a resistance coil $\left\{0, -\frac{1}{C\,p^2}\right\}$.

A DIFFERENTIAL WATTMETER FOR ALTERNATING CURRENTS.*

BY A. E. KENNELLY.

The measurement of the efficiency of transformers is necessarily an important matter, for, setting aside the cost of the power that has to be expended in their excitation, wasteful transformers must, by undue heating, limit to a greater or less degree the output they could be made to yield with better materials or proportions.

The earlier and calorimetric tests of transformers† have been latterly almost entirely superseded by electrical wattmeter methods, which have themselves been tried in a variety of forms‡. These instruments are capable of determining with all desirable precision the loss in transformers that are idle or that are worked on light loads. Although two such instruments, or two measurements with the same instrument, one for the energy absorbed, the other for the delivery, enable the efficiency to be determined at any load, yet, when the readings of the instruments are large, they are well known to be less reliable, and the most recent advances have, therefore, been made in the direction of null methods, which Dr. Sumpner§ and also Dr. Hopkinson§ have used with excellent results.

The object of this article is to describe a differential wattmeter that has been constructed and tested for the last nine months at the Edison Laboratory. This instrument is a double electro-dynamometer of the Kohlrausch unifilar type. These two dynamometers are arranged as wattmeters with their suspended coils rigidly connected by an aluminium shaft 8cms. long. The upper wattmeter is in the primary circuit of the transformer to be tested, the lower in the secondary. The intake is, therefore, measured by the former, and the output by the latter, so that when the sensibilities of the two dynamometers are adjusted to equality, that is to say, when they are balanced differentially, the reading of the torsion head corresponds to the loss of power in the transformer due to all causes combined—hysteresis, C^2R, eddies, and radiation.

Thus, assuming that the sensibility of each dynamometer was such that one degree of torsion represented an activity of five watts, and that they were independently inserted in the primary and secondary circuits of a 20 kilowatt transformer worked at full load, the upper instrument would indicate, say, 20,750 watts with a torsion of 4,150deg., the lower 20,000 watts with a torsion of 4,000deg. Such a degree of sensibility would be, of course, quite impracticable, but mounted in combination with a common suspended system, the resultant torsion would only amount to 150deg. An uncertainty of 1 per cent. in the indications of the independent instruments would affect the results to a range of 207·5+200, or 407·5, watts. In the differential instrument, 1 per cent. deviation at the same load would represent 1·5 watt error.

The framework of the instrument is entirely of hard rubber, supported by a stout brass tripod. To avoid frequent repetitions, we may denote the upper dynamometer's fixed coil by U, its suspended coil by *u*, and the corresponding coils of the lower dynamometer by L and *l* respectively.

In a differential instrument of this description it is, of course, essential that U should have no effect on *l*, and likewise L none on *u*, so that the mutual inductance of these pairs of opposite coils must be negligibly small. This result is mainly accomplished by setting the two dynamometers at right angles in azimuth, but there is a residual mutual inductance, if only from the axial components of the coils, which at this short range fail to be represented by simple solenoids. As this residual influence would introduce a very appreciable error at heavy loads, with the sensitive differential adjustment, it is necessary to eliminate it, and this is done by single turn auxiliary coils, set by trial outside the instrument in such a manner as to possess compensatory mutual inductance be-between L and *u*, U and *l*, but no appreciable additional inductance tween L and *l*, U and *u*. All the leads to the instrument have to be carefully double wound to prevent external electro-magnetic influence. There are four windings on L, and also four on U, making eight pairs of binding posts in all for fixed coils, with two pairs of smaller binding posts for the connections with the suspended coils.

Coil.	No. of turns.	No. of layers.	Wire.	Resistance at 20 ohms C.	Inductance in millihenrys.
U 1	432	8	26 B.W.G.	7·11	5·44
U 2	120	4	22 ,,	0·934	0·588
U 3	28	2	15 ,,	0·0388	0·055
U 4	6	1	9 ,,	0·0028	0·023
L 1	120	4	19 ,,	0·36	0·389
L 2	28	2	13 ,,	0·22	0·052
L 3	4	1	strip 0·4″ × 0·02″.		
L 4	2	1	strip 0·875″ × 0·02″		

The control of these eight coils in any combination gives the instrument a very wide range, and it can be used to test any transformer of the ordinary type up to 100 kilowatt capacity.

The two small suspended coils are made of hard rubber and are similar. They have each an external diameter of 2·8 cms., internal 0·75, and an interflange of 0·96, wound with 675 turns in 27 layers of No. 33 B.W.G., with a resistance of 20 ohms and an inductance of 6·6 millihenrys. Each coil weighs about 30 grammes, and the weight of the whole suspended system is about 65 grammes. Four connections have to be permanently maintained with this system, one through the torsion wire, one through the damping vane, and two by single loops of fine copper wire 0·002in. (0·005 cm.) passing under the base from opposite sides of the suspension rod of hard rubber to small binding posts. These loops are so flexible that they do not sensibly impair the oscillatory freedom of the system within the small limit of play allowed. The insulation of these fine wires is carefully preserved by carrying them up the suspension rod imbedded with wax in little grooves. This is essential, as 2,000 volts may be active between them. The suspension wire is of copper 32·6 cms. long, and 0·0115 cm. in diameter. Its torsional moment is 18·6 centimetre-dynes per radian of twist, and one complete revolution of the torsion head can be allowed without sensible elastic fatigue. The zero of the instrument is read by mirror, telescope, and scale. A slight directional

* From the *Electrical Engineer* of New York.

† *Journal* of the Institute of Electrical Engineers, Vol. XVII., No. 71, February, 1888, page 168; and Vol. XVIII., No. 81, May, 1889, page 608.

‡ Ayrton and Sumpner, *Phil. Mag.*, August 6, 1891.

§ *The Electrician*, July 1, 1892, Vol. XXIX., page 223.

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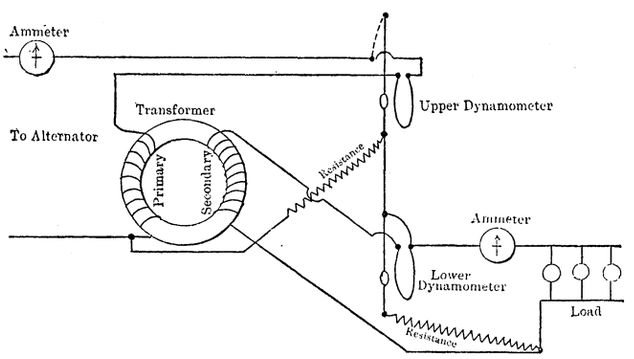
No. of Obs.	Torsion.	Primary current amperes.	R ohms.	R_a torsion constant watts.	Energy lost in transfr. (watts).	Load (lamps).	Secondary current amperes.	P. D. at second'ry terminal volts.	Energy in secondary ex. circ't.	Primary C^2R watts	Secondary C^2R watts.	Total C^2R loss watts.	Hysteresis and eddies (watts).	Efficiency of transf'rmr.
1	91°	0·1	19,480	1,000	91	—	—	52·4	—	0·1	—	0·1	90·9	0
2	91°	0·25	—	—	91	3	2·046	52·4	107	0·6	0·1	0·7	90·3	0·54
3	92°	0·3	—	—	92	6	4·092	52·3	214	0·9	0·2	1·1	90·9	0·699
4	93°	0·4	—	—	93	12	7·818	51·6	404	1·8	0·7	2·5	90·5	0·813
5	95°	0·6	—	—	95	18	11·46	51·5	590	3·1	1·4	4·5	90·5	0·861
6	99°	0·79	—	—	99	25	15·28	51·0	779	6·8	2·6	9·4	89·6	0·887
7	110°	1·13	—	—	110	36	21·32	50·3	1072	14·5	5·0	19·5	90·5	0·907
8	127·5	1·55	—	—	127·5	50	28·44	50·0	1422	27·2	8·9	36·1	91·4	0·918
9	91°	0·1	—	—	91	—	—	52·4	—	0·1	—	0·1	90·9	0

force is provided by two loops of wire from the vane head to the sides of the damping vessel, which wire loops, maintaining electrical connection between the vane and base terminal, are straddled by small rider weights whose gravitational influence is sufficient to keep the zero definite. The vane itself swings in water covered with a layer of heavy oil, so that the oscillations are almost dead-beat.

The transformer connections are indicated as shown in the accompanying figure. The compensation for mutual inductance between L u and U l, is first completed with each pair by trial. The two dynamometers are then balanced differentially. The fixed coils are connected in series and the suspended coils in parallel with suitable non-inductive resistances in their circuits, and these resistances are adjusted until balance is obtained. For 1,000 volts of alternating primary pressure, 20,000 ohms is a good resistance for the primary suspension circuit, and in the secondary whatever may be necessary. For 100-volt secondaries, 4,000 ohms can usually be paproximated to, making the C^2r loss in this circuit about 2·5 watts. The value of the torsion readings is then found for either dynamometer by trial.



When the connections are made, as in the Figure, and the secondary coil is open, the torsion needed to restore the zero is due to the upper dynamometer only, and measures the excitation loss. As the load is connected with the secondary, the torsion increases and measures the loss in the transformer plus the two or three watts absorbed in the circuit of l. If it is desired to analyse the loss due to hysteresis and eddies at each load, ammeter readings must be taken in both primary and secondary circuits, and in any case voltmeter and ammeter readings are required in the secondary circuit to determine the output. From this out put and the observed loss in the transformer, the efficiency can be immediately deduced. It is easy to show that with such an instrument the results are not influenced by the shape of the waves of E.M.F. generated by the alternator, and that the error due to lag in the suspended coil circuits is quite negligible when proper non-inductive resistances are employed.

The following is a specimen table of observations on a particular transformer. The calibration was so adjusted that each degree of torsion represented one watt. It will be seen that the loss due to hysteresis and eddies combined is practically constant throughout. In a few instances, tests of transformers whose magnetic leakage has been considerable, have shown an apparent decrease in excitation loss between idleness and full load, but amounting to only three per cent.

In this case the wattmeter was differentially balanced after compensation for mutual inductance and carefully adjusted.

Balance 19,480 ohms in primary suspension circuit.
3,735 ,, ,, secondary ,, ,,

These resistances were of bare German silver wire, non-inductively wound on insulating grids. The compensation and balance were checked after test.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 13th.

PHYSICAL SOCIETY.

5 p.m. Paper to be read: "Upon Science Teaching," by F. W. Sanderson, M.A.

SOCIETY OF ARTS.

8 p.m. Howard Lecture I. "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S.

SATURDAY, January 14th.

ASSOCIATION FOR THE IMPROVEMENT OF GEOMETRICAL TEACHING.

11 a.m. and 2 p.m. Meeting at University College. Papers to be read: (1) "A Model Lesson on Geometry as a Basis for Discussion," by Mrs. Bryant, D.Sc.; (2) "The Use of History in Teaching Mathematics," by G. Heppel, M.A.; (3) "The Teaching of Elementary Arithmetic," by F. E. Marshall, M.A.

JUNIOR ENGINEERING SOCIETY.

2 p.m. Visits: To the Millbank Street and Eccleston Place Stations of the Westminster Electric Supply Corporation.

TUESDAY, January 17th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed:—"Gas-Power for Electric Lighting," by J. Emerson Dowson, M.Inst.C.E. After which a Reception will be held by the President and Council in the Libraries.

WEDNESDAY, January 18th.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Annual General Meeting at the Institution of Civil Engineers. Election of Officers and Presidential Address by Dr. C. Theodore Williams.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Mining Industries of South Africa." By Bennett H. Brough, F.G.S.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Annual Meeting at 20, Hanover-square, W. Presidential Address by Dr. R. Braithwaite.

THURSDAY, January 19th.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting. Papers to be read.

FRIDAY, January 20th.

SOCIETY OF ARTS.

8 p.m. Howard Lecture II. "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S

ROYAL INSTITUTION.

9 p.m. Friday Evening Discourse:—"Liquid Atmospheric Air," by Prof. Dewar, F.R.S

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

The Hopkinson Three-Wire Patent.—Judgment in the action Hopkinson *v.* St. James and Pall Mall Electric Light Company will be delivered by Mr. Justice Romer on Saturday morning next.

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SPECIAL NOTICE.

With this Number is issued (Gratis to Subscribers) a MAP, printed in colours, showing the Streets in the Metropolis in which Mains for Private Lighting are actually laid, up to January, 1893, together with the areas allotted to the different Supply Companies.

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ELECTRICAL SUPPLY IN LONDON.

The progress of electrical supply in London during the past year is for the present to be estimated by the increase in lamp connections rather than by new mains laid. We say for the present, for the real measure will not be forthcoming until the accounts are made up and published. According to the table we printed as a supplement to our last issue, the total lamp connections in 8 c.p. amounted to 503,902, as against 179,060, in December, 1891, according to Mr. FRANK BAILEY'S estimate, showing an increase of 324,842 in about two years. We propose to analyse some of the figures given in our table, for the purpose of elucidating some points in the nature of the demand and in the provisions which exist for meeting it.

The maximum load observed during 1892 in the case of the Eccleston Place Station of the Westminster Supply Corporation, was only 25 per cent. of the possible demand. Of the other companies the Kensington Court Station of the Kensington and Knightsbridge Company shows the low figure of 27·8 per cent., and it thus appears that, in purely residential districts, only about one-quarter to one-third of the lamps connected are turned on at the same time. On the other hand, those companies which are fortunate enough to number theatres and clubs among their consumers, find that the proportion runs up to one-half, as in the case of the St. James-Pall Mall Company, and 53 per cent. in that of the Electricity Supply Corporation. After all the troubles of the London Electric Supply Corporation they have, at all events, succeeded in getting the best class of consumers, who, at one time, burned 58½ per cent. of their whole number of lamps. The average of all the London companies was 40 per cent., excluding St. Pancras Vestry, from whom we have been unable to obtain the necessary information.

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MAP OF LONDON

SHEWING

The Mains actually laid by the various Electric Lighting Companies exclusive of public lighting, up to January 1st, 1893.

KEY.

To avoid a confusing number of colours, the Chelsea and Metropolitan Companies are coloured .....

London and Notting Hill Companies ....

St. James', St. Pancras Vestry, Kensington and Knightsbridge and City Companies

House to House & Westminster Companies

Electricity Supply Company.....

Supply Stations marked thus ●

NOTTING HILL Co

KENSINGTON & KNIGHTSBRIDGE Co

HOUSE to HOUSE Co

CHELSEA Co

WESTMINSTER Co

METROPOLITAN Co

ST JAMES' Co

ST PANCRAS VESTRY

LONDON Co

ELECTRICITY SUPPLY Co

CITY Co

REGENTS PARK

HYDE PARK

GREEN PARK

ST JAMES' PARK

PALACE GARDENS

KENSINGTON GARDENS

PADDINGTON STA.

MANCHESTER SQ. STA.

DAVIES ST. STA.

CARLTON ST. STA.

RATHBONE PLACE STA.

SARDINIA ST. STA.

KNIGHTSBRIDGE STA.

SLOANE SQUARE STA.

VICTORIA ST.

WESTMINSTER BRIDGE STA.

DRAYCOTT PLACE STA.

LILLIE ROAD STA.

KENSINGTON COURT STA.

WHITEHALL STA.

ST. MARTIN'S LE GRAND STA.

BANKSIDE STA.

WHITTINGTON STA.

ST. LUKE'S STA.

ST. MARY'S WHARF STA.

PENTONVILLE ROAD

CITY ROAD

GOSWELL ROAD

ST JOHNS ROAD

GRAYS INN ROAD

EUSTON ROAD

TOTTENHAM COURT ROAD

MARYLEBONE ROAD

GREAT PORTLAND ST.

EDGWARE ROAD

HARROW ROAD

WESTBOURNE TERRACE

LADBROKE GROVE

BAYSWATER ROAD

KENSINGTON

UXBRIDGE ROAD

KENSINGTON GORE

KNIGHTSBRIDGE

KENSINGTON ROAD

CROMWELL ROAD

WARWICK RD.

SLOANE STREET

FULHAM ROAD

KINGS ROAD

CHELSEA BR.

VAUXHALL BR.

VAUXHALL BRIDGE ROAD

LAMBETH BR.

WESTMINSTER BR.

WESTMINSTER BR ROAD

WATERLOO BR.

BLACKFRIARS BR.

BLACKFRIARS ROAD

SOUTHWARK BR.

SOUTHWARK STREET

BOROUGH HIGH ST.

BOROUGH ROAD

LONDON RD.

GEORGE'S ROAD

NEWINGTON CAUSEY

NEW KENT ROAD

LONG LANE

GREAT DOVER ST.

HOLBORN

HIGH HOLBORN

FLEET STREET

LUDGATE HILL

CHEAPSIDE

NEWGATE ST

LONG ACRE

CHARING CROSS

PARK LANE

PICCADILLY

THE MALL

QUEEN VICTORIA STREET

CANNON STREET

LONDON WALL

CHISWELL ST

LEADENHALL ST

GREAT TOWER ST

THE EMBANKMENT

AMESS

STRAND

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We have alluded to the total number of lamps connected as representing the total possible demand. It has been customary to suppose that the plant capacity of a station ought to be sufficient to meet this demand at half-an-hour's notice; and in discussing the vexed question of the methods of charging it has been suggested that when a consumer connects a hundred lamps in his house, there ought to be enough plant, allocated to him as it were, at the station, to run these lamps if required. The demand that a bank should hold sufficient bullion to meet its notes in circulation would be much more reasonable. On the other hand, few, if any, of the London central stations are running "full," and, with one or two exceptions, they could all meet the maximum possible load, as far as their engines and dynamos are concerned, though we doubt if the boilers of a majority of stations would be equal to the task. One acknowledged exception is that of St. Pancras Vestry, where, if we are rightly informed, the lamp connections, estimated in 8-c.p. lamps, exceed the plant capacity 20 per cent. The House-to-House Company have lamp connections equivalent to 92 per cent. of their plant capacity, and the Chelsea Company 87½ per cent. This last, relying as it has done to a large extent on secondary batteries, would probably be unable to stand a long "run" on its resources. The St. James-Pall Mall Company, like the St. Pancras Vestry, have 20 per cent. greater lamp connection than plant capacity, but their new station in Carnaby-street is nearly completed, and, with the additional plant, the proportion will be reversed, and will come down to about 80 per cent. The Metropolitan Electric Supply Company, as we learn since last week, has a plant capacity equivalent to 240,000 eight-candle lamps. Of this, the lamps connected come to 52 per cent. At the other end of the scale, St. John's Wharf, Westminster, comes lowest with 31·6 per cent., and Deptford next with 33 per cent. Taking the average of thirteen, the lamp connections come to 68·2 per cent. of the plant capacity. The grand total of 503,892 lamps connected is 59 per cent. of the grand total of 852,000 plant capacity; this, by the bye, is equivalent to about 40,000 horse power.

Turning to actual facts instead of possibilities, we find that the nearest approach to a "run" last year was experienced by the St. James-Pall-Mall Company, who used 62 per cent. of their plant to provide the maximum observed load; but the same demand, when their new station is started, would employ only 48 per cent. The House-to-House Company comes next with 40 per cent., and Deptford with 39 per cent. The lowest is the St. John's Wharf Station with 12·1 per cent., but a considerable portion of the plant at this station is destined for the lighting of some large buildings which are not yet fitted. The average of eleven stations, according to the figures given in our supplement, comes to 27·3 per cent. The margin of 72·7 per cent. in the present plant capacity must not, of course, be regarded as a reserve, but as a provision for future consumers. The proportion of reserve or spare plant which will be actually required when the stations become fully loaded need not at present be considered. It is not probable that the overloading of the old Grosvenor Gallery plant will be repeated in any of the existing stations. The margin, such as it is, while an admirable security for the consumers, is not to be regarded with equal favour by the shareholders, since interest and depreciation continue to run whether it is used or not. In some cases the plant capacity given in our table probably represents the ultimate capacity of the station rather than the actual generating machinery in working order.

Not only is electric supply burdened for the present with spare plant, but a large expenditure of capital for mains in the streets has been incurred, and this is only partially utilised. The coloured map which forms the supplement to our present issue shows with what energy the supply companies have spread their network over the metropolis. The increase of business during the last year is to be found, as we have said, in the lamp connections rather than in the mains, and as a comparison between the present map and the one we published on January 15th of last year shows that, as no great number of new streets have been opened, there is good reason to suppose that the financial result will be better, the increased lamp connections having been made to the existing mains. The private lighting in the City is the chief addition to our map, but we regret that we are unable to give any particulars about the progress of the work. The City was divided into three districts, two of which were secured by the Brush Electrical Egineering Company, and one by the Laing, Wharton, and Down Construction Syndicate. The first two, now merged into one, are shown by the vertical blue ruling; and the third by horizontal ruling. The street lighting in the City, as in St. Pancras, is carried out by a special service of mains, which, by order of the Board of Trade, is kept distinct from those for private supply. Having extended our map eastwards, we are able to show some of the South London work of the London Electric Supply Corporation. The only considerable extension compared with last year is the advance of the Notting Hill Company into the Campden Hill district. This Company, we believe, like the St. Pancras Vestry, was a little too generous at first with its mains, and laid them in streets in which but few customers could be found. A demand then arose elsewhere, and more mains had to be laid. In connection with our map, the density of the lamps per mile of main is interesting. The happy St. James Pall-Mall Company leads the way, as might be expected, with 6,400 lamps per mile, or one lamp to less than 10in. of main. The Metropolitan Company comes last, with only 630 lamps to the mile, or about one to every 8ft. 6in. of main, and the House-to-House Company next, with 885. The Kensington and Knightsbridge, cheek by jowl with the latter, has 3,700 lamps per mile; the only other high figure, and one that is rather surprising, being St. Pancras with 4,360. A singular difference exists between the averages of the nine companies who have furnished us with their length of mains, and the ratio of the grand totals. The companies average 2,380 lamps per mile, but the 498,892 lamps (that is, excluding the 5,000 of St. Luke's, Chelsea) over an aggregate of 452 miles, 198 miles of the Metropolitan Company being added to those given in our table, comes to 1,100 lamps per mile.

ELECTRIC RAILWAY SCHEMES IN PARLIAMENT.

Possibly, it may be premature to call all those underground lines which have been projected "electric railways," but there seems to be a choice only between cables and electricity; and, while we are prepared to admit that cable traction may be the most serious rival of the electrically propelled car, it is likely to compete seriously only on lines with heavy gradients and with an irregular traffic. Six Bills for new underground lines were referred in March last to a joint committee, which reported strongly in favour of the Greathead system of tunnel construction, of electric traction under ordinary circumstances, and of cable traction for steep gradients. The report, which was printed in *The Electrician*, Vol. XXIX., p. 103, recommended that, as the schemes were satisfactory as instalments of yet larger proposals, the Bills should be sent forward in the usual way.

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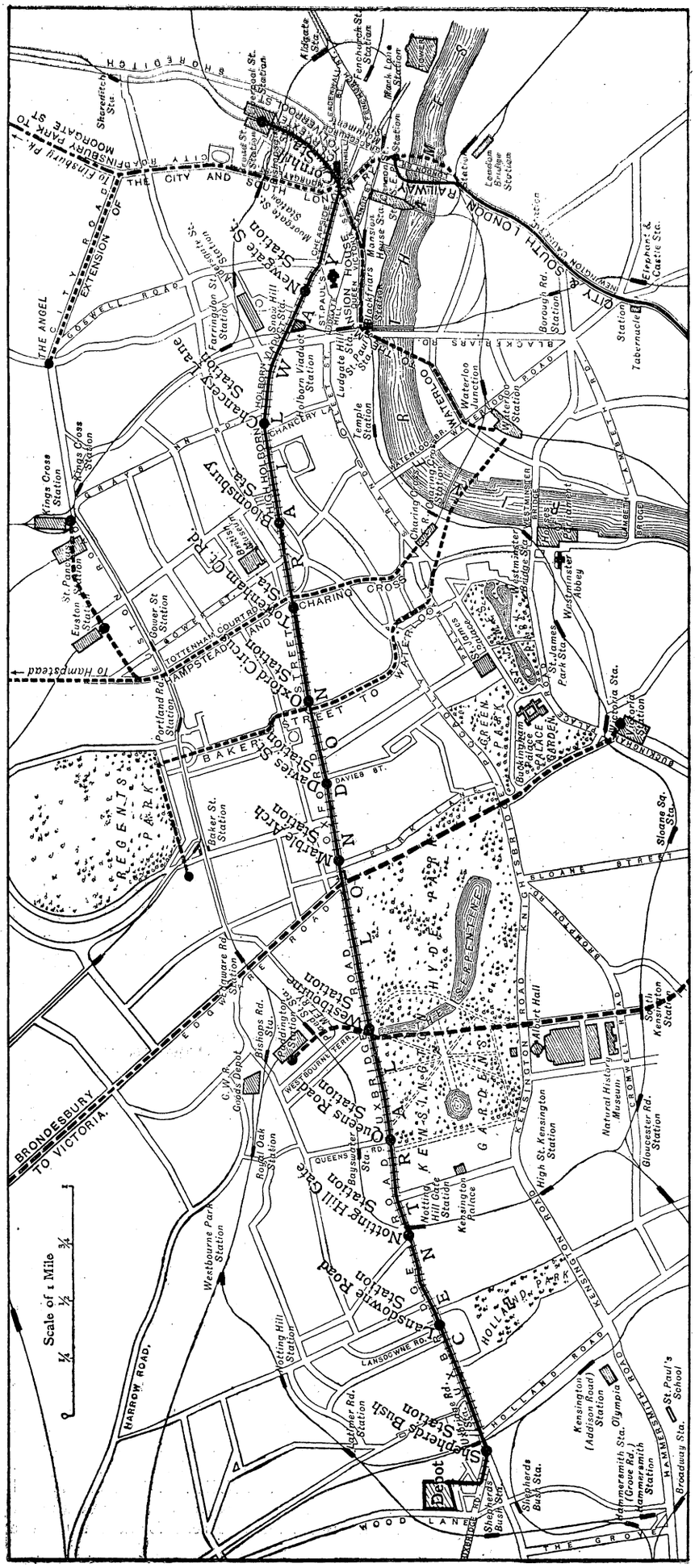

PROJECTED ELECTRIC RAILWAY SCHEMES.

The following lines were proposed:—

	Miles.
The Great Northern and City Railway	3¼
The Central London Railway	6½
The City and South London Railway (extension)	2¾
The Waterloo and City Railway	1½
The Baker-street and Waterloo Railway	3
The Hampstead, St. Pancras, and Charing-cross Railway	5¼

The proposed routes were clearly shown in a map published in *The Electrician*, Vol. XXVIII., p. 252, and herewith we print two maps, the one showing the above lines, together with the latest proposals, viz.:—

	Miles.
The Edgware-road and Victoria Railway	4½
The Clapham-junction and Paddington Railway	4½

the latter being also shown complete and in more detail on a separate map. We understand that the Charing-cross and Hampstead line is the only one of the eight not intended, for the present, to be worked by electricity. Of the six Bills of last year those of the Great Northern Railway and of the Central London Railway alone succeeded in passing, the remaining four being left by the late Parliament in different stages of development.

The schemes at present before us may be divided into two classes, lines which are intended to feed or to form extensions to or connection between existing railways, and lines which are intended to relieve, or, indeed, to compete with, that class of traffic which the daily Press is wont to call vehicular. The former being promoted in most cases by the railway companies will probably be financed by them in the usual manner. All the Bills have met, and will meet, with considerable opposition. The Paddington and Clapham line will be recognised by our readers as a development of the proposed subway from Paddington to South Kensington. The impudent attempt to drive a "cut and cover" line across Kensington Gardens, the actual staking out of the route on the grass, the threatening of disastrous disturbance to the laboratories on either side of Exhibition-road, and the complete victory of public and scientific opinion, have not be forgotten. The line was intended as a feeder to the Albert Hall, and was promoted by friends of that institution. The scheme comes forward again in a new shape, and with much more promise of usefulness. We do not, however, believe that the sinking of the line to a depth of 70ft. will

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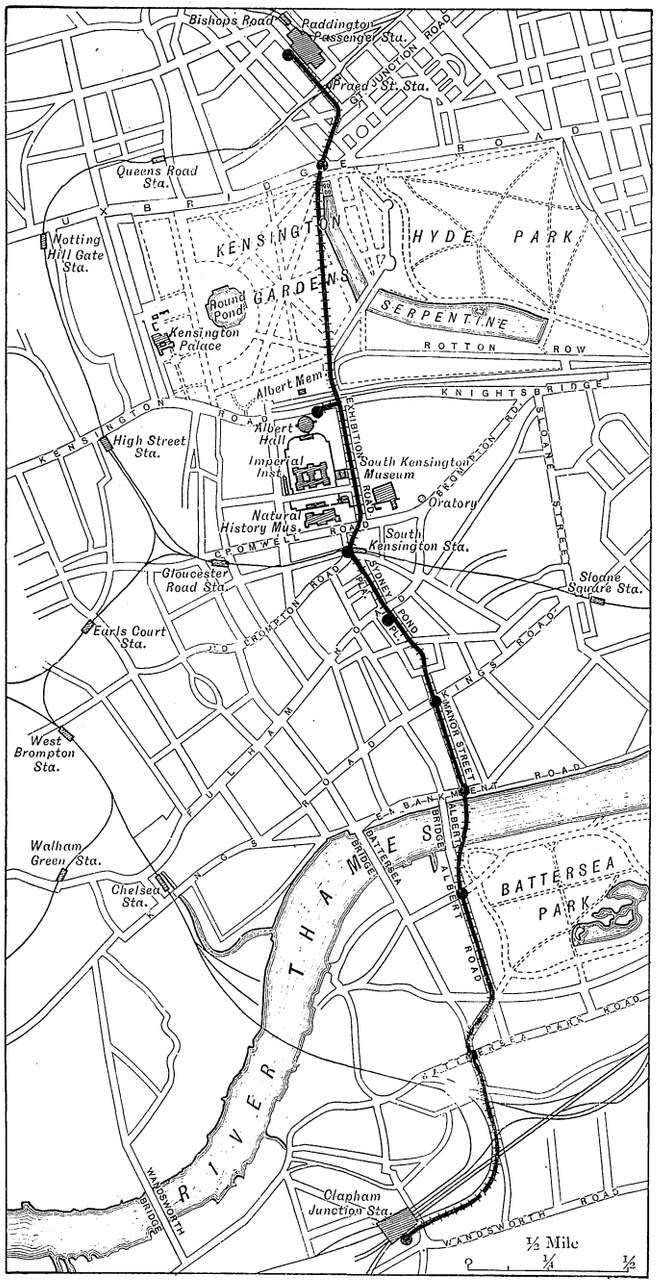

Route of Proposed Paddington and Clapham Junction Line.

alleviate the disturbance to the laboratories, and the professors, as well as the important bodies who govern their colleges, will, of course, renew their opposition. The inhabitants of river-side Chelsea, utterly without railway communication, will, of course, welcome the scheme; and the constituents of the member for Battersea will, no doubt, look favourably on it.

The Central London Railway, though giving access to a branch of the Great Western and other lines at Uxbridge-road Station, and, according to the proposed extension, to the Great Eastern and London and North-Western at Broad-street, may be considered a private line. So far as we have heard, the public have not been invited to subscribe capital for this most important railway, and there is every reason to suppose that it will fall into the hands of modern financiers, if indeed it has not stuck there ever since the day on which Royal assent was given to the Bill. The discussion of particular financial transactions is quite beyond our province, but the electrical industry has already suffered so much, and is likely to again at the hands of the greedy middlemen who pretend to assist it by their artifices, that we may for once depart from our usual custom so far as to discuss principles.

Not long ago, a scheme such as the Central London Railway requiring some two and a quarter millions, would have been offered to the public for subscription, and we now learn that "arrangements are being made with a leading house for a capital issue early in the new year." But before recourse was had to this leading house, whatever it may be, and if indeed the report be true, attempts were made to promote this line on modern principles. Certain systems of underwriting, of founders' shares and other tricks, which would not long ago have been denounced in any court of justice, have apparently been legalised by the Limited Company Acts. An Act acquired for any considerable undertaking is regarded to-day not as powers to do certain work, but as a "concession" to be bought and sold as often as possible, each successive buyer being regarded by the vendor as a bigger fool than the last—that is, himself. Eventually the work has to be done by somebody, or the money is lost—as in the early Niagara schemes—or abandoned, as at Panama. The "handsome" bonuses paid to concessionnaires are simply mulcted from the public, and lost to the electrical industry; not a soul but the speculators, granting that they are thus spiritually equipped, being the better for them This system may be well adapted for republics, but so far from assisting industrial enterprise in this country, we believe that a return to the old-fashioned systems, on old-fashioned principles, by men of old-fashioned morality, would lead to some of the old-fashioned genuine successes, upon which the greatness of England has been built.

THE POST OFFICE TELEPHONE.

In our issue of September 2nd last we published the text of a circular issued by the Postal Telegraph Administration on the subject of telephone circuits, which included a diagram showing the connections of a new arrangement of apparatus adopted by the Department to supersede the Gower-Bell telephone which has been employed so long, and with such good results. We are now enabled to furnish our readers with a description of the new instrument itself, which may be of interest.

It has been consistently maintained by the Postal officials that amongst the large number of telephonic instruments experimented with (which included all the principal combinations used in this country and abroad) the Gower-Bell transmitter and Bell receiver furnished the elements for constructing an instrument which should combine the maximum of efficiency and simplicity. Such an arrangement would constitute an apparatus suitable alike for use upon the shortest indoor telephone circuit, or for speaking over the longest line upon which it is at present practicable to converse. The transmitter arranged by Gower is, as is well known, an adaptation of Prof. Hughes' pencil microphone, eight carbon pencils being employed and arranged radially between supporting blocks fitted rigidly upon a pinewood diaphragm. This transmitter is entirely devoid of adjustment, and has stood well the test of time. Since its adoption by the Post Office it has undergone several modifications in detail, by which the articulation has been rendered much clearer than was the case with the earlier form. A distinct improvement was effected by covering the diaphragm with a board, in the centre of which a mouthpiece of porcelain was fitted, for the purpose of directing the sound waves of the speaker's voice upon the middle of the diaphragm, where is fixed the principal carbon block supporting one end of each of the eight pencils. Porcelain was selected as the material from which to construct the mouthpiece, as it afforded a good glazed surface, easily kept clean, and not affected by the breath, as is the case with wood coated with varnish or French polish. It was soon found, however, that the breath condensed upon the cold surface of the porcelain, and where the instruments were extensively used, moisture was formed, which found its way to the internal parts, and gave rise to troublesome faults. The advantages gained were thus to some extent neutralised, and in the new instrument the mouthpiece and board covering the diaphragm have been dispensed with, but the Gower-Bell transmitter has been retained. The dimensions of the diaphragm have been reduced to 7in. × 4¼in. It is held

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in position between india-rubber supports (see Fig. 1), the object of these being to intercept the transmission to the diaphragm of external vibrations which may affect the wooden case of the instrument. The carbon blocks supporting the pencils are fitted to the diaphragm by means of small brass bolts passing through both the diaphragm and the blocks, and tightened by a small nut on the lower or inside end of each bolt. The heads of these bolts are left projecting above the surface of the diaphragm, with the object of preventing its being temporarily employed as a desk for writing down communications. This practice was commonly resorted to in the earlier forms of the Gower-Bell instrument, with the result that the flexure of the diaphragm resulting from the pressure exerted in writing broke the pivots of the microphone pencils, the transmission was interfered with, and many other faults were occasioned.

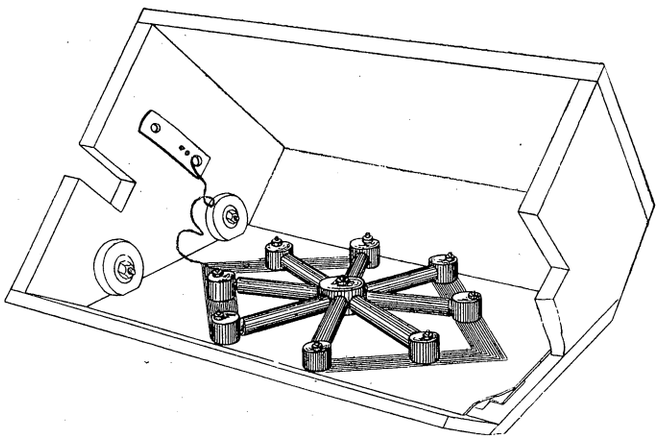

FIG. 1.—View of cover of New Post Office Telephone showing Gower microphone and diaphragm held in position between india-rubber supports. When the cover is placed on the telephone the microphone is uppermost.

The induction coil has also undergone some modification. It is well known that the presence of the secondary winding of the induction coil at the receiving end of a telephone circuit is distinctly prejudicial. Many attempts have been made to operate the telephone with this coil short-circuited when receiving, and by means of such devices conversation may be rendered possible on lines where it would otherwise be impracticable. The Post Office operators' telephones have for some years been provided with a press button inserted in the handle of the instrument, by depressing which the clerks may, in any case of difficulty in hearing, short circuit the secondary winding of the induction coil, and so increase the volume of sound from the receiver. The manipulation of such an arrangement requires a nicety of judgment and precision of movement which it has been shown cannot be expected from the ordinary user of the telephone, and the general application of the arrangement is, therefore, impracticable. In the Post Office telephone the next best condition favourable to the listener has been provided for by winding the secondary wire of the induction coil to a resistance of 150 ohms. It has been ascertained by experiment that this resistance represents the minimum number of convolutions with which satisfactory results for general working can be obtained with the gauge of wire usually employed for winding the coils. The resistance of the primary winding remains as before—·5 ohm.

Probably the most defective element of the Gower-Bell telephone was to be found in the india-rubber hearing tubes. These deteriorated more or less rapidly, according to the position and surroundings where the apparatus was employed. The effect of a cracked tube is to reduce the efficiency of the receiving portion of the apparatus in a surprising degree, and the renewal of the tubes was a somewhat expensive item in the maintenance of the instruments. So soon as the Bell telephone patent had expired the Postal Telegraph authorities therefore determined to abandon the use of the hearing tubes, together with the Gower-Bell receiver, and to employ in their place two Bell receivers. This change is being gradually effected as the india-rubber tubes become faulty. The Post Office telephone is similarly equipped with a pair of Bell receivers. They are of the double-pole type, which has of late so largely supplanted the older single-pole instrument, and is an adaptation of that originally introduced by Messrs. Siemens and Halske, of Berlin, and described in Preece and Maier's work on the telephone (page 54). The modern form has an external appearance similar to the single-pole instrument, and is manufactured by several English firms. When used in conjunction with a Gower-Bell transmitter, the efficiency of the combination is about 10 per cent. greater than that of the complete Gower-Bell apparatus. The electromagnetic inertia is minimised, and the discharge of the line facilitated in the new telephone by connecting the receivers in multiple. The resistance of each is about 120 ohms.

The employment of "French" terminals with the Bell receiver has become very general, but they have the drawback that some special form of fitting has to be attached to the ends of the flexible connecting cord, in order to ensure a reliable contact between the latter and the terminal. The Post Office department, however, employs a special terminal upon its Bell receivers (see Fig. 2), designed to admit of the use of ordinary

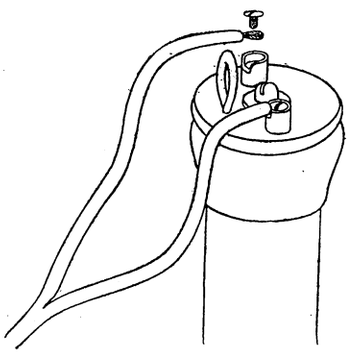

FIG. 2.—Special Post Office Terminal for Bell Receiver.

cord without the usual prepared ends, and to facilitate the renewal of worn out or broken cord ends. The upper end of the terminal is recessed to receive a connecting screw, and a carefully rounded groove is cut in one side to admit of the insertion of the conductor cord. The covering of the latter being removed, the bare conductor is inserted beneath the connecting screw, which is firmly screwed down. Should the conductor break or wear it is only necessary to strip back the covering and effect a new connection. Pillars provided with a similar connecting screw are fitted inside the case of the instrument to receive the cord

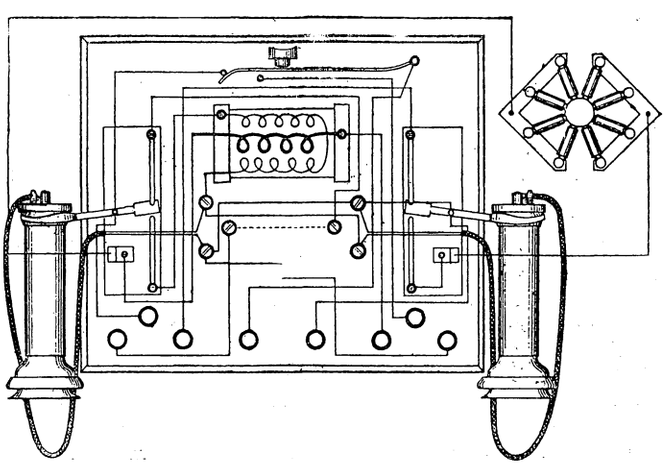

FIG. 3.—Diagram of Connections of New Post Office Telephone.

ends and the connecting wires from the relay coils. The arrangement is simple and economical, and seems well suited for its purpose.

The complete instrument appears to combine the maximum of efficiency with extreme simplicity of parts, and we understand that it has been satisfactorily employed for some considerable time at the offices of the various firms who rent

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private wires to the central switchboard at the General Post Office for speaking to Paris.

Eight terminals (see Figs. 3 and 4) are provided for receiving the external connecting wires, and the instrument can thus be used interchangeably with the Gower-Bell. The object of having so many outside connecting terminals is to enable the apparatus to be employed either upon a simple telephone line, at an intermediate office in conjunction with a switch, at an exchange, or at an ordinary subscriber's office, without altering the internal connections. It is only necessary to furnish each workman with a set of diagrams illustrating the various combinations of external connections which are required to meet the varying conditions under which the instruments may be employed. There is no case where all the terminals are in use together, but it will be obvious that many advantages will apply to an instrument of such universal application.

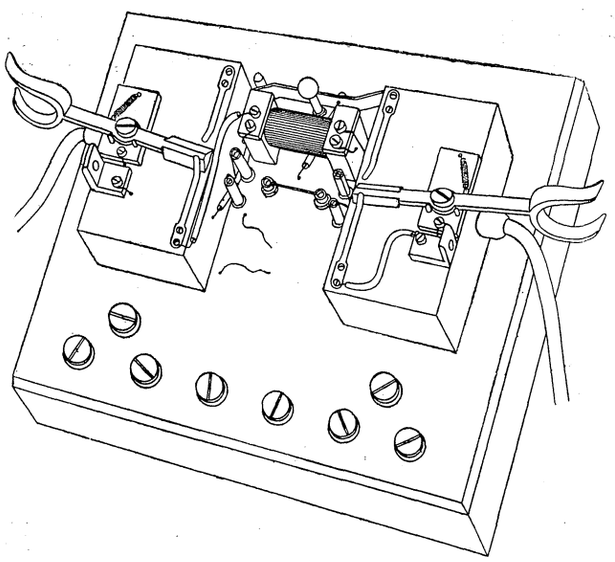

FIG. 4.—Perspective View of New Post Office Telephone with lid removed.

To suit the convenience of those who desire to have the telephone placed upon a desk or table in front of them, a table-stand is provided when desired. The telephone is fitted upon one side of the stand, and the opposite side is utilised for fixing the call bell. The permanent line and battery wires are connected to a tablet having seven terminals, fixed in a convenient position upon the desk or table, and a similar tablet is fitted to the table-stand. Between these two tablets a flexible connecting cord, composed of seven conductors, is inserted, and this cord enables the user to move the apparatus into any position where it may be desired to place it upon the table.

GAS POWER FOR ELECTRIC LIGHTING.*

BY J. EMERSON DOWSON, M.INST.C.E.

The author stated that in Great Britain alone gas-engines had been sold for electric lighting exceeding, in the aggregate, 7,000 H.P., and that in Germany engines were used for about 1,100 arc and 90,000 glow lamps. It was, however, only within the last few years that gas-engines of large size had been before the world in a practical form. The varying load-factor in central stations was a serious trouble, and the author hoped to show that much of the present loss due to fuel, water and wages, would be avoided if gas power were used instead of steam power.

Special reference was made to the central station at Dessau, belonging to the German Continental Gas Company. That station was opened in 1886 with two 60 H.P., one 30 H.P., and one 8 H.P. (effective) engines, worked with town gas, and all the dynamos were driven by belting and counter-shafts. In 1891 considerable alterations were made. One 60 H.P. engine, with its belting and counter-shaft, was retained, and one of 120 H.P. introduced, coupled direct to its dynamo. The speed of the engine and coupled dynamo was 145 revolutions per minute, and the consumption of town gas was equal to 39 cubic feet per kilowatt-hour. Formerly, without accumulators, it was thought necessary to adjust the size of the engines to the supply, so that they should always be worked to their full extent. It had, however, been found that a limited supply could be more advantageously furnished entirely from accumulators. In spite of the loss of about 21 per cent. in the accumulators, large engines worked more profitably in parallel than smaller ones supplying direct without accumulators. Since February, 1889, the Municipality of Schwabing, a suburb of Munich, had used an Otto engine worked with Dowson gas for 10 arc and 300 glow lamps. The load was variable, but, with an average output of 22·5 kilowatts per hour, the fuel consumption was 3·3lb. per kilowatt-hour. The town of Morecambe was lighted by nine arc lamps and glow lamps, equal to 1,600 of 8 c.p. each, the dynamos being driven by Stockport gas-engines worked with Dowson gas. With an output of only 1,155 kilowatts per week the consumption of fuel was 2·58lb., and the cost of the gas, including wages and fuel, was ½d. per kilowatt-hour delivered. At the *château* of M. Say, at Longpont, in the south of France, there were 650 glow lamps and on arc lamp, supplied by a dynamo driven by a Crossley engine worked with Dowson gas. The consumption of fuel was 1·2lb. per I.H.P. hour, and 2·7lb. per kilowatt per hour.

It was believed that the late Sir William Siemens first drew attention to the fact that, when illuminating gas was burnt in a gas-engine to drive a dynamo, much more light was produced electrically than could be produced by burning the same quantity of gas in burners in the usual way. Latterly the consumption of gas per H.P.H. in gas-engines had been reduced, and the ratio was at the present time about 20 to 1 in favour of converting the gas into an arc-light by means of a gas-engine. The author had collected data from various sources as to the consumption of ordinary town gas by engines supplying electric light, with and without accumulators. The average of all the returns, with engines under varying loads and without accumulators, was about 47 cubic feet per kilowatt-hour; when accumulators were used the consumption of gas was less, because the engines then worked under a full load. With 47 cubic feet per kilowatt-hour, and 55 watts per 16 c.p., one light of that power required only 2·6 cubic feet per hour; whereas a standard Argand burner required 5 cubic feet per hour. In this comparison it was assumed that the glow-lamps and gas-burners were in good order; but, unde ordinary working conditions, they did not maintain so high a duty.

The question of load-factor was a serious one with any type of engine, but with gas-engines the loss was much less than with steam-engines. When a gas-engine was stopped, its consumption of fuel stopped also, and there was no furnace to maintain; nor was there any water to boil at starting. At the same time, it was desirable that the gas-engine should be worked as much as possible under a full load, and in this respect the experience at Dessau was generally confirmed. A central station was worked under trying conditions, and in the London district there was only a full output of current during from three to five hours in every twenty-four; moreover, about 60 per cent. of the total output was required during that short period. In practice, this meant that in a station where the current was supplied without accumulators, the engines were run at a reduced speed during a portion of the time, and at other times some of them were stopped altogether; but all had to be ready to work in the evening, and occasionally in the day-time when there was fog. Generally, it might be assumed that the average consumption was more than 6lb. per kilowatt-hour where accumulators were used, and about 9lb. to 12lb. where they were not used. In any case, with the best possible arrrangement of steam power, there must be a large amount of fuel consumed which did no useful work; for, even if some of the fires were drawn, they had to be re-lighted, and the large quantity of water which had cooled during the time of standing must be re-heated.

The author believed that the solution of the difficulty was to be found in the use of gas plant instead of steam plant. With a large gas-engine, 1 B.H.P. per hour could be obtained with a consumption of 1lb. of anthracite, or 1½lb. of coke; whereas the consumption of coal with the steam-engines used for central stations, must be taken at about 2½lb. per B.H.P., when working under a full load. A saving of not less than 50 per cent. could therefore be effected in stations where the engines were fully loaded; and, where there were great fluctuations in the output, the loss of fuel with boilers not used, or only partly used, could be almost entirely avoided. For a maximum output of 400 kilowatts, there would be three gas generators, each capable of supplying one-third of the maximum required. The production of gas could be raised or lowered in several ways, and the working of each generator could be stopped immediately, by shutting off its steam supply. Supposing, therefore, that all three generators were working at their maximum rate, and a gradual reduction was

* Abstract of a Paper read before the Institution of Civil Engineers on Tuesday last.

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required, this could easily be effected; and, when the production of one or two generators could be dispensed with, their operation was at once stopped. The third generator could then be kept at work, and its production adjusted to suit the minimum consumption required. A gas generator had a small grate area compared with that of a boiler, and much less cooling surface; it contained no water, and required no chimney draught. A generator of the size referred to lost only 6 to 8lb. per hour whilst standing. If an average of only 40 per cent. of the maximum power were required for 21 hours, it was equivalent to letting two of the generators stand for that period; and at 8lb. each per hour that meant a total loss of only 3cwts., compared with the much greater waste when steam power was used. As the use of large engines, driven with generator gas, was of recent date, the author proceeded to describe the gas plant used, and gave the results of engines working regularly with Dowson gas, under the usual conditions obtaining in factories. He also gave the results of brake-tests made with several engines of large size, and reproduced indicator diagrams taken from engines of different makers. Although admirable results had undoubtedly been obtained from engines working with the Otto cycle, he was of opinion that, with engines of large size, the results would be still better if the cycle were altered, especially when generator gas was used. His reasons for this were fully stated in the Paper.

The following was a summary of the points urged by the author:—1. When town gas was used for driving the engines of an electrical station, the consumption was about 50 per cent. less than the volume of gas required to give the same amount of light by ordinary burners. 2. When town gas was used, neither boiler nor firemen were required, and there were no ashes to remove; less space was needed; no accumulators were required, except such as might be necessary to equalise the load of the engines, and to provide for a small amount of storage. The engines could be worked in the most crowded districts, close to where the lights were required, and where boilers were not allowed. 3. When generator gas was used, the consumption of fuel under a full load would be at least 50 per cent. less than with steam power, and the loss due to steam-boilers not being fully worked could be almost entirely avoided.

THE ELECTRIC LIGHTING OF KINGSTON.

As the proceedings at the last meeting of the Kingston Town Council possessed several features of more interest than is usual when electric lighting matters are discussed by local authorities, we think the following summary may not be without its value:—

The minutes of the Electric Lighting Committee stated that Mr. Preece had attended and given the Committee the benefit of his experience gratuitously, as a neighbour. Mr. Preece strongly advised the Corporation to establish electric lighting in the Borough, both for public and private purposes, and to keep the work in their own hands. He considered that after the works had been fairly established they would pay, and be no burden on the ratepayers. He considered that the price to be charged for the supply should be 6d. per unit. He recommended that instead of the Corporation deciding upon any particular system of electric lighting, they should advertise for tenders, which would bring tenders from the various firms, who would specify how they proposed to supply what was required. It would then be necessary to compare the tenders, and select that found most satisfactory. He considered that if the matter were at once proceeded with the Corporation would be in a position to supply electricity to the County buildings by September next.

It was thereupon resolved that the Council be recommended to authorise this Committee to obtain tenders for the purpose of supplying electricity for 5,000 private incandescent lamps and also to 30 or 40 arc lamps for street lighting in accordance with a specification to be prepared on the lines suggested by Mr. Preece, also to authorise the necessary steps to be taken to obtain the sanction to the borrowing of £16,000 for the above purposes.

The ex-Mayor said Mr. Preece had been preparing a specification for Tunbridge Wells, and he believed that with slight modifications it would answer for Kingston, and he had kindly said that he would send it to them when ready, and give them the opportunity of using it if they were so disposed. The Mayor, the Town Clerk, and himself went down to Oxford a few weeks ago, in order to see the installation there. They were struck very much by the fact that High-street, Oxford, was lit by electricity for part of its length, and for the other part by gas. Standing at the junction of the two systems they could see in a moment the immense superiority of the electric light, and therefore they were led to take Mr. Preece's recommendation in a spirit they would not otherwise have done. Mr. Preece was of opinion that within three years the light would pay as a commercial undertaking, and that subsequently there would be a profit applicable to the reduction of the rates. This had been borne out by what had occurred at Bradford. If Richmond, Surbiton, and other neighbouring districts were going to be lighted by electricity, it would not do for Kingston to lag behind. Therefore, he heartily commended the resolution in favour of borrowing £16,000 to the Council.

Councillor Baker moved, as an amendment, that "Inasmuch as the information before the Council as to the success of the electric lighting in other towns similar to Kingston is so meagre and unsatisfactory, and that so few householders in the Borough are likely to take the light if provided, it is unwise and inexpedient for the Corporation to apply to the Local Government Board for a loan of £16,000 to be used in experimenting in lighting part of Kingston with the electric light. Councillor Baker called in question the figures of Mr. Shoolbred, contending that he had not allowed enough for working expenses, and had over-estimated the probable consumption of the light by private customers. In order to make the receipts balance the outlay Mr. Shoolbred took credit for 5,000 8-c.p. lamps. He wanted to know how that estimate was arrived at, and he was told by the ex-Mayor that it was based on the experience of other towns. He asked for the names of the other towns, but he could not get them. Mr. Preece mentioned Eastbourne and Brighton; but where was the reason or fairness of comparing those places with Kingston? Then Mr. Preece wound up with the suggestion that wherever local authorities had taken up the matter it had been a success; but the only instance given by the ex-Mayor was Bradford, which it was absurd to compare with Kingston. He thought they would find very few customers for the electric light in houses rated under £40. In Kingston there were 5,434 houses, of which 4,074 were under £20, and 4,842 under £40. That did not leave much margin for private consumers. He alluded to Taunton, which was nearly the same size as Kingston, where they had found the electric light a heavy burden. He contended that it would be a losing game, and that it was a luxury which very few people could afford to pay for. No doubt he should be told that if they did not do it they would have a company come in and do it. He did not object to that, because then anybody who wanted the light could have it, and there would be no burden on the rates. There were many places where companies had been allowed to supply the light. Their debts were increasing by leaps and bounds, and he should like to ask the Chairman of the Finance Committee to say what was the present indebtedness of the Borough, so that they could see whether there was any possibility of borrowing the money if they made this application to the Local Government Board, or whether they had not already exceeded their powers.

Councillor Walker said the present financial position of the Corporation was that they owed £63,578 on loans, the repayment of principal and interest on which would require a rate of 10d. in the £. If they borrowed for electric lighting, &c., the total debt would be brought up to £93,578. If all the proposals involving expenditure were carried out the indebtedness of the Borough would be brought up to £131,078, to meet the repayment of which would necessitate a rate of 1s. 6d. in the £. The rateable value of the Borough was £125,000.

Councillor Selway suggested that the recommendation set out in the minutes needed transposing. It was useless to ask for tenders until they had obtained consent to borrow the money. If they obtained tenders, and the Local Government Board seeing the state of their finances should refuse to allow them to go into this experiment, then all their trouble and expense would be thrown away. He did not think there was a sufficient demand on the part of the public of Kingston for the light, and he thought the Committee would have been wise if they had canvassed the principal inhabitants and ascertained whether they would be prepared to take the light if the Corporation provided it. He thought it was a very risky thing to borrow £16,000 for a scheme until they knew what they were working upon.

The ex-Mayor, replying, said that with regard to the objections of Councillor Baker, Mr. Preece told them that the experience of other places was that the number of lights applied for was usually equal to half the number of inhabitants. The population of Kingston was 28,000, so that in fixing upon 5,000 lamps they were well within the mark.

For the amendment only five voted, and the motion was then agreed to.

Electric Traction at Milwaukee.—Numerous breakdowns and stoppages are stated to have occurred during November at the power-house of the Milwaukee Street Railway Company, and to have given rise to differences between it and the General Electric Company, the contractors, which have culminated in the termination of their business relations.

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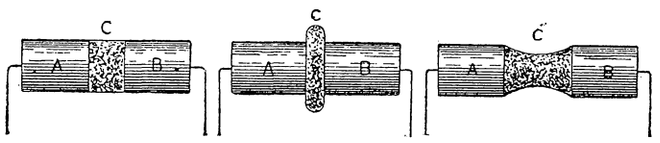
THE CLAMOND MICROPHONE.*

For the last twelve years so-called new microphones have been appearing, all of which, however, have involved contacts of unyielding carbon, the resistance of the contacts varying under the influence of the sound-waves. This form of microphone, nevertheless, has the inherent defect of permitting only sounds of medium intensity to be transmitted, since if the pressure at the points of contact is slight, the instrument is too sensitive, transmitting feeble sounds, louder ones only causing crackling due to ruptured contacts; whilst if the pressure is greater, the instrument is no longer sufficiently sensitive, and the speaker is obliged to shout. To overcome this, constructors have endeavoured to gain a *juste milieu* by carefully adjusted regulation. The aim of M. Clamond has been to avoid all necessity for adjustment. He has gone back on previous experience, and has abandoned the loose contact of unyielding carbon, substituting for it a plastic elastic body, the *shape* of which alters under the influence of the impinging sound waves.



The Clamond microphone (see Figure) is composed of a paste made by mixing some fine conducting powder with a viscous non-conducting liquid. This paste C is placed between two carbon rods A B connected with a diaphragm, and is deformed in the manner depicted, by the action of the voice. Experiments made are said to show that a microphone of this type has a wide range of action; that is to say, it transmits with equal facility words softly and loudly spoken, strident noises and violent explosions. It is also claimed that the Clamond microphone is outside the Berliner patent, and should, therefore, meet with a warm reception in the United States.

ANALYSES OF ELECTRIC SUPPLY IN LONDON.

The following figures have been calculated from the table published with our last issue, and are alluded to in our leading article this week.

—	Max. observed load. Lamps connected.	Lamps connected. Plant capacity.	Max. observed load. Plant capacity.	Lamps connected per mile of main.
	%	%	%	
Chelsea Co.	40·0	87·5	35·0	1,750
Electricity Supply Co.	53·4	46·2	24·6	1,760
House-to-House Co....	43·5	92·0	40·0	885
Kensington :				
Chapel-place.....	39·2	47·0	18·4	3,700
Kensington-court ..	27·8	63·2	17·6	
Deptford	58·4	33·3	39·0	2,140
Metropolitan Co.....	38·4	52·0	20·0	631
Notting Hill Co.	30·0	66·0	20·0	1,180
St. James's and Pall Mall Company.....	50·0	120·0	62·0	6,400
St. Pancras	—	120·0	—	4,360
Westminster :				
Davies-street	36·8	58·0	21·4	1,000
Eccleston-place.....	25·1	71·0	18·0	
St. John's Wharf...	38·2	31·6	12·1	
Average.....	40·0	68·2	27·3	2,380
Ratio of grand totals	39·7	58·5	23·2	1,110

LEGAL INTELLIGENCE.

National Telephone Company v. Graff-Baker.

The hearing of this action was resumed yesterday in Chancery Court IV., before Mr. Justice Kekewich. Mr. Swinburne was cross-examined, and M. Abdank-Abakanowicz gave evidence as to the superiority of metallic circuits for telephones, and also as to the Budapest and Vevey systems of traction, showing that the latter had, to some extent, disturbed telephones in the district. Mr. Stephen Sellon also gave evidence as to the Budapest line. Mr. R. Winthrop Blackwell said that he had constructed numerous electric lines in the United States, both with metallic returns and upon the single wire system, and stated that in his opinion the only practicable system of electric traction for streets was the single wire overhead system. Mr. Clarance Leighton said that he had seen an exchange in Stockholm with some 9,000 subscribers, of whom between 2,000 and 3,000 had metallic circuits, the remainder having earth returns. A full report of the proceedings will appear in our next issue.

* Abstract from an article by P. Clémenceau in *L'Electricien*.

CORRESPONDENCE.

OIL TRANSFORMER EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your issue of December 9, 1892, under the heading "Notes," some results obtained by Mr. Campbell Swinton with an oil-immersed induction coil working with condensers in substantially the same way devised by me for getting high-potential discharge. I refer to the experiments in which an incandescent lamp is lighted by the discharge of current passing, and which can be but a small fraction of an ampere.

I desire to say that similar phenomena were noticed by me in my early working with the apparatus. In fact, I found that on putting an incandescent lamp in the path of the discharge, not only was the filament brought to very high incandescence inside the bulb, and before the bulb broke, but that the filament itself was thrown from its supports, thrown around in the bulb, and the bits of filament moving about in the bulb were brought to brilliant incandescence. This was generally followed very quickly by the breaking of the bulb and the complete destruction of the lamp. Knowing that the current flowing was insufficient to bring about such a high incandescence of the filament, unless some new action came into play, I took an ordinary filament, without any enclosing globe, and placed it in the line of the discharge. I found that in this case the spark entering at one end of the filament and passing out at the other produced the same brilliant incandescence of the filament traversed by the spark. These filaments would have required more than an ampere to have brought them to equal incandescence by the ordinary lighting currents. I came to the conclusion, which I am pleased to note has been suggested by Mr. Swinton, that the filament did not actually conduct the current through its mass, but only upon the surface, and that, therefore, it became practically of very high resistance, so that a very small current would bring it to incandescence. These experiments were carried on over six months ago, since which time I have constructed a much larger coil, on the same general line as my first apparatus, but which is capable of giving discharges between its rounded terminals 64in. apart, and this limit of striking distance was evidently not the limit of the apparatus, because the terminals could not be further separated. There was no difficulty in getting the 64in. discharge as often as might be desired, or it might be continued as long as desired. The sparks took the form of a torrent, resembling in the most striking way lightning flashes, and they were accompanied by enormous developments of ramifying sparks in all directions from the electrodes. The development of ozone in the neighbourhood of the apparatus during the passage of the discharge is so great as actually to be very disagreeable and irritating. I think it quite possible that apparatus of this kind may be found useful in the artificial production of ozone. It is not, however, likely that such extreme potentials will be needed, but, by changing the gauge and length of the secondary coil immersed in oil, the potential, as well as the current which may be evolved, can be controlled.

Our experience shows that these high frequency discharges are not by any means harmless, as it was found that a kitten placed in the path of the discharge was instantly killed. While, no doubt, for some reason or other, an increase of frequency may lessen the danger to life, as shown by the experiments of Dr. Tatum, there is no certainty but that at

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some still higher frequency increased danger may exist, and for the present at least we must come to the conclusion that wherever high frequency currents have apparently been harmless there has simply not been enough current to do any harm.—Yours, &c., ELIHU THOMSON.

Lynn, Mass., December 28, 1892.

THE PERIODS OF ELECTRIC RESONATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There is a point in connection with the experiments of MM. Sarasin and De la Rive on electric radiation,* which may, perhaps, merit some elucidation. How is it that the wave-length in ether corresponding to the free period of a circular Hertzian resonator comes to be so much as "very approximately" eight times the diameter of the resonator?

The frequency of the vibrations in question appears to be so great that the degree of conductivity of the material of the resonator does not affect them. Under these circumstances it is simply a matter of the vibration of the free ether without any sensible dissipation of energy, and the mode of the vibration may be represented by imagining the ether to be an incompressible elastic solid medium, with cavities in it in the places of the conductors (which we may for convenience imagine to be filled with incompressible fluid devoid of inertia), and the walls of the cavities having so great stiffness that any point on one of them may move at right angles to the wall, but not tangential to it.† Now, the wave-length of the free vibrations of a system like this should be somewhat less than twice its greatest linear dimensions, for the same kind of reason as applies in the analogous case of the free periods of a sounding pipe or other partly enclosed air-cavity. We should expect the wave-length to be less than twice the diameter of the resonator.

The explanation is, perhaps, to be sought for in the static capacity of the condenser formed by the two balls which terminate the wire of the resonator. The system is, in fact, tuned by adjusting these balls. In the extreme case when they are replaced by two parallel plates, very near together, and therefore of considerable capacity, the electric oscillations become comparatively slow; so that Lord Kelvin's formula for the period, $2\pi\sqrt{CL}$, where C is the capacity of the condenser, and L is the (constant) self-induction of the system for steady currents, holds good, and shows at once the effect of capacity. This is, in fact, very easily followed in the mechanical illustration quoted above, in which the easy mobility of the plate representing the dielectric of the condenser slows the period.

A similar cause would also increase the free wave-length of the Hertzian resonator, but not to an extent readily amenable to calculation. Only the observation that the wave-lengths of different circular resonators are proportional to their diameters would seem to require that these resonators, the terminals included, are all geometrically similar to one another.—Yours, &c., J. LARMOR.

St. John's College, Cambridge, Jan. 9, 1893.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is now at press, and will shortly be ready. Firms and others who have not returned the slips asking for information are requested to do so *immediately*. The price of the Directory and Handbook will be as before: *Subscription*, 5s.; after publication, 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

* *Comptes Rendus*, December 26, 1892; *The Electrician*, January 6, 1893.

† See *Proc. Camb. Phil. Soc.*, Vol. VII., 1891.

TENDERS INVITED.—In our advertisement pages tenders are invited for an installation of wiring and fittings for the electric light (about 80 lamps) in a private house in the suburbs of London. Tenders should be delivered to M. J. Dary, 19, Dashwood House, Old Broad-street, E.C., not later than Saturday, January 21st.

——— Our readers will remember that the date for sending in tenders for the supply and fixing of fittings for the electric lighting of the interior of the Town Hall, Burnley, is Wednesday, January 18th.

SALE BY AUCTION.—Messrs. Wheatley, Kirk, Price, and Goulty will sell by auction on Wednesday, January 25th, and following days, a large quantity of machinery and appliances, engines, boilers, shafting, hydraulic presses, pumps, fittings, and fixtures, on the premises of the Swaisland Printing Offices, at Crayford, Kent. The sale commences each day at 10 for 11 o'clock prompt.

APPOINTMENT VACANT.—The county borough of Halifax require an electrical engineer, at a salary of £200 per annum, capable of advising the Corporation on the lighting of the borough. Further particulars are given in our advertisement columns, and applications must be in by Thursday, January 26th.

ECLIPSE ELECTRIC LIGHTING SYNDICATE (LIMITED).—Claims against this Syndicate, in voluntary liquidation, must be sent in to Mr. E. R. Wood, 8, Finsbury-circus, E.C., by February 14th.

DISSOLUTIONS OF PARTNERSHIP.—Easton and Waldegrave, electrical and mechanical engineers, Whitehall Foundry, Taunton; debts by W. W. Easton.——Hill and Co., electrical and scientific apparatus makers, 2, Aldersgate-buildings, E.C.; debts by A. L. Adams.

POOLE AND WHITE (LIMITED).—The following is the list of principal creditors in this failure:—

	£	s.	d.
Abel and Imray	187	6	7
Bayley Bros.	91	18	4
Benton and Stone	738	2	8
Berriman, G.	304	19	7
Best and Lloyd	27	17	1
Brabey, E. and C.	88	1	2
Braham, A. and E.	30	6	5
Britannia Rubber Co.	83	18	3
Bullers (Limited)	1,356	0	0
Davey, Paxman, and Co.	150	0	0
Edison & Swan United Company	693	4	0
The Electrician	87	8	0
Electrical Review	155	19	6
Everitt, A., and Sons	251	5	1
Finch, J.	58	15	0
Fowler-Waring Cables Company	45	12	5
General Electric Co.	66	6	8
Hawkins Bros.	31	17	4
Heine Bros.	180	9	0
Henley's Telegraph Works Company	37	11	3
Hervé, L.	748	11	1
Highton and Co.	146	18	11
Holcroft and Sons	26	10	9
Hudson and Co.	34	10	3
Hunt and Co.	35	12	8
International Okonite Company (London)	380	6	0
Johnson and Benjamin	52	4	7
Johnson and Phillips	51	18	4
Joyner and Co.	25	1	11
Kempton and Sons	32	12	1
Latimer Clark, Muirhead, and Co.	85	15	10
Le Carbone	64	5	10
Lion, S.	78	7	10
London Electric Wire Company	126	5	3
Mackintyre and Co.	24	6	8
Mancur, E.	36	15	0
Max, Kroy, and Co.	59	5	10
Mills, Walker, and Co.	24	13	4
Nalder Bros.	21	7	10
Nash, Bond, and Co.	173	2	10
Pfeil and Co.	600	16	8
Saltwell, Tryon, and Saltwell	466	4	0
Schonan	387	7	11
Selig, Sonnenthal, & Co.	26	19	9
Smith and Sons	31	2	2
Southwood, Smith, and Co.	33	9	1
Taylor, Tunnicliffe and Co.	196	14	10
Tresize, W.	23	19	0
Tryon, J.	868	0	7
Wall, G. P.	80	7	1
Webb, Shaw, and Co.	49	11	9
Winn and Co.	28	18	2
and a number of creditors under £20			
Fully secured creditors.	1,300	0	0

Liabilities £10,104 19 6
Net assets 11,692 1 5

The determinations arrived at by the recent meetings of the creditors and the contributories will be considered before Mr. Registrar Emden, at Bankruptcy-buildings, Carey-street, on Jan. 18th, at 11.

ELECTRO-MEDICAL APPARATUS COMPANY.—In the note referring to this Company last week, a clerical error made "from 1 to 100 milli-amperes" into "1 to 1,000,000 amperes."

MESSRS. DRAKE AND GORHAM.—This firm, during the past year, have received contracts for no less than 96 installations of the electric light, equal to considerably over 10,000 lamps. A number of these installations were at country houses throughout the country, where petroleum engines of Messrs. Priestman's and Messrs. Crossley's make have been in several cases used. In conjunction with Captain Holden, Messrs. Drake and Gorham have introduced some new recording instruments, and these have been very favourably received, more particularly those of the photographic type; their electrostatic indicator has been further improved, and a steady demand for the instrument is the result. The D. P. battery has also undergone improvement during the

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year, and satisfactory progress is recorded in the sale of these batteries. As was to be expected, there has been a large sale of the Cardew instruments, the patents for which are held by Messrs. Drake and Gorham. The firm have in past years made a feature of electric hoists, and they are now installing a passenger and luggage hoist at Callaby Castle, Northumberland, in connection with the electric lighting installation. This lift has all the latest improvements, and is to be driven by a 6 H.P. motor.

THE SILVERTOWN COMPANY.—During the past year, in addition to the usual rubber and gutta-percha manufactures, the Company's electrical department has made and laid a submarine cable of more than 2,100 knots in length, connecting Senegal in Africa with Pernambuco in Brazil. Another cable to duplicate the system originally laid down by this Company for the Central and South American Company has also been manufactured during the past 12 months, and is now on board the "Silvertown." This cable is of a total length of 2,620 knots, and will be laid from Salina Cruz Mexico) to Chorrilas (Peru), touching at Sta. Elena (Equador) and San Juan del Sur (Nicaragua). In addition to these the Company have manufactured a large amount of cable for the telegraph companies and the British and Foreign Governments, representing a total of 5,400 knots for the year. The Company have also been busy with electric light cables, which have been supplied, and in some cases laid, for Dublin, Leeds, Oxford, Cambridge, Dundee, and Glasgow. The demand for cables and wires for installation work has been very heavy, and the Silvertown Company have secured nearly all the Admiralty orders for *main* cables. The Company's machinery department has been fairly active, and the orders have included sets of dynamos for the British Government and for the extension of the Hague Tramways Company. The outdoor department of the Company's business has been busy with installation work for shops, factories, and private houses, and the instrument and battery shops have been fairly well employed on Government and other work.

MESSRS. TOWNSEND AND MACINTYRE.—The address of this firm is 15, Brook-street, London, W.

BREWERS AND ALLIED TRADES' EXHIBITION.—The success of the Brewers' Exhibition in London (at which several electrical firms exhibited) has led to the promotion of a similar show at Birmingham This is to be held in the Bingley Hall from April 13th to 22nd next. Mr. G. Emett is general manager, and the offices are situated at 66, Finsbury-pavement, London, E.C.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—An interesting pamphlet is issued by this Company dealing generally with the question of Municipal Electric Lighting. The object of the Company in issuing this pamphlet has been to treat the subject from a popular rather than from a technical point of view, and especially in the hope that members of Municipal Councils of the country will find information therein of service when discussing the subject of the introduction of the electric light into the districts which their local authorities serve. The pamphlet includes: "Definitions of Electrical Terms," "Parliamentary Regulations Regarding Municipal Electric Lighting," "Systems of Generation and Supply," different forms of "Motive Power," a short chapter on "Street Lighting," and "Cost to the Consumer."

ELECTRIC CONSTRUCTION CORPORATION.—A handsome catalogue, with price list of the electrical machinery and apparatus manufactured by this Corporation, has been recently issued. The general contents are preceded by large illustrations of the Manchester-square station of the Metropolitan Electric Supply Company, and of the central station of the Liverpool Electric Supply Company, an electric travelling crane, conduit tram car, and a switchboard. Illustrations of various patterns of Elwell-Parker dynamos and motors for continuous and for alternating current are given, together with a very complete price list. The list, which includes transformers, switches, cut-outs, &c., is excellently printed and substantially bound.

MANCHESTER EDISON SWAN COMPANY (LIMITED).—For the past year this Company report an unusually busy time, not only in their manufacturing department, where they have considerably increased the output, but also in connection with their installation department, which has carried out a large number of installations in Manchester, Sheffield, Leicester, Gloucester, Rochdale, and other towns in all parts of the country. These installations include clubs, banks and insurance offices, hotels and restaurants, several of the leading newspaper offices, two theatres, and a long list of business premises. The result of this large access of work is that their present factory has become too small, and the Company have under consideration the building of large new works outside Manchester. New showrooms are being prepared at the Exchange Approach Station, Manchester, where complete sets of electric lighting plant will be in operation. The Company are applying for a Provisional Order covering the districts of Altrincham and Bowdon, under which it is proposed to lay down a central station with a capacity of 15,000 8-c.p. lamps.

MESSRS. MATHER AND PLATT.—The London branch of this firm are carrying out an electrical installation at the East London Water Works, Lea Bridge, the total number of lights being about 250. The firm have also in hand an order for the fitting up of the Manchester New College, Oxford, including the library and chapel; and also the electric lighting installation for the *Lancet* printing and publishing offices, Strand, W.C.

CALENDARS, 1893.—Messrs. Shand, Mason, and Co. are issuing a hanging calendar, with date pad attached, the frontispiece of which is a drawing by Linley Sambourne.

ANNUAL DINNER.—The annual dinner to the *employés* of the Exchange Telegraph Company was given on Saturday last at the London Tavern, Fenchurch-street, and proved a great success.

BECKENHAM.—Mr. Kapp's report respecting the cost of the necessary works to provide electric current for the compulsory area included in the Provisional Order, has been submitted to the Local Board.

BOMBAY.—An electrical power transmission plant has recently been erected at the Mannockjee Petit Mills, Tardeo, Bombay. The work has been carried out to the designs of Messrs. Nowrosjee Wadia and Sons. We understand that the machinery has worked very satisfactorily.

BUDAPEST.—Messrs. Ganz and Co., of Budapest, have definitely received the contract for the central station at Sophia, Bulgaria. Water power is to be utilised, and some difficulty is anticipated in connection with it owing to its high-pressure. The Mannesmann Tube Company have the contract for the supply of seamless steel pipes to conduct the water to the turbines, and have given a guarantee for their efficiency.

CARDIFF.—In reference to the arrangements being made to prepare a scheme for the electric lighting of Cardiff, it is suggested that water power be utilised from the mains from Cantreff to Cardiff.

CHRISTMAS TREE LIGHTING.—On Tuesday last a children's treat was given to the school children of the Ward of Farringdon Without, London, E.C., at which a huge christmas-tree formed an interesting feature. The Edison and Swan Company supplied a large number of electric glow lamps, and Messrs. Lund Brothers supplied the necessary current and undertook the work incidental to the lighting of the tree by electricity.

CORINTH.—The cutting of the canal across the Isthmus of Corinth is approaching completion, and it is anticipated that it will be possible for a large steamer to go through at the end of April next. The canal will be lighted by electricity; two powerful lights having been placed at each end, and a row of lamps throughout its entire length.

DOVER.—The Mayor, Aldermen and Burgesses of the Borough of Dover announce that they propose to transfer their powers under the Dover Electric Lighting Order, to a company to be called the Dover Electric Supply Company (Limited). The area of supply is the whole of the borough, and the Company may be required to sell to the Corporation at the period of 21 years, and subsequent periods of 10 years.

EDINBURGH.—As a result of the recent visit of a deputation of the Edinburgh Town Council to the various electric lighting stations in London and the provinces a report is to be submitted to the Council in a few days. A feature of the report will be the particulars it will contain of the effect the introduction of the electric light has had upon the consumption of gas in the districts visited. For instance, from Newcastle it is reported that the introduction of the electric light has led to an excess consumption of gas, owing to a desire on the part of gas users to display their wares with increased effect. The deputation have expressed themselves equally favourable to both the high and the low systems of supply.

EDISON-SWAN COMPANY (LIMITED).—The annual entertainment given by this Company to its *employés* at Ponder's End was recently held. Owing to the large number of workpeople employed, it is necessary to have two entertainments. It will be remembered that the Company recently applied for and obtained a licence for music and dancing for their *employés'* entertainment hall. A feature of the affair was a presentation to upwards of 300 of the best timekeepers in the Company's employ, the presentation being made by Mr. Gimingham, the manager of the works.

EDMONTON.—The Board of Guardians at their last meeting discussed the advisability of introducing the electric light to the schools and other premises under the control of the Board, and it

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was decided that the time had arrived for giving the matter consideration.

FROME.—The Local Board is in treaty with the Gas Company for the taking over of the gas works, and are disposed, should the terms be unfavourable, to invite tenders for the lighting of the town by electricity. The matter has been referred to a committee.

GLASGOW.—The Electric Lighting Committee anticipate that the lighting of the Glasgow streets by electricity will not be completed until about March.

HECKMONDWIKE.—Further discussion on the subject of preparing a scheme for the introduction of the electric light into Heckmondwike has been deferred to the next meeting of the Board.

HULL.—The Electric Lighting Works at the Hull Docks are now complete. The inauguration ceremony will take place at the Town Hall on Monday, when, for the second time, the Corporation buildings will be lighted by electricity. It will be remembered that the first attempt to introduce the electric light into Hull was a failure. At this, the second attempt, everything has been done to render the installation a success. It is contemplated that the principal streets of the town will shortly also be lighted by the electric light. After the inaugural ceremony, an Electrical Exhibition is to be opened, and a lecture delivered on electric cooking and heating, by Mr. H. J. Dowsing.

LIVERPOOL.—The Council Chamber at the Town Hall is now lit by the electric light, and it is generally agreed that the illumination is much more satisfactory than hitherto.

PORTRUSH.—The Town Commissioners' contract with the Gas Company expires on the 1st prox., and at a recent meeting Captain Massey proposed that the Commissioners should obtain a loan of £5,000 to acquire the old mill at Glenmanus with its water-power, and also the water-power of the Glenmanus Burn, which, as he believed, would be sufficient to supply motive power for an electric lighting installation capable of lighting the whole of the district. He complained of the insufficiency of the gas supplied and its cost. A committee was appointed to make inquiries as to the best means of lighting the town by electricity, and to report to the Board at the earliest opportunity. The committee were empowered to obtain the assistance of an engineer if necessary.

PRESTON.—At the annual gathering of the *employés* of the Preston Electric Supply Company (Limited) a satisfactory report was given by the manager of the Company on the past year's work. He was able to state that the growth of business was represented by 6,000 lights for 1892, as against 2,000 for 1891. The Company had supplied a large number of electric motors, which, he was pleased to say, had been found to compare as to cost favourably with other motors. The Company had proved a success.

READING.—At the last meeting of the Town Council the report of the Electric Lighting Committee, recommending the acceptance of the terms offered by the Reading Electric Supply Company (Limited), was adopted unanimously. The negotiations between the Electric Lighting Committee and the representatives of the Company have been lengthy, and seemed a short time back to be likely to result in failure. By the terms now agreed upon the Council have arranged that the Company shall work the Provisional Order, and if the Council shall ultimately decide to purchase the undertaking it will be on the basis of £133 for every £100 expended by the Company, subject to the amount expended being certified by the Board of Trade auditor year by year. As an earnest that work is shortly to be started, the tenants on certain land belonging to the Council, which is likely to be required for the central station, have received notice to quit.

RUNCORN.—At the meeting of the Improvement Commissioners last week a motion was carried to instruct the Canal Boats and General Purposes Committee to inquire as to the probable cost and practicability of installing the electric light for the public lighting of Runcorn, and to report to the Board at the earliest opportunity.

SINGAPORE.—Mr. O. V. Thomas, electrical engineer of Singapore, has recently sent in a tender for the installation of arc lamps for the public lighting of Singapore of a temporary character, the Thomson-Houston system being adopted. The estimate of Mr. Ritchie, the municipal engineer, for lighting the whole town, is $350,000.

STAGE EFFECT AT THE NEW OLYMPIC THEATRE.—In the course of Mr. Oscar Barrett's present production of *Dick Whittington*, the stage gradually darkens, and a screen, placed in the background, is illuminated with a number of tiny incandescent electric lamps, which appear to twinkle like stars, representing the cluster of stars in the constellation of Hercules. To produce the effect 400 incandescent lamps, run on twenty distinct circuits, are employed. All the circuits are joined to two copper conductors placed at the top of the screen, and each circuit is protected by an automatic cut-out. For the desired variation in the brilliancy of these artificial stars, lamps of voltages varying from $3\frac{1}{2}$ to $4\frac{1}{2}$ volts are used. The batteries are placed on the stage, and are of the Lithanode type. The screen was designed and manufactured for Mr. Barrett by the Lithanode and General Electric Company, of Westminster.

SUNDERLAND.—The Town Clerk has been instructed to write to certain firms asking upon what terms they are prepared to undertake the work which the Corporation require in connection with the proposed adoption of the electric light for the borough.

TUNBRIDGE WELLS.—It has been decided to print the report of the Electric Lighting Committee dealing with the cost of the electric light scheme which is before the Town Council. In order to meet the expenses necessary for the building, &c., in connection with the lighting order, it has been resolved to charge the maximum price per unit allowed by the Board of Trade until circumstances justify a reduction. Mr. Preece, who has advised the council in the matter, has been requested to prepare the plans and specifications for the necessary buildings.

WHITEHAVEN.—The large engineering works of Messrs. Ramsey Brothers, in Albion-street, Whitehaven, have recently been lighted throughout by the electric light. Brockie-Pell arc lamps are used in the installation, as well as a large number of incandescents. The work has been done by Mr. Watson Bell, of Whitehaven. The *Workington News* of the 7th inst. devotes two columns of small type to a description of the installation.

COMPANIES' MEETINGS & REPORTS.

International Okonite Company (Limited).

The adjourned annual meeting of the shareholders of this Company was held on Tuesday at the Cannon Street Hotel, Mr. Samuel Pope, Q.C., presiding.

The CHAIRMAN stated that, unfortunately, he was absolutely unable to be present at the former meeting, which was convened for November 30th, and which was adjourned until that day. The present was, therefore, so to speak, a continuation of the former meeting, and, with their permission, they would resume the discussion on the report and balance-sheet at the point where it left off before the adjournment. He owed them a word of thanks, because he could not help believing that the cordiality with which they received the suggestion for adjournment arose partly from considerations for himself, who was unable to be present. He would be glad now if any shareholders would ask for any information regarding any point, and, as far as he (the Chairman) was concerned, any explanation which was desired should be offered as far as the question was capable of explanation. A few questions were raised at the last meeting upon which he would like to say a few words. The first point that appeared to him necessary to refer to in the balance-sheet was the £20,000 which practically had been refunded out of the purchase-money by the original vendors, who were the managers in America. This matter had caused the Directors very great anxiety, and there had been considerable negotiations regarding it at the beginning of the year. They found in the course of their business that the valuation of the stock upon which their previous profits had been nominally based was practically an over-sanguine valuation. They therefore, of course, felt bound, as Directors, not to proceed to present any balance-sheet in which the assets were, in their judgment, over-valued, and therefore, of necessity, the present balance-sheet had to be prepared upon an amended valuation of the stock consistent with what they believed to be its true and legitimate value. Of course, the profits of the present year would be necessarily diminished by the amount which they thought it necessary to write off the original valuation, for the profits depended very largely upon a true valuation of the stock. Therefore they felt that, inasmuch as their previous balance-sheet had been very largely based upon the valuation for which their American colleagues were responsible, and largely also upon the valuation for which the original vendors were responsible, it was advisable to send their general manager to America with a view to insisting upon some return to the Company of the purchase-money which had been paid on the basis of such valuation. After considerable difficulty they induced those gentlemen to hand over, for the purpose of cancellation, £20,000 of the shares which had been given to them in part payment of the purchase price, and this £20,000 had been treated as a reduction of capital, because, of course, the shares which were issued and upon which dividends—if any should be earned – would be payable would be diminished by this £20,000. This seemed to him to be fairly and correctly stated in the report, and he owned that he did not see how the Directors could either have done other than they had done, or treated the amount which had been so refunded in a different way, because it was practically £20,000 repaid out of the purchase-money by reason of their insisting that the valuation should be rectified, and he would never have been a party to presenting a balance-sheet if it were

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to show a profit by an over-valuation of stock, although that might have been the principle upon which it had been valued before. Therefore, one of the main features of the present balance-sheet was that they hoped and believed that they had started with a proper valuation of their stock at Passaic,—a real, true, sound valuation—and although, the writing off of £20,000 from the valuation of the stock prevented any profits from accruing this year, the advantage of it would be derived hereafter, because in the future there would be no such over-valuation to contend against. Something was said at the last meeting, by way of inquiry, regarding the London expenses, amounting to some £2,000 odd. These were the entire expenses of the Company in England, because, wisely or unwisely, their Company, although largely consisting of property in America, was managed by a board in London. The expenses in question consisted of rent, rates, taxes, stationery, printing, postages, wages to secretary and accountants, and various other incidental expenses, which were, of course, inevitable. However, out of the £2,000 odd, £750 was repaid to them by other companies who had the advantage of using this Company's staff and establishment, so that the net expenses would be the amount appearing in the balance-sheet with the allowance of this £750. The Manchester business showed a considerable loss. The Directors were unanimous in their opinion that it ought not to do so, and they were equally unanimous in their opinion that the management of the Manchester business had been not only disastrous, but disgraceful. They had, therefore, thought it right to remove from the service of the Company the gentlemen who had hitherto been in charge of the business in that city. They were unanimous in believing that they would be able to reorganise the Manchester factory upon a basis which would make it satisfactory and profitable, but the agreement which, in the first instance, was made with the vendors of the Manchester business had operated to hamper the discretion of the Directors. They were unanimous, however, in their opinion that, at any cost, if cost were necessary, a "clean sweep" must be made in the management of their affairs in Manchester, but this could not be done in a moment, or without a certain amount of difficulty. He knew that there might be some differences of opinion on this point, and shareholders were entitled to hold other views. He desired, however, to say frankly that the Directors were unanimous on this matter, and if there were a feeling upon the part of the shareholders that the Manchester business should be left in the hands of those with whom the original agreement left it, the Board asked to be relieved from any responsibility in the management of the concern. If it was the view of the shareholders that the Manchester business should be left with Mr. Conolly—and he would even say with Mr. Shaw—the Directors would not consent to hold office under any such conditions.

Mr. CONOLLY: That is special pleading.

The CHAIRMAN: I do not know what you mean by special pleading; I think it is a direct statement enough. We think that you have so mismanaged the Manchester business that we are justified in discharging you. Continuing, the Chairman said that the shareholders might judge of the propriety of the Directors' decision by what had just taken place. He (the Chairman) thought that the Manager was subservient to the Board. As long as he held his present position that would be so, but the simple circumstance which had just arisen illustrated the difficulties which the Directors had had from the first in carrying out what they believed to be their duty. Some of the views and criticisms which had been expressed by the gentlemen who had issued a circular to the shareholders were in his judgment, though he did not say this was the deliberate opinion of the Board, well worthy of respectful consideration; but the first thing to be done was to secure management which they thought would be competent. The gentlemen who had issued the circular in question had deposited with the Company a certain number of proxies since their last meeting with a view, probably, to use them in the enforcement of their opinions. These proxies covered 1,803 shares distributed among 79 shareholders. Some had been sent too late in any case for use, representing about 60 shares more, so that the support which had been accorded to the circular amounted, at the outside, to 1,863 shares. If he were called upon as Chairman to rule as to the legality of these proxies he should say that they could not be used, because the present was part of the general meeting, and no proxy which was not delivered by a certain time before the meeting, of which the present was simply a continuation, could be legally exercised. He did not, however, think it was necessary that he should absolutely rule to that extent. The Directors held proxies for 11,221 shares. There could not be any objection to a full ventilation of opinion at the meeting; but if the Directors were put to it, or if he were asked to rule, he should rule against the use of the proxies on the other side to which he had alluded. The Directors had an overwhelming majority of the confidence of the shareholders, and it could, therefore, hardly be worth while to put them to the trouble of a vote in such a case as the present.

A SHAREHOLDER: But there may be a question as to the validity of the Directors' proxies.

The CHAIRMAN said he would be prepared to rule upon this question when it was raised. He then quoted from the circular in question, and in answer to one of the statements therein said that the Directors did their best to settle the difficulty which had arisen in America to which he had already alluded. He thought that there should have been more restitution than the £20,000 mentioned, but they had done the best they could and had got all that they could. The circular went on: "Apparently, on the face of it, the report would convey the impression that the difficulties with regard to management are of very recent date, whereas we have reason to believe that such is not the case." The difficulties occurred during the year covered by the report—the American difficulties in the earlier portion of the year, but the Manchester difficulties came to their knowledge afterwards. He might say that, for a long time, he was in hopes that the Manchester management would justify itself, and that they would have a business there which could be conducted profitably, and the disappointment had been a very bitter one to him. They came to the conclusion late in the year that it was impossible to continue the Manchester business under the management which then existed. The circular continued:—"The state of the Company's business as disclosed in the balance-sheet calls for at least a Committee of Inquiry fully empowered to ascertain all details of the Company's business, and that such Committee should present a report of their investigations to the shareholders." If the shareholders desired such a Committee they must get rid of the present Directorate. They would regard it as a vote of want of confidence in the Board, and they would not allow any such Committee to interfere with their administration—at all events, under existing circumstances, which were difficult enough to deal with. Then, the circular said, "If no Committee be appointed, most certainly a change ought to be made in the Directorate of the Company, and, if possible, Directors appointed who would be able to devote attention to the Company's affairs, and to influence business and the introduction of business." He did not know what that meant. The circular continued: "The balance-sheet of the Company, as presented with the report is of a very meagre character, and does not give sufficient data to enable the shareholders to ascertain fully the losses and where the losses have arisen." Well, he never knew a balance-sheet which gave such particulars in detail. The circular added: "Generally speaking, we are of opinion that in the interests of the shareholders themselves, they should demand the fullest explanation of these matters." Well, generally speaking, he was of opinion that in the interests of the shareholders the fullest explanation on all matters should be asked for and should be furnished. The circular was signed by Mr. John Kenyon, who held 100 shares; Mr. Henry Lacy Peters, who held 50 shares, Mr. Thomas Thorp, who held 250 shares, Mr. Edward Gladstone, who held 10 shares, and Mr. William Griffiths, who held 30 shares. Out of the total capital of the Company 2,420 shares were represented in the opinions expressed in the circular. He moved the adoption of the report and balance sheet.

Mr. GLADSTONE asked who were the vendors to this Company.

The CHAIRMAN: The American Okonite Company.

Mr. GLADSTONE said he thought it was the Woodhouse and Rawson Company.

The CHAIRMAN replied that the Woodhouse and Rawson Company sold to this Company the agreement which they had made with the American Okonite Company.

Mr. GLADSTONE quoted from the prospectus, and said that what he wanted to get at was, who were the vendors?

The CHAIRMAN: They are stated in the prospectus.

Mr. GLADSTONE: Are you one of the vendors?

The CHAIRMAN: No, I am not.

Mr. GLADSTONE said it appeared to him by the prospectus that the Woodhouse and Rawson Company were clearly the vendors to the Company.

The CHAIRMAN, in answer to Mr. Holt, said that they believed that the £111,000 in the balance-sheet standing against stock-in-trade represented the actual value of that item. There had been no "ruinous loss" at Manchester.

A long discussion followed, in which Messrs. Holt, Gregory, Hawkins, Emery, Mather, William Griffiths, Hopps, and Bond took part, the nature of the remarks and criticisms being indicated by the subsequent replies of the Chairman and of the Managing Director (Mr. Vaughan-Stevens).

Mr. F. L. RAWSON (Woodhouse and Rawson United) said that the business, in his opinion, was a first-class one, and he had shown his belief in the Company by the amount he had invested in it, for probably at the present time he was, outside the vendors, as large a holder as any two gentlemen in the Company. He originally held £10,000 in ordinary shares, and his holding now in ordinary shares and debentures represented very nearly that amount. The business in America itself had been most profitable, but in the year after the Company was formed they had a very bad time there—the worst they had ever had. When he went to America to verify the statements made by the vendors he chose the firm of Messrs. Price, Waterhouse, and Co. to assist him, regarding that house as the most competent to test the statements in question. One of the partners of that firm accompanied him to America. When they came to test the stocks, &c., they only had a certain time in which to do it. The vendors had already raised their price on the ground that their business was progressing so much, and the option of purchasing it was only given to them up to a certain time. They discussed the matter most fully, and eventually he absolutely refused to do anything further unless the vendors showed their good faith in regard to their statements by depositing the shares they were to receive, as security. To this they assented, and he did not suppose that they would have been able to recover anything from them had it not been for the fact that the shares had been so deposited. With reference to the loss that had been made, it was but a small one for this class of business. He knew of one firm in it which, not long ago, lost more than their capital, and yet within two years recovered it all and held £30,000 in the bank besides. It was not true that Woodhouse and Rawson United were responsible. Where he expected to make large profits was in America; but unless they strengthened the Directors' hands, what had occurred before in other cases would happen to them, and they would lose their money, owing to differences among themselves. The whole point for their consideration was whether, by dissensions among themselves, they should allow other people to derive the full benefit of the business.

Mr. GLADSTONE inquired if any application had been made to the Woodhouse and Rawson Company to return any of the money they had received as vendors.

The CHAIRMAN replied in the negative, but added that such an application would have been made had the Woodhouse and Rawson Company done anything except sell to this Company the agreement they had made with the American Company. They had discharged their liability to the Company.

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Mr. GLADSTONE: Well, that is a matter of opinion.

The CHAIRMAN: Not at all, it is a matter of fact.

Mr. KENYON asked whether it was not the fact that up to the time of the Company taking over the Manchester business the business of Messrs. Conolly and Shaw had been very remunerative.

The CHAIRMAN said that it had been thought so.

Mr. KENYON asked whether the Directors had themselves obtained a single order for the Company.

The CHAIRMAN: It is not the duty of Directors to "tout" for orders. He added, in answer to Mr. SQUIRE, that practically no Okonite had been manufactured at Manchester.

Mr. SQUIRE said he thought that there must be "something rotten in the State of Denmark." If he had a manager who did not obey his instructions he would get rid of him.

The CHAIRMAN: That is precisely what we have done.

Mr. SQUIRE urged the shareholders to trust the Board.

The MANAGING DIRECTOR (Mr. Alfred Vaughan-Stevens), in reply, said that the original prospectus stated that the agreements as to the purchase of the various properties might be seen at the offices of the Company. He had charge of those agreements at the time, and he could assure them that not a single shareholder applied to see them. They embodied the whole of the information about which it was very necessary that the shareholders should be informed, in the event of their wanting to plead later on that it was through sheer ignorance that they took their shares. It was very evident that those who had asked what profit the promoters made out of the business had not seen the agreements. Woodhouse and Rawson made, on paper, £46,500, but, as a matter of fact, that Company had not made a penny, because the whole, and more than the whole, of that supposititious profit was represented by shares or debentures which they took in the Company, and therefore they stood to sink or swim just as much, or more so, than any shareholder in the room. The Chairman had answered a question on his behalf, and had stated that when he joined the Company he was not a technical man. Perhaps it would have been better to have obtained a technical man, but his knowledge at that time and now were two very different things. Unfortunately, the experience he had gained had been a very hard one. In November, 1891, after the first annual meeting, he went to America, as a police officer would say, "from information received," and the information he received was very startling. One result of his visit was an alteration in the management in America, and also an alteration in the Board of directors resident in the United States. He was not going to explain the entire reasons which led to his going to America, and which led—after three weeks' protracted discussion between three or four of the most eminent legal firms in New York, and after repeated telegrams to the Directors in England — to the fact that, after having claimed £50,000 or £60,000 in cash, he received only £20,000 in shares. He would merely state that he got all he could, and he could assure them that it was utterly impossible to obtain anything further. He by no means said that the £20,000 in shares represented what the Company ought to have recovered; and he asserted that if he had got all that he had been really entitled to, the profits of the Company, notwithstanding the heavy losses in Manchester, would have been most satisfactory. A question had been asked as to the working capital. It was put down at £110,000, but originally £15,000 of debentures were not issued, which reduced the amount to £95,000. The sum to be remitted to America as working capital was £65,000, so £45,000 was supposed to have been left for this side, but, as he had said, £15,000 of debentures were unissued, so that the amount was reduced to £30,000. Unfortunately, owing to the advice of the experts of the Company, headed by Mr. Thomas Conolly, they spent the money almost before they knew where they were, and he had that day sufficient experience to know that a good deal of the money had been very foolishly expended, and that results from the outlay would not come back for some time. He thought that if they had spent their money properly they would have received a return fully in accordance with the statements made in the prospectus, for which, however, he was in no way responsible, nor were any of the Directors, he believed. With respect to the management of the Manchester business, they were at present in a state of interregnum. They had discharged the people who formerly conducted the business there. Those people sold the Company their trade secrets, their secret processes, and their goodwill, but, as a matter of fact, they refused to part with all three. The Company had a very difficult task indeed before them to find another works manager who would know the whole of the business which the Company required to know. There were only two, or perhaps, at the outside, three successful cable manufacturing companies in England, and their success was almost entirely owing to the efficiency of their works managers. The only possible way for their Company to act was to train up a man, and they intended to do so with the least possible delay. Their late works manager had grossly mismanaged their factory, but beyond that he did not wish to say anything in explanation of the present state of affairs. The Articles of Association provided for the payment of a sum of £1,500 for the Directors in England, and he certainly thought that those gentlemen had earned it. Had the Company been successful, the Directors would not have half the trouble which they had had. The Chairman's time was extremely valuable, but he had given ungrudgingly every possible assistance to the Company's affairs, and in a way that they were not entitled to expect. His (the speaker's) remuneration was £1,000 a year, and if he had known the trouble which was going to be given to him for this sum he would not have taken the office. As a matter of fact, however, he was not receiving anything in cash, but was being paid in debentures.

Mr. KENYON: Well, the ship is sinking.

The MANAGING DIRECTOR: It is not sinking unless you sink it, Mr. Kenyon. You have damaged our business greatly, and you, who wanted to become a Director of this Company, are mainly responsible for any difficulties that may occur. You have done this Company an amount of harm by damaging its credit which you can never repair. Continuing, in reply to other questions, he said that the trustees had been paid £200 a year, but they wished to retire, and did so. The Chairman thereupon offered to take the office as one of the trustees without remuneration, and he (the speaker) offered to do the same. The Company thus saved £200 a year. Mr. Kenyon had handed him a note, in the handwriting of Mr. Robert Shaw, a discharged Clerk of the Company: "Have any losses been charged to this Company on any rubber transactions between the Managing Director and the manager in New York?" In so many words, that imputed fraud, and he declined to answer such a question. Mr. Squire had asked the reason why they had not made okonite in England. He only regretted that he was led by the works manager, and had not put his foot down and said, "You shall not make any more of the stuff you have been making." Unfortunately, they had run away from the manufacture of okonite, but they would come back to it. With respect to the management in America, the business, after dropping off through bad management, had been put into really good hands, and the last report he received, giving detailed accounts month by month, showed that their business in America was steadily increasing. As a proof of the satisfactory position of the business in that country, he might state that the managers there were pressing him not to make any more experiments in this country, and to shut up the English business if they could not make it succeed now. They might find it necessary to lose a little more money in reorganising the business here, but they would not lose much. He might state that the largest sales ever made by them in America in any one month amounted to $100,000, whereas their sales last October amounted to $85,700, and they were very nearly as large in the preceding month. The depreciation was only shown on machinery, tools, &c., and he did not believe that they could write depreciation off goodwill. It was also foolish, if the sales could be kept up, to write anything off patents. Success had now been attained in their business in America, and he believed it would be attained here, and that they would surmount their present difficulties, in spite of the opposition of their discharged servants, who would never return to their employ.

The CHAIRMAN observed that all such items as goodwill and patents were, more or less, "in the clouds" in the balance-sheet, and if they could succeed in earning sufficient profits, his advice to them would be to be contented with moderate dividends, and to reduce the items in question in the balance-sheet by writing off a certain proportion every year. He thought that every matter that was capable of argument had now been dealt with, and he would, therefore, propose the adoption of the report and accounts.

Mr. HARRY HANKEY DOBREE seconded the motion, which was carried by a large majority.

The CHAIRMAN, in answer to a question, stated that Lord Greville did not like the duties cast upon him as Chairman, and therefore resigned, and Sir William Davies ceased to be a Director practically because he had not the necessary qualification.

The retiring auditors were afterwards re-elected, an amendment for the appointment of Messrs. Parkinson, Mather, and Co. (of Manchester) being negatived on a show of hands.

The meeting then separated after a cordial vote of thanks to the Chairman.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322 *&c., &c.*]

GORDON AND FELL (LIMITED).—This Company was registered on January 4th with a capital of £100,000, in £10 shares. The objects are to acquire and take over as a going concern and carry on the business of J. E. H. Gordon and Co. (Limited), electrical engineers, and the goodwill thereof, with the premises where the said business has been carried on, and the plant, machinery, stock-in-trade, capital, contracts, property, and effects of the said business, subject to the debts and liabilities; to acquire and carry on the business of a builder and contractor for public works, of a worker of and dealer in timber, and of a brick and tile maker, and dealer in fireclay and other minerals, carried on by John Fell at Leamington; to carry on the business of electrical engineers in all or any of its branches, and the business of constructing, manufacturing, supplying and maintaining electric light machinery and apparatus both for public and private purposes, and any appliances connected with the production, transmission, distribution, accumulation, and employment of electricity for the purposes of light, heat, motive power, or otherwise; and also to carry on the business of contractors for the construction, maintenance, and working of roads, tramways, railways, waterworks, gasworks, electric light, heat, and power supply works, wharves, canals, piers, quays, &c.

NEW CAPE CENTRAL RAILWAY (LIMITED).—Amongst the objects of a new Company which has been registered under the above title, with a capital of £100,000, in £5 shares, are those of telegraph and telephone engineers, mechanical and electrical engineers, ship owners, manufacturers, &c.

NEW JERSEY METAL REFINING WORKS (LIMITED).—A Company with this title has been registered with a capital of £50,000, in £10 shares, to acquire the business now carried on in the State of New Jersey, U.S.A., by a Company called the New Jersey Extraction Works (Limited), and to carry on the business of smelters, refiners, chemical manufacturers, &c.

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STEPHENS AND CO. (LIMITED).—This Company was registered on January 7th, with a capital of £20,000, in £1 shares. The objects are to take over as a going concern the business of electrical and general engineer, smith, and boiler maker, carried on by John Stephens, at Cuba-street, Millwall, London, E.; to acquire by purchase from J. G. Statter and Co., of 68, Victoria-street, Westminster, London, S.W., certain machinery, plant, stock, &c., upon the said premises at Cuba-street; to enter into and carry into effect an agreement with a view to the acquisition of the above properties, dated December 12, 1892, and made between John Stephens, of the first part; John Grice Statter, Henry Foote, and Leonard Milne, trading under the style of "J. G. Statter and Co.," of the second part; and Arthur M. Sillar (on behalf of this Company), of the third part; and to carry on the business of electricians, electrical and general engineers and contractors, ironfounders, smiths, boiler makers, and manufacturers of and dealers in all apparatus and things required for, or capable of being used in connection with, the generation, supply, distribution, accumulation, and employment of electricity. John Stephens is Managing Director, with a salary of £400 per annum, and John Grice Statter and Henry Shirley Price are the remaining Directors.

WATERHOUSE ELECTRICAL MANUFACTURING COMPANY (LIMITED).—This Company was registered on the 9th inst. with a capital of £20,000, in £10 shares. The objects are to enter into and carry into effect an agreement between Addison G. Waterhouse and the firm of Waterhouse Brothers, of the first part, James H. Gamble and Francis T. Chambers, of the second part, and Reginald Bolton, of the third part, to acquire any patents, licences, concessions, &c., conferring an exclusive or non-exclusive right to use any invention, and to use, develop, or grant licences in respect of the patents specified in the above-mentioned agreement (further particulars of which are not given), or any other patents or inventions that may be acquired.

MISCELLANEOUS. — FENBY'S (LIMITED), founders, engineers, and machinists; capital £10,000, in £5 shares.——HAYDON AND VAIL (LIMITED), general engineers; capital, £3,000, in £1 shares.

AURORA ELECTRIC LIGHTING AND DISTRIBUTION COMPANY (LTD.).—The first annual return of this Company, made up to October 11 last, has been filed. Forty shares out of a total capital of £25,000, in £1 shares, have been taken up, and the full amount called on the first 35 shares, resulting in the payment of £35. Upon the remaining five shares no calls have been made. An agreement, dated January 2, 1893, between the above-named Company and Charles James Fox, engineer and contractor, states that the said Charles J. Fox has rendered in the past valuable and efficient services towards the said Company, and has also agreed to render such services in the carrying out of various contracts, and it is therefore agreed that the Company shall allot to the said Charles J. Fox 5,000 fully paid-up shares of £1 each, Nos. 926 to 5,925 inclusive, in full satisfaction and discharge of the services above-mentioned, and of all claims and demands in respect thereof.

BIRMINGHAM TELEGRAPH FACTORY (LIMITED).—The annual return of this Company, made up to December 8, 1892, has been filed. The Company was registered on December 31, 1890, with a capital of £50,000, in £10 shares. At the time of making-up, 707 shares were taken up, of which 400 were issued as fully paid, in accordance with the above agreement. Upon the remaining 307 shares, the full amounts had been called, resulting in the payment of £3,010, leaving £60 in arrears.

BLAKEY, EMMOTT, AND CO. (LIMITED).—The annual return of this Company, made up to November, 12, 1892, has been filed. The Company was registered on September 8, 1886, with a capital of £35,500, in £100 shares. At the time of making up, 302 shares were taken up, of which 185 were issued as fully paid in accordance with the above agreement. Upon the remaining 117 shares £50 per share has been called, resulting in the payment of £5,850. In addition to this, £300 has been paid in advance of calls. Edward Blakey holds 36 shares and Walter Emmott 67 shares.

HENLEY TELEGRAPH AND ELECTRIC CONSTRUCTION COMPANY (LIMITED).—At meetings held on December 5th and December 21st, it was resolved and confirmed that the Company be wound up, and Mr. J. H. Stephens, 6, Clement's-lane, was appointed liquidator.

HERCULITE MANUFACTURING COMPANY (LIMITED).—At meetings held on November 17th and December 12th resolutions were passed and confirmed that a reconstruction of the Company is desirable, and that the Company be therefore wound up; that Mr. E. J. Lunnon, 19, Ironmonger-lane, secretary to the Company, be liquidator; and that the liquidator consent to the registration of a new company, to be named the Herculite and Electrical Manufacturing Company (Limited).

KENNEDY STORAGE BATTERY COMPANY (LIMITED).—The statutory return of this Company, made up to December 15, 1892, has been filed. The whole capital of £100,000, divided into 100,000 shares of £1 each, has been taken up, and has been allotted as fully paid, in accordance with the contract dated August 30, 1892, with Patrick Kennedy and Charles Joseph Diss. The shareholders are as follows:—William L. Barker, of New York (6,250); Patrick Kennedy and Charles J. Diss, both of Brooklyn, New York (33,750 jointly); The Doris Syndicate (Limited) (3,300) Herbert W. Hooper (3,000), Ernest Zuccani (2,500), Benjamin G. Lake (2,500), William J. Sutherland (2,500), and George C. A. Kohler (46,200).

LONDON ELECTRIC WIRE COMPANY (LIMITED).—The statutory return of this Company, made up to October 6, 1892, has been filed. The Company was registered in May, 1892, with a capital of £50,000, divided into 5,000 ordinary and 5,000 preference shares of £5 each. At the time of making up, 4,138 preference and 4,451 ordinary shares had been taken up, of which 3,860 shares of each denomination had been issued as fully paid, in accordance with the above contract. Upon the remaining 278 preference and the 591 ordinary shares, the full amount had been called, resulting in the total payment of £4,345.

REVOLVING ADVERTISER COMPANY (LIMITED).—This Company has been registered with a capital of £816, in £1 shares, to acquire an invention, described in Patent No. 14,183, for an improved mechanism for effecting the movement of indicating tablets in railway coaches and other public vehicles. The subscribers include Frederick J. Beaumont, electrical engineer, and John Kent, electrician, the latter of whom is one of the first Directors.

WESTERN COUNTIES ELECTRIC LIGHT AND POWER SYNDICATE (LIMITED).—The statutory return of this Company, made up to September 9th last, has been filed. The Company was registered in April, 1892, with a capital of £25,000, divided into 120 deferred and 380 ordinary shares of £50 each. At the time of making up 41 ordinary shares had been taken up, the full amount called and all calls (£2,050) paid.

WOODITE COMPANY (LIMITED).—At a meeting held on December 8th, at Woodite Works, Mitcham Common, it was resolved that the Company be wound up; and Mr. Henry Godfrey, 9, Southampton-street, Bloomsbury, and Captain Walter Wood, Woodite Towers, Mitcham Common, were appointed liquidators.

CITY NOTES, &c.

ARCAS PLATING COMPANY (LIMITED).—Letters of allotment in the recent issue of capital by this Company have been posted.

BABCOCK AND WILCOX (LIMITED).—The Directors have declared an interim dividend at the rate of 10 per cent. per annum, for the past half-year, payable on the 14th prox.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts fro the week ended January 8th were £998, as against £858 for the corresponding period of last year, being an increase of £140. The total receipts for half-year amount to £998, against £858 in the corresponding period of 1892, being an increase of £140.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of December were £3,600, as compared with £3,420 in the corresponding month of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company notify that the coupons on their Five per Cent. Debentures, due February 1st next, will be paid on and after that date at the banking house of Messrs. Glyn, Mills, Currie, and Co., 67, Lombard-street, E.C. Coupons should be left at the bank three clear days for examination.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—This Company announces the payments by warrants on February 1st next, of interest for the half-year ended January 31st on their Four per Cent. Mortgage Debentures. The transfer books will be closed from January 27th to February 1st, both days exclusive.

GEORGE ANGUS AND CO.—The Directors of this Company recommend a dividend of 10 per cent., being the same as last year.

GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).—An interim dividend of 1s. 3d. per share has been declared by the Directors of this Company, payable on the 20th inst.

GORDON AND FELL (LIMITED).—This is the title of a new Company, formed to amalgamate the electrical and contracting business of Messrs. J. E. H. Gordon (Limited), 11, Pall-mall, and the general contracting business of John Fell, Leamington. The share capital of the concern is £100,000, added to which there are 2,000 Five per Cent. First Mortgage "Profit" Debentures of £50 each. The whole of the share capital is taken by the vendors as purchase money. The debentures are repayable after twenty-one years, or redeemable at the option of the Company after five years at 5 per cent. premium. The payments are £2. 10s. on application, £2. 10s. on allotment, £12. 10s. three months after allotment, and £12 10s. six months after allotment. The interest upon these debentures, at the rate of 5 per cent., has been guaranteed (the prospectus states) for five years by the Securities Insurance Company (Limited). The trustees for the debenture holders are Major-General Sir R. Pollock, K.C.S.I., and the Hon. H. Willoughby. The Directors include Mr. J. E. H. Gordon and Mr. John Fell. The secretary is Mr. Henry Sinclair, and the offices of the Company are at 11, Pall-mall, S.W., and at Leamington. After dealing with the number of works carried out by the two firms, the prospectus states that the aggregate of average profits of the two businesses during a certain period has been at the rate of £13,750 per annum. The works, properties, and estates of Messrs. J. E. H. Gordon and Co., taken over by the new Company, have been valued by Sir Henry Mance at £61,500. Application is to be made to the Stock Exchange for the usual quotation in due course. It is estimated that the amount of working capital remaining, after the purchase of the businesses from the vendors and the payment of all liabilities, will be £32,500. The list closed yesterday (Thursday).

LIVERPOOL OVERHEAD RAILWAY COMPANY (LIMITED). — A special meeting of the shareholders of this Company has been held under the presidency of Sir W. B. Forwood. The Directors submitted a resolution to create 12,500 Five per Cent. Preference Shares of £10 each, and to issue 7,500 of these at par, the Chairman explaining that the money was required to carry out the Northern extension, at a cost of £37,000, and to complete the present undertaking. The proposal was adopted.

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SIAM.—At a meeting of the Siam Electric Light Company on November 13th last a statement was read showing the Company's financial position. It was decided to petition the King of Siam to take over the business, he to pay the shareholders 25 per cent. on their investment.

STOCK EXCHANGE QUOTATIONS.—The Stock Exchange Committee have ordered the additional shares, Numbers 82,441 to 91,240, of Elmore's Patent Copper Depositing Company (Limited) to be quoted in the official list.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended Jan. 6, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £3,507.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name	Previous Week's Price. Jan. 4.		Price Wednesday, Jan. 11.		Rate per cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Jan. 4. Highest.	Lowest.
			TELEGRAPHS								
£1,247,720	Stock	12/6	Anglo-American	51	52	51½	52½	4 15 3	Jan., Apr., July, Oct.	51¾	51½
£2,876,140	Stock	25/0	Do. Preferred	92½	93½	92⅝	93⅛	5 12 4	,, ,,	93*	92⅛
£2,876,140	Stock	5/0	Do. Deferred	10⅛	11	11	11¼	.. ..	,, ,,	11⅝	11
£250,000	100	4%	African Direct, Telegraph 4% Debentures	99	102	100	103	3 17 8	January and July	101½	..
130,000	£10	3/0	Brazilian Submarine	11	11¼	11	11½	5 13 1	Mar., June, Oct., Dec.	11⅜	11⅛
£68,200	£100	6%	Do. 5 per Cent. Bonds	101	104	101	104	4 16 2	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	104	108	104	108	4 12 7	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175	180	175	180	3 17 9	Jan., Apr., July, Oct.	179	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 19 2	February and August	..	..
6,000	10	10%	Do. Preference 10%	17½	18½	17½	18½	5 8 1	,, ,,	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2	3	2	3	5 6 8	April and October	2 1/16	..
6,000	5	10%	Do. Preference 10%	9	10	9	10	5 0 0	,, ,,	9¼	..
60,710	20	3/6	Direct United States	11½	11¾	11½	11¾	6 1 9	Jan., Apr., July, Oct.	11¾	11 5/16
400,000	10	2/6	Eastern	14¾	15	14¾	15	4 6 8	,, ,,	15	14¾
70,000	10	6%	Do. 6 per Cent. Preference	16	16½	16	16½	3 5 5	,, ,,	16½	16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	109	112	110	113	3 10 10	May and November	111½	111
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107	110	107	110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	14⅜	15	14⅜	15	4 13 4	Jan., Apr., July, Oct.	15	14 11/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109	112	111	114	3 10 2	February & August	112	110¼
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 2	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101	104	101	104	4 16 2	,, ,,	104½	103
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	..
180,227	10	1/9	Globe Telegraph and Trust	9⅜	10	9⅝	9⅞	4 16 2	Jan., Apr., July, Oct.	9⅞	9 1/16
180,042	10	6%	Do. 6 per Cent. Preference	15	15½	15	15½	3 18 8	,, ,,	15⅝	15⅜
150,000	10	5/0	Great Northern	19	19⅜	18⅜	19½	4 8 4	Jan., April, and July	..	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	44	46	44	46	5 8 8	May and November	..	..
38,348	10	4/0	London Platino-Brazilian	4	6	4	6	6 13 4	,, ,,	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108	111	108	111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½	8½	7½	8½	4 14 1	April and October	..	..
3,381	£100 Cert.	30/0	Submarine Cables Trust 6%	116	120	117	122	4 18 4	,, ,,	119¼	..
15,609	10	5/0	West African Telegraph	6½	7½	6½	7½	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100	103	101	104	4 16 2	March & September	..	..
30,000	10	2/0	West Coast of America	2½	3½	2½	3½	.. ..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	100	104	101	105	7 12 5	June and December	103	..
88,321	10	6d.	West India and Panama	1⅛	1⅜	1¼	1½	.. ..	,, ,,	1⅜	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10¼	10¾	5 11 7	May and November	10¼	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8	9	8½	9½	6 6 4	.. ..	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	103	106	104	107	4 13 6	June and December	..	..
64,242	15	3/0	Western and Brazilian	7¼	7¾	7½	8	5 13 2	,, ,,	7 13/16	7½
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5½	6	5⅝	6	6 5 0	,, ,,	5⅝	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1⅞	2¼	1⅞	2¼	.. ..	,, ,,	2	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106	109	106	109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106	109	106	109	5 10 1	,, ,,	106½	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120	125	120	125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100	103	100	103	5 16 6	March & September	..	..
			TELEPHONES.								
40,000	£5	10/0	Chili Telephone	3	4	3	4	.. ..	..	..	..
22,500	14/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16	1/8	1/16	1/8	7 16 5	May and November	..	..
220,000	£1	4⅜d.	Oriental (11s. paid)	1/16	1/8	1/16	1/8	7 18 2	Yearly	..	..
454,747	5	2/6	National	4¾	5	4¾	5	6 0 0	June and December	5	4¾
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14	15	14	15	4 0 0	,, ,,	14½	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13⅜	14½	13⅜	14½	4 4 3	,, ,,	14	..
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref (£3 paid)	4¼	4½	4¼	4½	.. ..	..	4 7/16	4 5/16
726 477	£100	4½%	Do Deb. Stk. 4% Prov. Cert. (fully pd.)	111	113	111	113	3 19 8	January and July	112¾	112½
48,000	£10	..	New Telephone, Limited (£4 paid)	4⅜	5	4⅜	5	.. ..	..	..	..
58,000	5	1/0	United River Plate	2¾	3¼	2⅜	3	.. ..	January and July	2⅜	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	,, ,,	..	..
			ELECTRICITY SUPPLY COMPANIES.								
30,152	£10	..	City of London Electric Lighting (fully paid)	10½	11	10⅜	11¼	..	..	11	10 13/16
20,000	£10	..	Do. 6 per Cent. Preference	5¼	5⅜	5⅜	5⅝	4 3 6	..	5 1/16	5 1/16
19,900	£5	..	Electricity Supply Co. of Spain	..	..	..	..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	5	5¼	5	5¼	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	..	..	..	..	..
8,332	£5	..	House to House Electric	1½	2½	1½	2½	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5	5⅜	5	5⅜	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	6	6⅜	6	6⅜	..	January and July	..	..
30,000	£5	4⅛%	Liverpool Electric Supply (£3 10s. paid)	3⅝	3⅞	3⅝	3¾	..	March	..	..
10,000	£5	4⅛% '91	Do. (fully paid)	5 1/16	5 1/16	5⅛	5½	..	March	..	..
111,000	5	..	London Electric Supply	..	..	⅜	⅝	..	..	..	..
45,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6¾	7¼	6⅞	7⅛	..	..	7⅛	7
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102	105	102	105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5	6	5	6	..	..	..	..
18,680	£5	2/6	St. James' and Pall Mall	7⅞	8¼	7⅞	8⅛	..	..	8 3/16	8⅛
7,900	£5	7%	Do. 7% Preference	8¼	8⅜	8¼	8⅜	4 0 0	..	8⅜	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5½	6	5½	6	2 10 0	..	5⅞	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	1/9⅜	Brush Electrical Engineering	3	3⅛	3	3⅛	..	..	3 3/16	3⅛
69,996	2	6%	Do. 6 per Cent. Preference	2¼	2⅜	2¼	2⅜	4 16 0	..	2 7/16	..
£125,000	Stock	..	Do. 4½ per Cent. Debentures	..	..	100	102	..	..	101⅜	100½
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5	5½	5	5½	6 7 3	January and July	5 1/16	..
12,139	5	..	Edison and Swan United	..	..	..	..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid) xd	1⅞	2⅛	1⅞	2⅛	..	..	..	..
45,000	10	12/0	Electric Construction	2¼	2⅜	2¼	2⅜	..	..	2 7/16	2⅜
70,000	2	10/0	Elmore's Patent Copper Depositing	⅝	¾	½	¾	..	..	¾	⅝
20,000	5	..	Fowler-Waring Cables (fully paid)	2	3	2	3	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	21⅞	21⅝
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2⅜	3⅜	2⅜	3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6	7	6	7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/9	4/3	3/9	4/3	..	..	..	..
78,949	5	4/2⅜	Swan United (£3. 10s. paid)	3	3⅛	3	3⅛	10 0 0	May and November	3⅜	..
37,350	12	12/0	Telegraph Construction and Maintenance	45	47	45	47	5 2 2	March and July	46½	..
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	101	104	4 16 2	January and July	..	..
..	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	¾	1¼	..	..	..	..	..	..
..	£5	8%	Do. Preference (fully paid)	..	..	¾	1¼	..	..	..	..
			RAILWAYS AND TRAMWAYS.								
63,000	£10	..	City and South London Railway	..	..	..	..	..	..	..	..
600,000	Stock	½%	Do. Stock	36	38	35	38	1 6 3	..	37½	53

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AND

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RENEWED INSTRUCTIONS for 1893 from Advertisers in the 1892 Edition represent, up to January 17, no less than **94 per cent.**

NEW ADVERTISERS represent nearly 30 per cent. over 1892.

SUBSCRIPTIONS to the 1893 Edition represent an increase of nearly 40 per cent., chiefly from Local Authorities and other large users of Electrical Machinery and Apparatus; and from the Colonies and India.

OLD FEATURES of the Book will be thoroughly revised and brought up to date.

NEW FEATURES of interest and value to the Electrical and Allied Trades will be added, and therefore New Advertisers and Subscribers for the 1893 Edition should send in their orders at once.

The Publisher especially requests the immediate return of the printed circulars asking for information from those who have not already sent them in.

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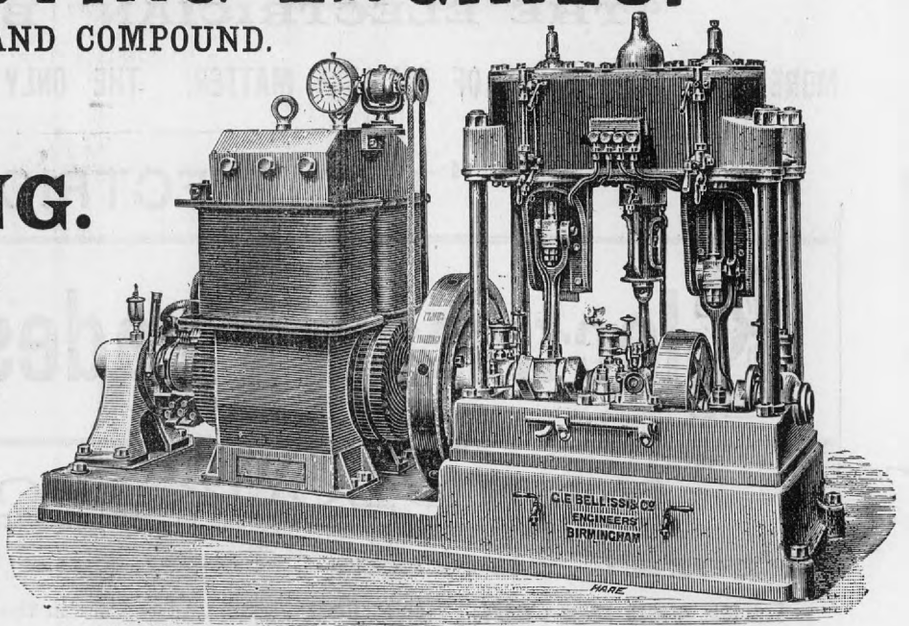

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FEBRUARY, 1st and 2nd, 1893.

Re Thomas Barraclough and Co., Limited (In Liquidation).

TO ELECTRICAL CABLE and TELEGRAPH WIRE MANUFACTURERS.

WHEATLEY KIRK, PRICE AND GOULTY have received instructions from the Liquidator to SELL BY AUCTION in detail, on WEDNESDAY and THURSDAY, 1st and 2nd, February, 1893. Commencing at Eleven O'clock prompt each day, at the GLOBE WORKS, WHITLEY STREET, ROCHDALE ROAD, MANCHESTER, the whole of the PLANT AND MACHINERY,

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BOROUGH OF KINGSTON-UPON-THAMES.

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The CORPORATION invite TENDERS for the CONSTRUCTION, SUPPLY, and LAYING DOWN of the necessary PLANT and MAINS for the supply of ELECTRICITY in the Borough, in accordance with the specification, plan, and form of tender, which can be obtained from the undersigned after Tuesday next, the 24th inst.

The person or firm whose tender is accepted will be required to enter into a contract and a Bond with two approved sureties for the due performance of the contract. Sealed tenders, endorsed "Electricity," to be delivered at this office not later than Saturday, 11th of February next.

The Corporation do not bind themselves to accept the lowest or any tender.

By order,
HAROLD A. WINSOR, Town Clerk.

Town Clerk's Office, Clattern House,
Kingston-on-Thames, 18th January, 1893.

THE ELECTRIC TRAMCAR SYNDICATE (Limited).

NOTICE is Hereby Given that Mr. JOHN JAMESON TRURAN, of 184, Gresham House, Old Broad-street, London, E.C., the Receiver for the Debenture Holders of the above Company, is prepared up to the 28th day of January, 1893, to receive offers for the SALE BY PRIVATE CONTRACT, subject to the approval of the Court, of the Electric Tramcars, Dynamos, Working Plant, Tools, and Sundry Stores, used by the Company in connection therewith, now at the premises of the Croydon Tramways Company, Thornton Heath, Croydon, and for the English and other Letters Patent connected with the Undertaking. Forms of Tender to be obtained from the Undersigned.

J. JAMESON TRURAN, Receiver.

184, Gresham House, London, E.C.
12th January, 1893.

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WANTED, by the HECKMONDWIKE LOCAL BOARD of HEALTH, a practical and efficient ENGINEER to prepare plans and estimates, and carry out the work required in the lighting by electricity of Heckmondwike (the Board having obtained a Provisional Order authorising the same). Applicants must state full and inclusive terms with copies of testimonials as to ability, &c., to the undersigned (from whom any further particulars may be obtained) not later than WEDNESDAY, the 25th instant.

DIXON S. SYKES, Clerk to the Board.

January 17th, 1893.

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Miscellaneous Advertisements, Plant Wanted and for Sale, &c., &c., continued on next page.

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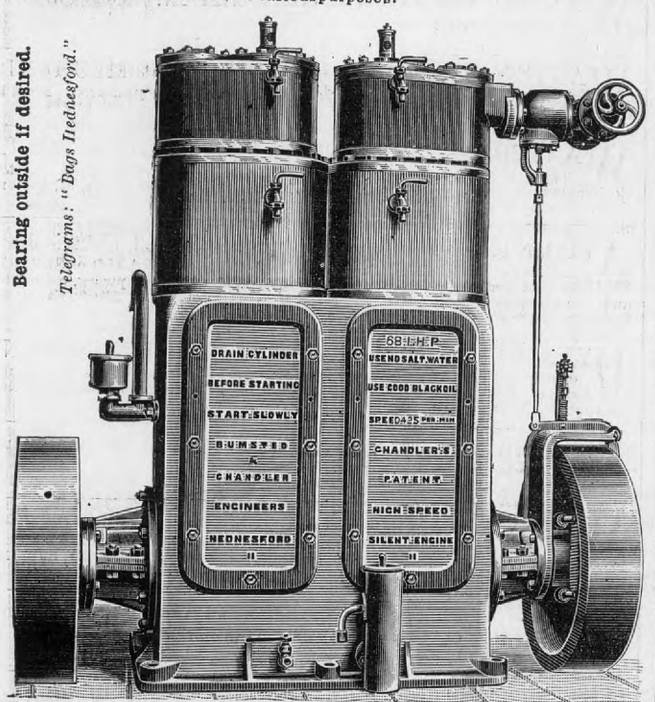

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By order of the Board,
GEORGE DRAPER, Secretary.

London, 17th January, 1893.

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For the use of Electricians and Engineers.

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SPECIALITY.—Underground Electric Light System for High and Low Tension. The only System which has given complete satisfaction.

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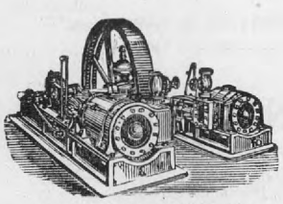

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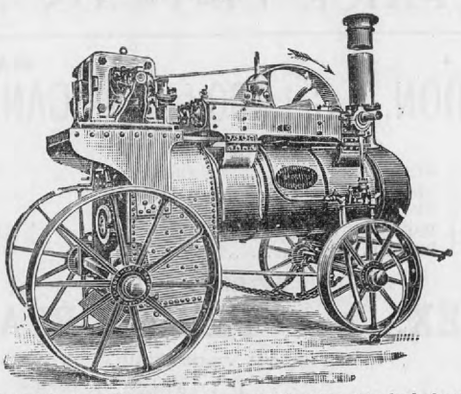

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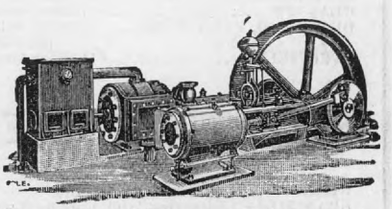

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 766.—Vol. XXX. FRIDAY, JANUARY 20, 1893. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6.

NOTES.

Before the Metropolitan Railway was commenced, Mr. E. A. Cowper was consulted about the use of steam on the proposed line, and he made the suggestion that a "very large" boiler, starting with steam at 250lb., would run nearly six miles and do the necessary work without any furnace or fire. Though suggested, we are not aware that it was seriously recommended, and it was not until 1878 that M. Léon Francq designed his fireless locomotive. This was intended for tramways of moderate length. The boiler contained some 400 gallons of water, and steam at 220lb. Stationary boilers, steaming at a maximum of 242lb., charged the locomotive boilers by passing the steam into them through specially arranged pipes. Locomotives were built at the Hunslet Works, Leeds, and ran with some success on the Rueil Tramway, in France.

The idea essentially was merely one of storage, and now that storage is the desideratum of electrical engineers, Mr. Druitt Halpin's scheme for thermal accumulation described last week by Prof. Unwin at his first Howard lecture, deserves their careful attention. A condensed report of Prof. Unwin's lecture will be found in another column. So far from being a fireless system, it appears to allow the fires to be maintained uniformly, and thus the "stand-by losses" of boilers worked for only a few hours a day may be avoided. It is proposed to raise steam at 250lb.; but what is, perhaps, more important, a considerable body of water will be at the same time raised to 406deg. This water, when the pressure is released, will develop steam during certain working hours, independently of any additional supply of heat which it may receive during that period. It is proposed to use the steam at 130lb. As some form of storage is needed to put the use of refuse destructors on a practical footing, the combination of such furnaces with high pressure boilers seems to be worthy of consideration.

While far better than electrical storage, so far as facility for rapid discharge is concerned, Mr. Druitt Halpin's thermal storage cannot be considered to be quite perfect, for it involves steady wire-drawing; but, no doubt, Mr. Halpin has considered the losses occasioned thereby. These are capable of accurate calculation from well-known thermo-dynamical principles, they are proportional to the fall of temperature and not to the reduction of pressure; superheating might, therefore, be considered in connection with them; the wire-drawing would dry the steam, but no doubt all the pros and cons will soon be made public. It is, however, clear that the use of the steam by successive expansions would be preferable to wire-drawing, and while triple and quadruple expansions for the sake of reducing fuel consumption have been attended with so many losses by friction that many engineers have fought shy of the practice, there would be an undeniable advantage in multiple expansion, where considerations, altogether outside the design of the engines, provide a supply of steam at 250lb. This pressure is modest enough, and the difficulties of carbonisation of lubricants experienced by Mr. Perkins ought not to give trouble.

The discussion on Dr. Fleming's Paper on "Experimental Researches on Alternate Current Transformers" has been brought to a close without the smallest addition to our knowledge of the actual loss incurred in the mains of an alternate current system, on account of the magnetising currents of transformers. It is true that his most interesting Paper does not pretend to deal with the economical considerations of supply, but what of that? Do not discussions at scientific meetings meander round the subject and ramify into the neighbouring problems? Mr. Arthur Wright, whose remarks brought the discussion to a close, thought that even with a transformer of 98½ per cent. efficiency, "there is no room inside a circle of a mile and a-quarter radius for transformers." We are not aware that the advocates of continuous current supply on the three-wire—No! we beg pardon, we mean the compound parallel system—have ever contemplated the supply of so large a district from a single network, without the assistance of dynamotors, as at Oxford, or high pressure charging mains. Looking down the column headed, "Distance of Farthest Lamp in Yards," in our supplement of Jan. 6th, we find that out of nine London Companies who have given us the necessary information, seven work within this radius, and two beyond it; while out of fifteen provincial stations, twelve work within and three beyond it, and two more may shortly be added. These majorities, of course, include a large proportion of alternate current systems. It is little use to further discuss the efficiency of transformers while the efficiency of mains and feeders are neglected. We shall be greatly disappointed if Dr. Fleming does not contribute something to this branch of the subject in his reply.

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Among our reviews this week we have had to notice two books which we believe to be purely American, but which have been "got up" with more or less care to resemble and to pass off as English. In one case the attempt fails, in spite of a specially-printed title-page pasted in. The book purports to treat of Modern Mechanism. It is a cyclopædia, and gives, no doubt, an excellent account of the subject from an American point of view, without altogether ignoring certain European manufactures. American mechanism is, of course, of world-wide reputation, and no one who desires to be conversant with the whole science and practice of mechanism can afford to neglect the American branch. But we assert that a book published and sold in this country under this title, with no indication on the title-page that it is of American origin, is calculated to cause great disappointment to incautious purchasers. The other book so closely resembles an English work, but for the capital G's and a few minor indications, that ninety-nine persons out of a hundred would take it without hesitation to be a genuine English cyclopedia. It is true that the contents are of a fairly international character, and are likely to be almost as useful to a student, or whoever it is that reads electrical dictionaries, as a real English work; and in this respect it differs widely from "Modern Mechanism." But we contend that the purchaser is likely to be deceived, and may probably be disappointed.

The Merchandise Marks Act was framed with the object of preventing this misunderstanding. We do not for a moment allege any inferiority, nor is the Merchandise Marks Act confined to cases of fraudulent substitution of inferior articles in the guise of better ones. It merely provides that, when an article bears such marks or words upon it as may be calculated to lead a purchaser to imagine that he is buying an English article, it shall also bear a prominent notice by which he may be properly warned. Such a notice, we contend, ought to be given on the title-page of the books to which we allude, and, perhaps, in the preface also. It can hardly be included in the title—but either it should appear in publishers' catalogues, or some means should be adopted to protect the unwary. The printing of books in this country from American stereotypes is the natural outcome of the Copyright Convention. It does no direct harm to the printing trade, as might be imagined, since in no case would these books be produced here, for, if not printed in this manner, they would be simply imported. Our anxiety is for for the misguided buyer and for the indiscriminating reader.

The experiments with an induction coil, described in another column, throw an interesting light upon the character of the currents obtained from induction apparatus. Although the total quantity of electricity discharged by the secondary is the same both on making or breaking the primary current, the electromotive force is greatest, and the discharge quickest, in breaking. Mr. Maclean shows this by using a voltameter in conjunction with a vacuum tube. The fact, however, may be shown in a much simpler manner; for if the knob of a Leyden jar be placed near, though not in contact with, the terminal of an induction coil, and the latter be set working, it will after a short time be found that the jar is highly charged. The high potential induced when the primary is broken is sufficient to cause a brush discharge to the jar, while the potential induced on make has no effect on the charge. The numerical results obtained by Mr. Maclean are not very concordant, but they could hardly be expected to be so. The current measured by the voltameter is the arithmetical mean of a current which varies in a most irregular and altogether unknown fashion; and it must also be remembered that the contact breaker of an induction coil is a very rough piece of apparatus. The average value found for the ratio of the primary and secondary currents is 6,000 to 1. It is interesting to compare this with the ratio of the turns of the two coils. This ratio is not given in the Paper, but for many well-made induction coils it is about 1 to 100.

The Blake Transmitter Patent.—This patent expires to-day. (No. 229, January 20, 1879.)

Coast Communication.—The Royal Commission on Lighthouse Communication with the Shore has concluded its interim report, which will be laid before Parliament on the 31st inst.

Hull.—The municipal central lighting station was opened with due ceremony on Monday by the Mayor. The three-wire system with batteries has been adopted, and the station is of 10,000 light capacity.

Taunton.—At the last meeting of the Town Council the Electric Light Committee reported that it had been decided that an application should be made to the Local Government Board for leave to borrow £16,000, instead of £14,000 as originally estimated. The report was adopted.

An Electric Railway Across the Simplon.—A proposal was on Tuesday brought before a number of Swiss bankers in Geneva for the construction of a rack railway, operated by electricity, to traverse the Simplon. The cost of the line is estimated at £1,600,000, and the period of construction at four years.

Forthcoming Life of Werner von Siemens.—Messrs. Asher and Co. inform us that they will publish shortly an English translation of the "Recollections of the Life of the late Werner von Siemens." The German original, published in December last, ran most successfully through two editions in the course of a few weeks.

Telephone Litigation in Belgium.—The State and the Bell Telephone Company are "in interference" in Belgium regarding the taking over of the Belgian telephone system by the Government. According to the contract, the State has power to take over the telephones at the end of ten years. The State, says *Industries*, holds that this term has expired, while the Bell Telephone Company argues that it does not expire till the end of this year.

"Cause of Fire Unknown."—We take from the *Electrical World* of New York a syllogism, which we recommend to the notice of Captain Simonds, in connection with the Regent-street fire of November last:—"Electricity is something the exact nature of which is unknown; the origin of that fire is something the exact nature of which is unknown; therefore, as things equal to the same thing are equal to each other, the origin of that fire is electricity."

The Electric Lighting of Gedney's Channel.—According to a Reuter's telegram, dated New York, January 14th, the ice has broken the lamps and lanterns of the electric lighting system in Gedney's Channel, which is consequently left without beacons. It is expected, however, that the damage done will be speedily repaired. A description of the system em-

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ployed in Gedney's Channel will be found in *The Electrician*, Vol. XXVIII, April 22, 1892, p. 663.

Richmond.—At the meeting of the Town Council last week the Electric Lighting Committee reported that the works were proceeding satisfactorily and with all possible promptitude, having regard to the inclement weather. Councillor Thompson stated that the works ought to have been finished by December 8th. There was a penalty of £8 a day if the contractors failed to do this. But they had only just commenced. An amendment "that the penalties be enforced" was lost, and the report was adopted.

Electricity in South Africa.—Mr. Bennett H. Brough lectured on Wednesday evening, before the Society of Arts, on the "Mining Industries of South Africa, as shown at the Kimberley Exhibition," and stated that the gardens there were lighted by electricity. At the De Beers diamond mine the electric light is used both at the surface and underground, the greater part of the levels and the main ladderways in the mines being illuminated in the same way. The most important colliery in the Transvaal is situated 20 miles from Johannesburg, and is lighted by electricity.

Cable Interruptions and Repairs—

Cable.	Interrupted.	Repaired.
Singapore-Saigon	Jan. 17, 1893	Jan. 19, 1893
Cayenne-Vizeu	Sept 24, 1892	—
Senegal-Pernambuco	Dec. 26, 1892	—

An error occurred in our report of cable repairs last week. The paragraph should have read—

Cable.	Interrupted.	Repaired.
St. Thomé-Loanda	Nov. 24, 1892	Jan. 11, 1893
Mozambique-Laurenço Marques ...	Jan. 5, 1893	Jan. 12, 1893

The Popp Mains.—A burn-out recently occurred on the electric light mains of the Popp Company running along the Boulevard Beaumarchais, where the *canalisation* consists of bare copper bars placed in cast-iron troughs filled with bitumen run in hot. At corners and curves the troughs are made of cement, and, for some reason, the insulating compound kept in a semi-fluid condition at these points, with the result that the conductors gradually became displaced and short-circuited, setting the *canalisation* alight. The system, says *L'Industrie Electrique*, will, therefore, probably be altered once more.

The Corrosion of Lead-Covered Cables.—It has been known for many years that lead pipes frequently suffer from corrosion when laid in certain kinds of earth, while certain waters eat away the inside. During the discussion on a paper on "Cables" at a meeting of the students of the Institution of Electrical Engineers, Mr. A. T. Weightman mentioned the case of the Loch Katrine water at Glasgow. He stated that this water contained free carbonic acid, which attacked the lead, and that the fault was corrected by treating the supply with chalk. He proposed, therefore, to embed lead-covered cables in chalk.

The Association for the Improvement of Geometrical Teaching.—A meeting of this Association was held on January 14th, at University College, Gower-street, W.C., the chair being taken by the Master of St. John's College, Cambridge. Mrs. Bryant, D.Sc., gave a model lesson on geometry to a class of about 20 ladies. After an adjournment, Papers were read by Mr. G. Heppel, M.A., on "The Use of History in Teaching Mathematics," and by Mr. F. E. Marshall, M.A., on "The Teaching of Elementary Arithmetic." The attendance was larger than usual, and interesting discussions followed the lesson and the Papers.

Electric Traction.—At the last meeting of the Pembroke Commissioners, Mr. Clay, solicitor, attended, and submitted particulars of the proposed introduction of electricity as motive-power for the tramways in the district. It was resolved that the Board should consent to the introduction of electricity, subject to an undertaking by the Company that a clause should be introduced giving the township engineer power to direct where the posts should be placed, and to have them shifted if necessary, and also that they might be used free of cost for lamps if the Commissioners saw fit to light the township with electricity.

Railway Rates.—In a circular to the members of the London Chamber of Commerce, it is stated that the Railway Association have appointed a Committee of General Managers to meet the traders and discuss any grievances alleged to have arisen from the new rates and arrangements, and in order that proper representations may be put before the Committee, and also to afford the basis for any other steps it may prove necessary and possible to take, members are asked to kindly supply particulars of any grievances they may have under the new scale of rates, and also to attend a special general meeting to be held in the Council Room to-day, at 12 noon.

Accumulator Patent Litigation in Belgium.—The Brussels Courts have just given a decision in the action brought by the Société l'Électrique, La Compagnie Franco-Hollandaise (in liquidation), and M. Julien against the Société Franco-Belge Tudor. The plaintiffs originally asserted that the Tudor accumulator was an infringement of the Faure and Julien patents, but ultimately restricted the issue to an alleged infringement of the Faure patent. The Court, in a lengthy judgment, held that the plaintiffs' case was not made out, and admitted the claim of the Tudor Company to compensation for the damage done to its business by the seizure of its apparatus and the publicity given to the action.

Obituary.—We regret to record the death at Sydney on the 14th inst., after a very short illness, of Mr. E. C. Cracknell, the Superintendent of the New South Wales Government Telegraphs. Mr. Cracknell was born at Oxford in 1831, and proceeded to Sydney about the year 1855, where he organised the telegraph system in New South Wales, and remained at its head until his lamented decease. His last visit to Europe was in 1885, when he attended the Telegraph Conference at Berlin. He took great interest in the Australian volunteer movement, and held the rank of Major in the New South Wales Volunteers, especially devoting his energies to the defences of Sydney Harbour. He had a large circle of acquaintances, both in Europe and Australia, by whom he will be deeply regretted.

The Hopkinson Three-Wire-Patent Case.—The following is extracted from *The Times* of Tuesday:—

SIR: With reference to the report of this case and the statement at the end thereof that the Judge suspended the injunction for six months, our clients, the Westinghouse Electric Company (Limited), of 4, Victoria-mansions, 32, Victoria-street, the owners of the patent in question, feel that a wrong impression may be conveyed. They, therefore, would like it known that they agreed to this suspension of the injunction as a concession and out of regard to the great public inconvenience that would have been caused by a summary stop being put on the electric lighting of the St. James's district. The St. James's Company have, however, to continue the account of profits which the judgment has awarded the plaintiff during the suspensory period.—Yours truly,

FAITHFULL and OWEN, Solicitors for the Westinghouse Electric Company (Limited),

11, Victoria-street, Westminster, S.W., Jan. 16th.

The City-road Windmill.—Messrs. Carwardine's windmill, which has been used for the electric lighting of their flourmill, besides other work, has been attacked by the County Council as a sky sign, and now the Ecclesiastical Commissioners, as freeholders of the land, have obtained an injunction restraining its further use on the ground that it is an erection contrary to the terms of the building agreement. A rather interesting experiment is thus brought to an end. We understand that the plant gave Messrs. Carwardine every satisfaction while it lasted, the power obtained being sufficient to light their premises with 27 16 c.p. lamps and 3 arc lights. The storage cells are in excellent condition, and have given no trouble whatever. At the time the injunction was granted Messrs. Carwardine were about to erect a motor, to be driven by the accumulators, for the purpose of hoisting sacks.

The American Telegraphs.—The annual report of the Postmaster-General of the United States (Mr. Wanamaker) for the year ended June 30, 1892, contains the following:—

"It was said long ago that the telegraph must be a monopoly, and so is the postal system; but the difference is that one is operated for private gain and the other for the public good. The Government follows a settler across the plains and into the mines. The telegraph goes where it can find paying business only; and so it falls out that only a sixtieth part of the people of the United States employ the telegraph. Practically, so far as the public is concerned, there is but one telegraph company. This enormous business, producing gross revenues nearly one-third as large as the

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entire revenue of the post office department, increases every year. I have never, as you know, advocated the purchase or construction of telegraph lines by the Government. My proposition is to make a contract with some telegraph company to connect post offices by telegraph or telephone, commencing with the most important offices and proceeding gradually in the order of probable usefulness. I would contract with a telegraph company to perform the service with its own operators for a fixed sum per message."

The Chicago Exhibition.—It is announced by the officers of the department of electricity at the World's Fair, says the *Western Electrician*, that the manufacturers of "electric belts," "magnetic rings" and the like will not be allowed to display their wares in the electricity building. Chief Barrett has decided that these impostors do not come within the scope of any legitimate application of electricity, and they will, therefore, be excluded.——The fuel being used in the Exhibition buildings is said to be a very soft coal, the smoke from which is rapidly discolouring many of the white buildings. But as soon as the necessary arrangements are completed, oil will be the only fuel used. A line of 6in. piping is now nearly completed to bring petroleum from Indiana to the storage reservoirs on the gronds. The length of this piping is between 70 and 80 miles. The reservoirs will contain more than a day's supply. The Exhibition Authorities hope to commence using oil in February.

Nelson.—On Thursday, December 22nd, the municipal supply of electrical energy to Nelson was commenced. The engineer and contractor is Mr. Thomas Barton, of Blackburn. Steam is generated principally by means of hot air passing from the gas retorts, the hot gases being passed between the tubes of an ordinary boiler; this heat is sufficient to raise ample steam for the present engine at 60lb. pressure. The central station is 35ft. by 20ft. by 20ft., and at present contains one central valve engine capable of generating 80 I.H.P. at 460 revolutions. The capacity of the dynamo is 360 amperes at 120 volts. The distributing mains are on the 2-wire system. The main cables are insulated with vulcanised rubber, and are carried upon vitrified porcelain bridges in cast iron conduits, distributing and tapping boxes are placed at intervals in the usual way. The sub-mains are insulated in the same manner, and are carried inside iron tubes lined with glass. The majority of the shops have adopted the light which the Corporation have offered to supply at cost price for three years. The centre of the town is lighted by arc lamps.

The Brighton-Rottingdean Electric Railway.—Under the Bill for powers to construct an electric railway from Brighton to Rottingdean the promoters seek to be authorised to construct a railway just under three miles in length, commencing near the Paston-place Groyne, at Brighton, thence proceeding along the beach and foreshore, between high and low water-mark, about 100 yards in front of the cliff to its termination on the seashore at Rottingdean, whence a pier is to be erected. The railway is to be constructed on the extraordinary gauge of 24ft., while the platforms and carriages are to "be placed at such an elevation as to be safe from interruption by the sea." The capital of the proposed company is set down at £15,000, with power to borrow a further sum of £5,000. The first Directors of the Company are given as Mr. Edward Overhall Blackley, Mr. John Jackson Clark, Mr. Magnus Volk, and Mr. Steyning Beard. The time sought within which to complete and open this railway is five years from the passing of the Bill; and from the clauses fixing the maximum rates and tolls, it appears that only passengers and small parcels will be carried over the line.

Cement for Pipe-Joints.—The use of Portland cement is recommended, says the *Journal of Gas Lighting*, for steam joints, and is said to answer every purpose, besides being exceedingly cheap. Herr Adolph, of Mayence, is putting upon the market packing-rings made of cotton tubing filled with cement, in assorted sizes. These can be used for making manhole and other flange joints by the simple process of wetting them thoroughly, laying them in place, and screwing up; taking care to keep a uniform pressure over the whole ring. A still cheaper joint can, however, be made with neat cement alone; the cotton casing being superfluous. It is only necessary to gauge the cement into a thick paste with water, until it is of such a consistency that when daubed on a vertical wall it neither falls off nor flows down. The flanges are to be cleaned of grease and dirt, and the cement applied evenly, in quantity according to the area to be covered. The joints thus made are to be screwed up carefully until the thickness is reduced to about $\frac{1}{8}$inch, when they are to be left for the cement to set. The screws are then finally tightened, and the edges of the joint plastered over with a little fresh cement, which two or three hours after is wiped over with a wet cloth or brush. Socket joints can be made in the same way.

The Junior Engineering Society.—Recent visits of this Society have been to the Central Telegraph Office and the General Post Office, St. Martin's-le-Grand, and to the Millbank-street and Eccleston-place stations of the Westminster Electric Supply Corporation, both of which were very largely attended. In connection with the former visits excellent arrangements for the guidance of the members through the extensive premises were made by the authorities, and every feature of engineering interest was pointed out. In the Central Telegraph Office the instrument galleries, telephone departments, battery rooms, pneumatic tube apparatus, the engines producing the vacuum and pressure actuating it, and the boiler room were seen. In the post office were shown the stamping machines, mechanical lifts and engines working them, the electric light installation now in course of extension, and various models of postal appliances, including one of a mail railway car with gear for taking on and throwing off the bags. At Millbank-street and Eccleston-place the members were shown round by the respective resident engineers, Mr. Newington and Mr. Grimshaw; Prof. Kennedy, past-president of the Society, who was announced to receive the party, being prevented at the last from doing so by an unexpected engagement in Scotland. At each station every point in the arrangement and working of the plant was explained. In regard to steam supply it was noticed that at Millbank-street Babcock and Wilcox water tube boilers were fitted, while at Eccleston-place boilers of the marine type were in use, which, it was stated, worked so satisfactorily that the most economical coal consumption of any electric light station had been obtained. The regularity of the load on the station had assisted to this good result.——The eighth anniversary dinner of the Society will be held in the Queen's Salon of the Holborn Restaurant, at 6:30 p.m., on Saturday, January 28th, Dr. John Hopkinson, F.R.S., President, in the chair.

Windsor.—The Corporation who are endeavouring to electric light Windsor and Eton are still in conflict with the authorities. The difficulties under which they labour, through certain shortcomings in respect to initial capital, and the conditions of the Provisional Order, are in themselves a sufficient obstacle to cope with; but beyond that, it seems that they will have to fight the anti-electric element in the Council over every step they take. The Company having been fined a week or two ago for breaking up the streets without permission, it was thought that the Corporation would be content with this vindication of their rights, and allow the Company to proceed with their scheme in peace. At the last meeting of the Council fresh complications arose, the Company having opened more streets without due notice and permission. At the Town Council it was argued that until the Company had complied with Board of Trade requirements, the Company did not legally exist, and no countenance could be given to its acts. The discussion waxed warm and even slightly personal, until a compromise had to be arranged. The motion to give the permission for the cutting of a trench was replaced by a proposal to refer the question to the Streets Committee for consideration and report, and the vote given upon this was eight on each side. This created a fresh difficulty; but it was overcome by the Mayor giving his casting vote for the proposal. The Company contemplate starting running on Monday next. The sequel to the latest action of the Corporation is curious and instructive. Determined to have the electric light, for which the fittings have been up some time, one firm has resolved to set up their own installation, and have obtained for this purpose a gas-engine and a dynamo. Very opportunely, in view of the difficulties attending the introduction of the electric light into the town, the Windsor and Eton Scientific Society are organising an electrical exhibition in connection with their annual meeting.

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NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Continued from page 299.)

25. Buoying a Bight.—It is sometimes necessary to buoy the grapnel rope if it is found in lifting cable that the strain becomes too great for the rope. In such cases, instead of risking breakage of the cable or rope it is safer to stop lifting and attach grapnel rope to buoy. The bight of cable then remains suspended on grapnel while ship proceeds to another position and lifts cable again. The illustration (Fig. 89) is from an instantaneous photograph on board the "Electra," taken while grappling and for the purpose of showing the effect of a heavy strain on the dynamometer, the sheave of which is seen to be raised so that the rope passes almost in a horizontal line underneath it. The strain in lifting a bight of cable is due more to the pulling of the cable from both sides towards the bight than to the weight of cable alone. A certain percentage of slack varying according to the depth, is payed out at the time of laying for the purpose of facilitating lifting during repairs; but even with a liberal allowance, spread as it is uniformly along the route, there is a good deal of shifting of cable on both sides towards the ship when she lifts a bight. Say the ship raises a bight of type D in 1,500 fathoms laid with 10 per cent.

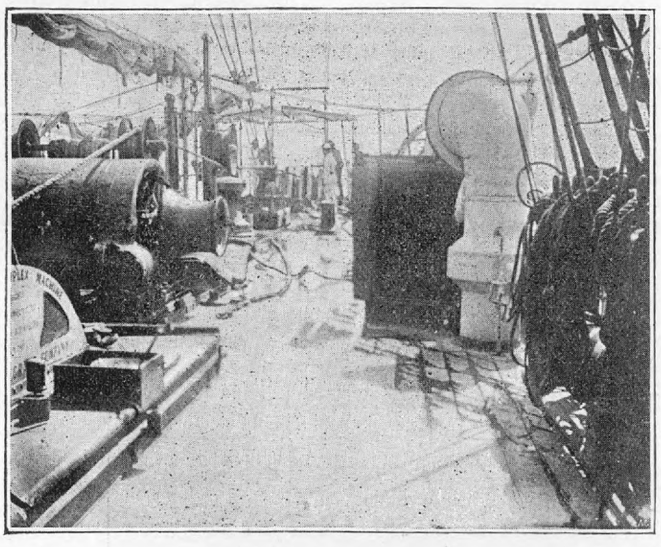

FIG. 89.—Grappling. Dynamometer Showing Heavy Strain.

slack. To raise this to the surface cable must be lifted off the ground or pulled towards the ship from a distance on each side of bight equal at least to double the depth, or a total lifting or moving of about six knots of cable. This adds to the strain about as much again as the weight of cable alone, and means about seven tons' strain on the grapnel rope when cable is nearing the surface, which is equivalent to five tons per square inch on the cable itself. Beyond this there is a margin of two or three tons per square inch before breaking strain is reached; but, as the cable gets older, this margin diminishes.

Sometimes on a repair circumstances necessitate putting in a piece of intermediate in too great a depth. In lifting this again on any subsequent repairs in the same spot the strain will be unusually great. Suppose a length of type B laid in the moderate depth of 700 fathoms. In raising this the cable would be put to a strain of four tons per square inch, and the grapnel rope would have to bear quite nine tons, which is very near its breaking strain. The proper size cable of type D laid in this depth would only be subject to two and a-half tons per square inch, or about three and a-half tons on the grapnel rope.

Whether due to this cause or too little slack, or the cable being buried, the grapnel rope is buoyed as in Fig. 90 if the strain is considered unsafe. The sketch for want of space, does not represent the correct curve taken by the cable when lifted. After buoying the bight in this manner the ship proceeds to a position further on, at a distance equal to double or half as much again as the depth of water, and lowers grapnel again. This time a cutting and holding grapnel is used and the knives set to cut the cable on the side next the buoy, the other end being lifted inboard and tested. On returning to the buoy and getting grapnel rope connected to drum again, the bight is easily lifted, as half the strain has been removed by cutting.

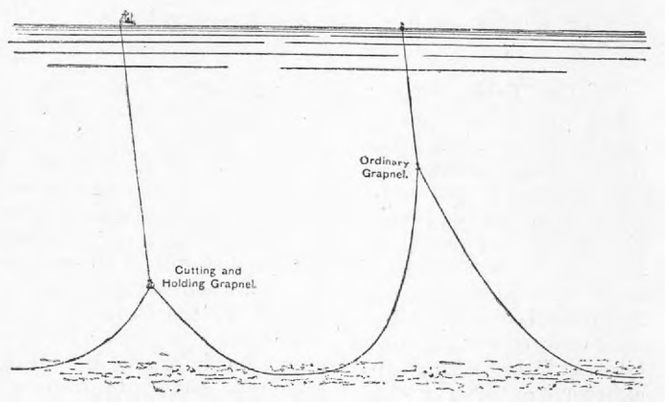

FIG. 90.—Bight Buoyed. Ship Cutting.

When grappling the second time and raising to cut, ship must be kept moving a little towards buoy so that no strain comes upon the latter; otherwise the cable which it supports may be dragged away and pull the buoy under the surface, when it may collapse. On a repair to one of the Australian cables where a bight was buoyed in this manner, the ship while lifting the second time to cut, was carried by a surface current away from the buoy. The latter was seen disappearing below the surface in time to avert its sinking too far, the ship being immediately steamed against the current and kept moving up towards the buoy to relieve the strain. Buoys have also been known to sink in a strong tideway.

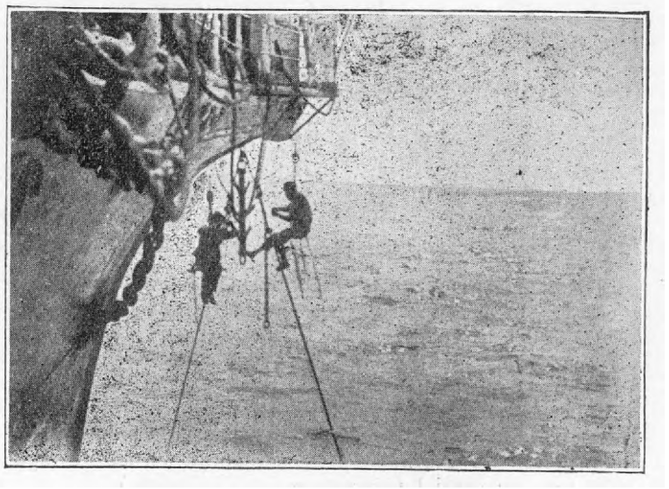

FIG. 91.—Cable Hooked on Shackle of Grapnel.

Another way of effecting the same object is to buoy the second bight and then run between the two bights and part cable with a simple cutting grapnel; such a grapnel is of the old five-prong type with knife edges fixed in the seat of each prong. Or it may be possible to raise cable between the two bights without cutting below the surface.

The most difficult conditions to perform this under are when two or more cables cross each other near the point or lie very close together. In that case two bights can be buoyed and the centre raised to the surface and examined before cutting. In

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one instance on raising the second bight to the surface and cutting, the end next buoy was about to be thrown overboard in the usual way, but on the chance of its being a piece of abandoned cable the end was retained, and on picking up was found to be separate altogether from that on buoy, being, in fact a piece of cable abandoned on a previous repair which was thus all recovered.

A curious case of raising cable occurred some little time ago on board the "Electra." The cable came up as shown in the photograph (Fig. 91), on the shackle of the grapnel, not being caught by the prongs at all. The illustration shows the manner of letting down two men over the bows seated in boatswains' chairs, to put the chain or rope stoppers on each side of the cable.

26. The Cable Ship "Mackay-Bennett."—This steamer, owned by the Commercial Cable Company of New York, is employed in the maintenance of the Company's system in the Atlantic and European waters. The two Atlantic cables of this company from Ireland to Nova Scotia represent together 4,732 miles, the two from Nova Scotia to the States 1,337 miles, and the two European cables connecting Ireland with England and France 839 miles, or a total of 6,908 miles. Of the four other companies owning Atlantic cables only two, the Anglo-American Telegraph Company and the French Company, have their own repairing steamers (the "Minia" and the "Pouyer-Quertier"), the other companies when repairs are needed, hiring either one of these or one of the large cable manufacturing companies' steamers at a cost of from £160 to £240 per day.

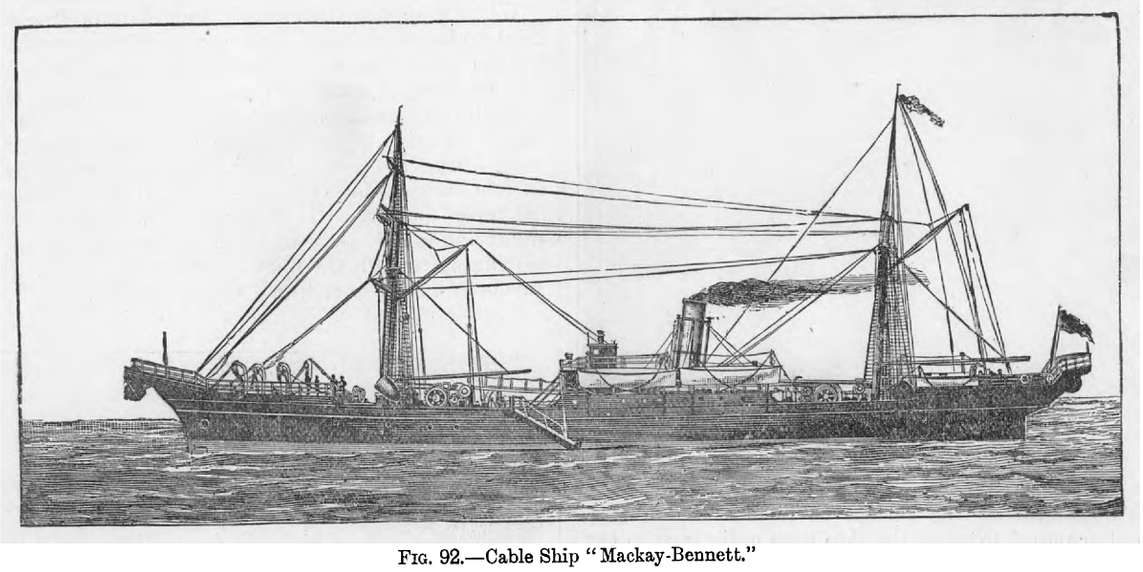

FIG. 92.—Cable Ship "Mackay-Bennett."

The "Mackay-Bennett," launched in September 1884, was built at Govan on the Clyde, in the yard of Messrs. John Elder and Co., and measures 270ft. by 40ft, by 24ft. 6in. depth moulded. Her tonnage is 1012·92 net registered and 1,700 gross registered. The illustration (Fig. 92) has been kindly lent by the Company's General Superintendent in England, Mr. G. H. Bambridge, to whose courtesy the writer is indebted for the accompanying details. In the design of this steamer special pains have been taken to give her good steering and manœuvring qualities. In addition to the usual stern rudder, a second rudder is fixed at the bow inside the line of the stem, which can be worked by a hand-wheel. This very useful addition enables a course to be kept when going astern (frequently required in repair work), in easing strain on cable or in fetching or getting clear of a buoy or splice. Steam steering gear on Messrs. Muir and Caldwell's system is fitted in the wheel-house aft, and can be operated from either of two wheels, one amidships and one on the poop. A hand-wheel is also fitted aft as a stand-by, giving a third means of steering independent of steam. Her manœuvring qualities are still further increased by the use of Brown's patent hydraulic reversing gear, already referred to in these Papers as fitted on board the "Electra." As the "Mackay-Bennett" is a twin-screw steamer and Brown's reversing gear is fitted to each engine, there is not much time lost in turning her round either way. Bilge keels are also fitted which minimise the rolling in heavy weather.

The engines are compound surface-condensing, with cylinders 25in and 50in. diameter. On her trial trip a speed of 12·3 knots was attained, the engines developing 2,190 I.H.P. The coal bunker capacity is 750 tons.

Three cable tanks are fitted, having a total capacity to loading lines of 385 knots or 710 tons of deep sea cable 1in. in diameter. The fore tank, No. 1, is 20ft., No. 2 30ft. and No. 3 28ft. in diameter, and the mean diameters of the cones are respectively 6ft. 2in., 7ft. 2in. and 6ft. 2in. The fore and aft tanks can be loaded to a height of 10ft., and the tank amidships to 14ft. At these heights the fore tank holds 60 knots, the midships 195, and the aft tank 130 knots of the above type of cable. The tanks are all in connection with pumps in the engine-room, by means of which they can be flooded with water or discharged, as required.

Steam cable gear capable of dealing with repairing work in the deepest waters of the Atlantic, is fixed both forward and aft. That in the fore part of the ship, used chiefly for grappling and picking-up, has a single drum driven by a double-cylinder engine with inclined cylinders, fitted with clutch for single or double purchase, and a brake for paying-out with the engine thrown out of gear. The brake is controlled by a hand wheel and screw. The aft gear is driven by a similar engine with clutch for throwing out of gear when paying-out with the brake. The bow and stern sheaves are fitted underneath the working deck or platform, as in the "Faraday." The testing room is situated at the forward end of the ship's bridge, and underneath it. Lord Kelvin's sounding air-tube navigational machine, and James's submarine sentry for indicating depths while in motion are carried, and the ship is also supplied with Messrs. Johnson and Phillips' sounding machine for deep-sea work.

For trimming purposes the "Mackay-Bennett" is built with a special cellular double bottom running the whole length of the vessel, which can be utilised for water ballast to the extent of 300 tons.

The equipment of this handsome vessel is completed with an electric lighting plant consisting of two Siemens dynamos each with a normal output of 90 amperes at 110 volts. These are driven by a pair of Tangye's engines, the light being distributed throughout the ship, and night operations facilitated by deck-light reflectors fitted with six and eight incandescent lamps.

The faults chiefly met with in the Atlantic are caused by ships' anchors.

(To be continued.)

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SPARKING AT COMMUTATORS.

BY F. M. WEYMOUTH.

(*Continued from page 246.*)

Commencing now to give our attention to the sparking that takes place at commutators particularly, it may be well if at the outset we consider what are the conditions that usually obtain with a commutator of a well-made dynamo. For simplicity's sake, we will refer only to the case of an ordinary two-pole machine, of a closed-coil type. Such a case is represented diagrammatically in Fig. 7 herewith. It will be observed that a horizontal field is shown; and to avoid confusion, we will assume this throughout our remarks, together with the north pole-piece on the right-hand side, and the direction of rotation of the armature, as shown by the curved arrow. Each segment *c c* is connected up to an armature coil *b b*; and the latter may be considered to be coils round a ring as in Gramme winding; or else as each carried round the whole diameter of the core, as in drum winding.

Now, it is well known that in the course of the generation of current and electromotive force under the above conditions, the coils of the armature winding, which are nearly or quite horizontal, as at *w x*, generate the most potential: for they are here including or excluding the horizontal lines of force of the field at the greatest *rate*. Hence each segment of the commutator connected to coils in this position will have its potential raised above that of the one below by an amount equal to the potential gathered by the coil or section of winding that connects them. Thus there will be a

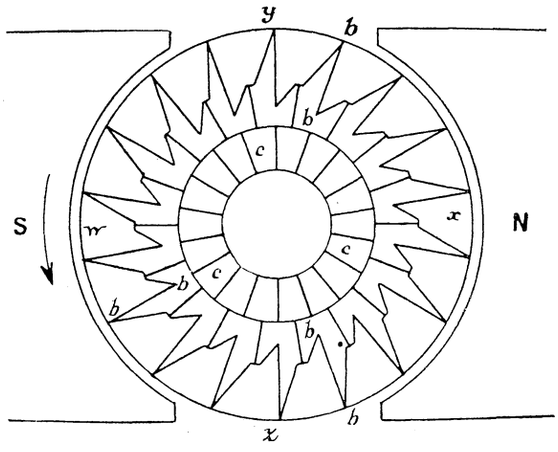

FIG. 7.—Diagram showing Commutator, Armature Winding and Field.

maximum potential difference between adjacent segments at the *sides w* and *x*. But the coils that lie in planes nearly or quite vertical, as at *y z*, are practically not including or excluding lines at all: hence they generate no potential. Consequently, there will be a minimum, or practically no potential difference between their commutator segments; and the potential difference between any two adjacent segments will increase as the plane of their connecting armature coil leaves the position normal to the lines of force of the field, and approaches a position parallel to them; and *vice versâ*.

Now, a plane in or about a position containing a line through *y x* (Fig. 7), is known as the plane of commutation; for it is herein, as the armature coils successively arrive into it, that they change the direction of the current within them, or are "commuted." It needs to be clearly understood, however, that this plane is one through the *armature winding* only, and not through the commutator, at least necessarily. The segments of the commutator may lie in or about the same plane as the coils to which they are connected, as in the case of Gramme winding, or with drum winding (approximately) when the parallel conductor bars on the armature run straight out to the lugs of the commutator. Or the segments may be at right angles to their connecting armature coils, as with drum winding when the connection with the commutator segments is made from the interior of the end-winding—that is, from the middle of the cross connectors instead of from their exterior ends. This interior connection was exemplified by the Hopkinson and Eickemeyer end windings illustrated and described

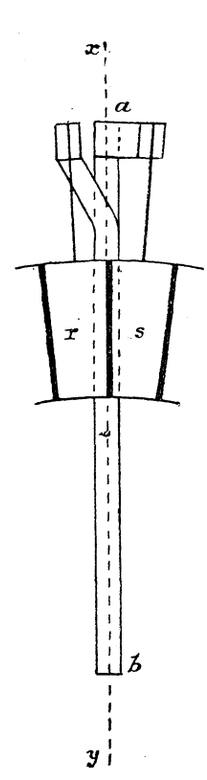

FIG. 8.—Plane of Coil between two Commutator Segments.

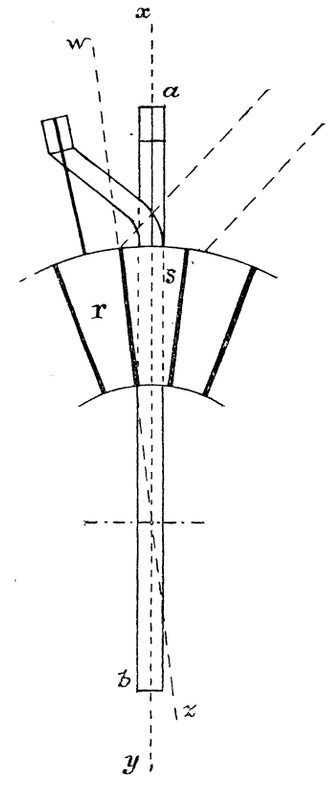

FIG. 9.—Plane of Coil Cutting through one Commutator Segment.

in another article (see *The Electrician* for December 5, 1890, pp. 135 and 136); while various outside end connections may also there be found. Figs. 8 and 9, will, however, make the matter yet more clear. In both of these *a b* is an armature

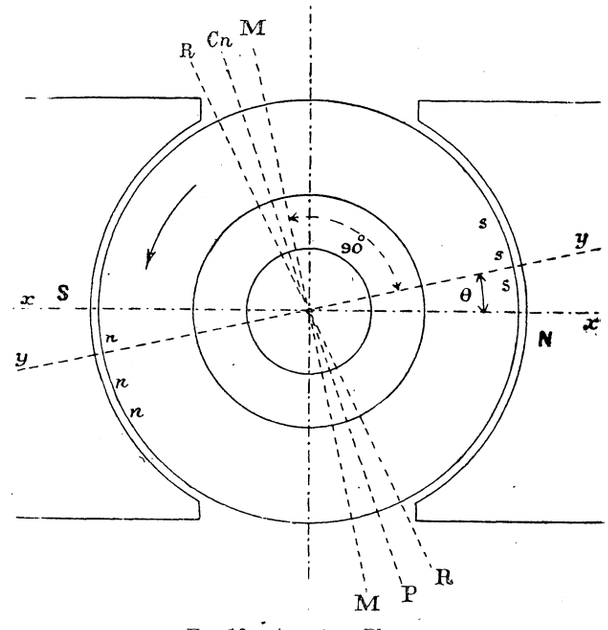

FIG. 10.—Armature Planes.

coil seen endways, and lying in a plane *x y*. But in the former we find this plane cuts exactly *between* the segments *r* and *s* to which it is connected; while in Fig. 9 it cuts through the segment *s*; the latter is perhaps more usual in dynamo construction.

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It is from this point, however, that we shall now need somewhat to enlarge. Having thus far made allusion to what is termed the plane of commutation, it will be necessary to expatiate more fully in this direction. For in order to arrive at a good understanding of our subject as a whole, we may assume four other such planes. These, together with the plane of commutation, are represented variously in Figs. 10, 11, and 12, and may be enumerated as follows :—

(1) The plane of commutation.

(2) The neutral plane or plane of non-sparking.

(3) The plane of requisite reversal.

(4) The plane of maximum and minimum potential through the commutator.

(5) The plane of maximum and minimum potential through the armature.

We thus find that, as we had five orders of sparks, so we have here five different planes. To these we may now give our attention. In the first instance, however, we will merely briefly consider them, so as in some degree to define each one, postponing a fuller discussion till afterwards, when we

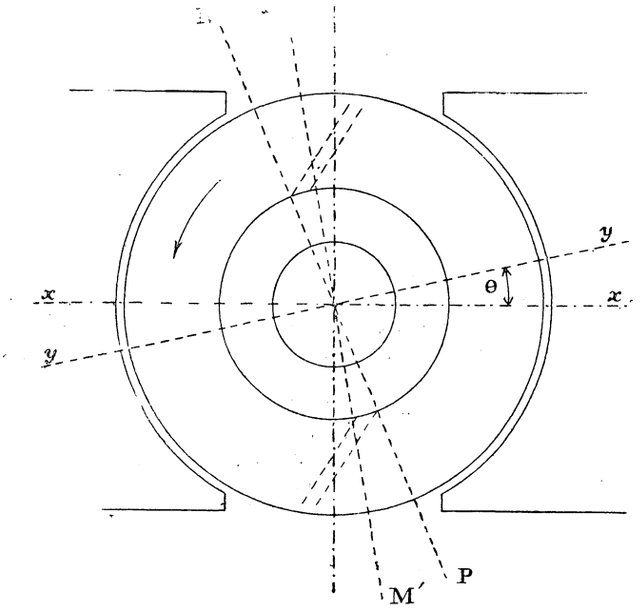

FIG. 11.—Commutator Planes. Brushes above and below.

may take them all, more or less, into consideration in conjunction with one another, in the same manner, in fact, as we dealt with our category of sparks. Thus, to touch on them in order, we return once more to the plane of commutation, which comes first in the list. This plane is indicated by the line Cn P in Figs. 10 and 12.

As the act of the reversal of current in a coil cannot take place—that is, from full strength in one direction to full strength in the other direction—without *some* expenditure of time, however small, this plane of commutation may be considered as occupying that position wherein the coils, as they arrive into it, have an infinitesimally small amount of the reverse current commencing to flow in them. Practically, this is, of course, tantamount to saying that it occupies a position where there is *no* current in the coils. But this is the exact instant of change, that is, of commutation ; and such a definition has the advantage of being, as it should be, definite. Further, however, it has to be understood that this plane is *not a fixed element* in the dynamo. For its position is governed by the brushes, which are moveable. But it follows these with some degree of elasticity none the less, which we shall discuss later in our remarks.

Now, whereas the plane of commutation had to do with the armature coils, the neutral or non-sparking plane, the next in our order, has to do with the commutator. This is indicated by the letters N P in Figs. 11 and 12. As its name implies, it is that plane through the axis of the commutator which contains the points on either side, where, if the brush points are resting there, no sparking occurs. Unlike the last, it is a more or less *fixed* element in a dynamo—that is, normally and with a steady load. It does not move with the brushes ; but, contrariwise has to be found by shifting the brushes to and fro, and so by experiment noting the position where no sparking takes place. Of course, in some dynamos there is no such position ; or, at the best, only a point of minimum sparking. But to this we shall return.

The third plane is distinct from the first two in more than one respect. We have termed it the plane of requisite reversal. It is indicated by the line R R in Figs. 10 and 12, and is an element of the winding, and not of the commutator ; and is, moreover, a normally fixed element. As regards its fixity, in fact, it accords with the neutral plane of the commutator : and, depending entirely on construction and the method of connecting up the armature winding with the commutator, it *might coincide* with the neutral plane. This latter, however, would only occur when, as in Fig. 8, the plane of the coil divides the two segments to which its ends are connected ; or, more

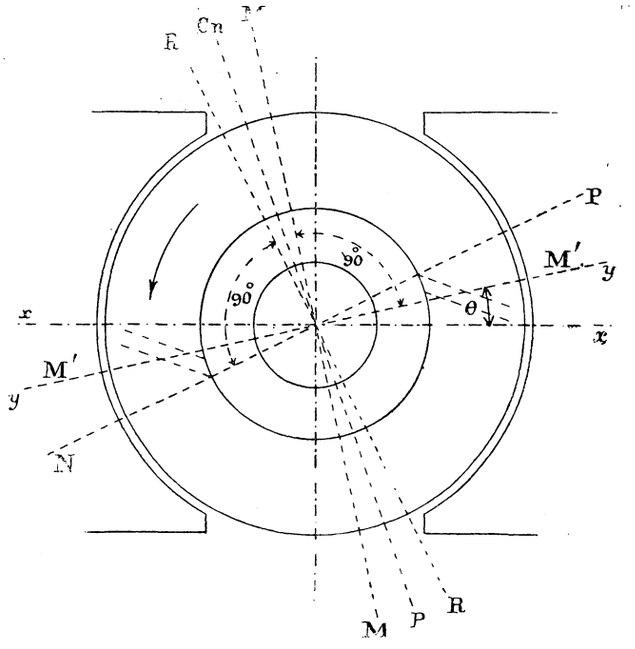

FIG. 12.—Armature and Commutator Planes. Brushes at the sides.

accurately, when it passes through the edge of the receding segment *r*, as shown. Otherwise, as in Figs. 9 or 12, the two planes will be distinct, though at a fixed and invariable angle with each other. It is necessary to defer a more full explanation of this third plane, until we can consider them all conjointly.

Like the second, the fourth plane is an element of the commutator. It is represented in Figs. 11 and 12 by the line M′ M′, and is that plane through the axis of the commutator which contains the points on either side where there are respectively the maximum and minimum potentials. When the brushes are at the non-sparking points, then this fourth plane would lie somewhat behind, as shown in the diagrams. It is normally a fixed element not moveable directly with the brushes ; and with a steady load, should not vary in position.

(To be continued.)

Austrian Telegraphic Statistics.—The following figures are from the report of the Minister of Commerce, recently issued regarding the working of the telegraphs during 1891, as compared with 1890 :—Number of telegraph offices in 1891 was 3,905, and in 1890 3,801. Number of telegrams in 1891 was 9,661,297, and in 1890 9,081,631.

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SOME RECENT EXPERIMENTS WITH AN INDUCTION COIL.*

BY MAGNUS MACLEAN.

The total quantity of electricity set in motion in the secondary circuit of an induction coil by the make in the primary is equal to the total quantity set in motion in it by the break in the primary; but the durations are quite different. Fig. 1 will help to illustrate this point. A B represents the time during which the inverse-make current lasts, and B C the time during which the direct-break current lasts, D E the maximum of the inverse current, and F G the maximum of the direct current. The area A D B, which represents the total quantity of the inverse-make current, is equal to the area B F C, which represents the total quantity of the direct-break current. That the quantity set in motion by the break is equal to the quantity set in motion by the make was experimentally proved by Faraday, and subsequent theory and experiments have corroborated the fact.

If, however, there is a non-metallic gap in the circuit, whether of air at ordinary pressure, or at much-reduced pressure, as in vacuum tubes, the *break* impulse causes a flow in one direction, and the make causes either no flow or a much less flow in the opposite direction; because the short intense impulse of the former breaks down the resistance, while the comparatively long and less intense impulse of the make either does not break down the resistance at all, or only does so to a much less degree, so that the effective resistance is much greater in one direction than in the other.

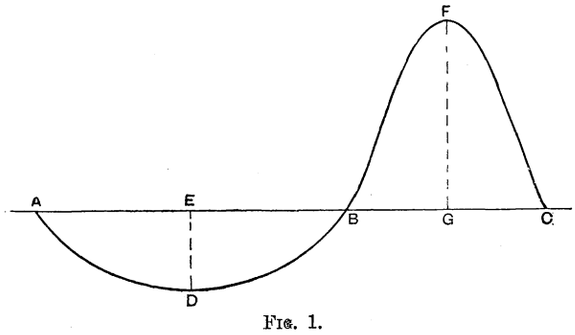
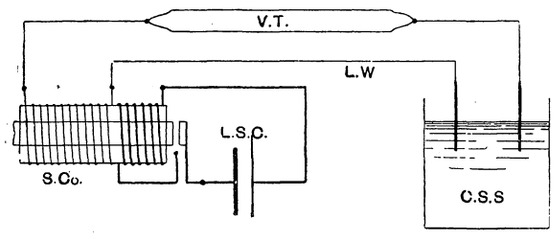


FIG. 1.

To obtain the average difference of quantity of electricity set in motion in one direction above that in the other, a copper electrolytic cell was put in circuit with a vacuum tube and the secondary coil of a small Ruhmkorff coil. The solution in the cell was copper sulphate of density 1·17 with one-half per cent. of commercial sulphuric acid added. The electrodes were No. 36 B.W.G. copper wire 0·012 centimetre in diameter, and they were immersed in the solution as little as possible, to give the best current density for the deposit. To obtain the best result the total immersed area of the cathode plate should be 50 square centimetres per ampère. Fig. 2 gives a diagrammatic representation of the arrangements. The



S.Co. Secondary Coil. L.S.C. Large Secondary Cell. L.W. Loss Wire. C.S.S. Glass Vessel, containing Copper Sulphate Solution. V.T. Vacuum Tube to indicate Current.

FIG. 2.

experiments were mostly performed by Mr. Alex. Galt, B.Sc., F.R.S.E., in the Physical Laboratory of the University. It was imperative that the small and very light electrodes should be manipulated with the greatest care. Before each experiment they were carefully cleaned, dried, and weighed, and at the end of the experiment they were detached singly from the connecting wires, plunged at once into a vessel of clean water to remove any adhering copper sulphate, and immediately placed in the folds of thick, dry blotting-paper, where they were thoroughly dried; then they were again weighed. Table I. gives the results of seven of the experiments. The shortest time any of these experiments lasted was one hour and ten minutes, and the longest time four hours and five minutes.

* Abstract of a Paper read before the Philosophical Society of Glasgow.

The average current showed by all these experiments is one-sixth of a milliampere. It is noticeable that the gain is in six of the seven experiments greater than the loss—the one exception being June 8th. On looking up the laboratory note book, no remark is found regarding this experiment, to, in any way, explain why in this respect it differs from all the other experiments.

Table I.

Date.	Time the experiment lasted in seconds.	Loss of one wire in milligrammes.	Gain of other wire in milligrammes.	Current in milliamperes calculated from the gain wire.
1892.				
June 6	7,200	0·24	0·3	0·127
,, 7	4,200	0·0	0·23	0·1669
,, 8	10,980	0·42	0·29	0 0828
,, 10	9,660	0·1	0·3	0·0946
,, 14	10 800	0·83	0·88	0·2484
,, 15	13 500	0·89	1·04	0·2224
,, 16	14,700	0·58	0·8	0 1819

REMARKS.—The average current given by these seven experiments s one-sixth of a milliampere.

An electrolytic cell with copper electrodes was now inserted in the primary, and Table II. gives the results of three experiments. The current in the secondary coil calculated from the gain wire was found to be slightly less than a sixth of a milliampere, and the average current in the primary, calculated from the gain plate, a little less than an ampere. The mean ratio between the two currents was 6,000.

Table II.

Date.	Time experiment lasted in seconds.	Gain of plate in Primary circuit in grammes.	Current in Primary calculated from gain plate in milli-amperes.	Secondary Circuit.			Current in Primary ÷ current in Secondary
				Loss of one wire in milli-grammes.	Gain of other wire in milli-grammes.	Current calculated from gain wire.	
1892.							
July 4	10,080	3·0229	914·3	0·33	0·55	0·166	5,496
,, 5	10,800	3·10465	876·4	0·62	0·43	0·121	7,220
,, 6	10,800	2·08885	589·0	0·58	0·40	0·113	5,222

REMARKS.—Taking the average of these results, it is found that the current in the primary is 6,000 times that in the secondary, which is a little less than that found in Table I., viz., one-sixth of a milliampere.

A long thermometer tube full of solution of copper sulphate was now inserted in the secondary circuit instead of the vacuum tube. The resistance of this column of copper sulphate solution would be comparable to the resistance of the vacuum tube. A "Kelvin" multicellular was put at the terminals of the vacuum tube while the experiment was going on. It indicated 165 volts. This would give the effective resistance of the vacuum tube to disruptive discharges as $165 \div \frac{1}{6000} = 1$ megohm. In this case there was no air gap in the secondary circuit. The whole circuit was completed by metal and copper sulphate solution. The results obtained are inconclusive, as sometimes both electrodes showed a slight loss, and sometimes they indicated neither gain nor loss. Some experiments were also tried with an air gap instead of a vacuum tube, the results obtained being similar to those obtained with the vacuum tube. A few experiments were also tried with nothing in the secondary circuit but the secondary coil and the electrolytic cell. In every case both electrodes showed loss.

It would be interesting to try these experiments, commencing with the largest air gap that the secondary coil could spark across, and gradually diminishing the air gap till there is metallic contact. A beginning has been made in this direction, but no definite results have as yet been obtained.

GAS v. ELECTRICITY FOR ILLUMINATING PURPOSES.*

BY S. A'COURT.

Dealing with the public lighting of the streets and squares of London, the author referred to the fact that no two parishes were alike in the quantity of light per unit area of streets of equal size, nor did they agree in the actual positions of the lamps. In St. Pancras the arc lamps were on posts in the centre of the main thoroughfares; while Westminster was content with gas-lamps in the middle of the roads, and along the edges of the pavements.

* Abstract of a Paper read before the Civil and Mechanical Engineers' Society, January 5, 1893.

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He thought it would be admitted that the tendency of the age is towards better public lighting. He acknowledged that gas-lamps had lately been much improved in respect of their light-giving power; and the reflectors fitted to the street-lanterns distribute the light well. The three and five-burner lights in Westminster consume 30 and 50 cubic feet per hour respectively, which, at 3 candles per cubic foot, means 90 and 150 c.p. The author had not been able to discover any proof of the makers' claim of 270 c.p., or 5·4 candles per cubic foot, for the 50ft. burners. Arc lamps burning with 10 amperes and 45 volts had been tested photometrically, and found to give 1,500 c.p. at 45deg.

While, for small streets, gas-lamps of 12 c.p., with those of 90 c.p. at crossings and refuges, will give sufficient light, yet, when important streets are taken, the number of high-power gas-lamps required to give proper illumination means a large initial outlay and a heavy bill for running expenses. A 10-ampere arc lamp complete, with post and lantern, costs £18. 10s.; a 50ft. gas-lamp complete, with post and lantern, costs £14. 11s. The contract price per arc lamp per annum for current, cleaning, carbons, and repairs in London and other towns is £26 on the all-night schedule. A 50ft. gas-burner on the all-night schedule, with gas at 2s. 2d. per 1,000 cubic feet, will cost £23. 8s. for gas alone, or £25 per lamp per annum with cleaning, &c. This is paying the same price for practically one-tenth of the light. It has been found that, to secure good lighting, there are required on both sides of the street, 10-ampere arc lamps, placed at a height of 25ft., and at a distance not exceeding 150ft. apart, measured from lamp to lamp on the same side. When streets are more than 50ft. in width it is necessary to reinforce the lighting with arc lamps on central refuges. In order to give an equal lighting effect with gas, it is found that high power lamps have to be placed in groups of three on refuges, and erected about 50ft. apart along the sides of the even 40ft. streets. Roughly speaking, yet making every allowance for gas, five 50ft. gas burners are required as against every 10-ampere arc lamp. On this basis, the first cost of each, for equal lighting effect, works out to electricity 1 to gas 3·9; and running expenses, 1 to 4·8. In small streets, where lamps serve only as buoys to mark out the channel, gas is cheaper than incandescent electric lamps of equal power (12 candles). But before long we shall be wanting better illumination of small streets; and then it may be found that, if the power of the lamp is raised to 50 candles, electricity can compete, and that favourably.

EXPERIMENTAL RESEARCHES ON ALTERNATE CURRENT TRANSFORMERS.

The following is an abstract of the discussion on Dr. Fleming's Paper, which took place on Thursday evening last week at the Institution of Electrical Engineers. Speakers whose remarks are prefaced by an asterisk have returned their proofs revised.

DISCUSSION.

Prof. FITZGERALD, in resuming the discussion, said that he had attended the meeting in order to make some remarks upon some letters that passed between Prof. Ayrton and himself some years ago in connection with the question of the eddy currents that would be produced in the windings of tranformers. He was sorry to say he was not practically acquainted with the subject very much, but he thought that it would possibly be worth while to call the attention of makers of transformers to the conditions under which eddy currents would be produced The letters were written in March, 1891, in connection with a discussion on the efficiency of transformers then going on. It seemed to him that those engaged in the discussion had not paid attention to a warning which Lord Kelvin had called attention to as to the eddy currents which would be produced in the thick wire of a transformer if it was sufficiently thick. The point that Prof. Ayrton wrote to him about was upon this very question as to how it happened that although there was induction tending to produce a current *round* copper coils there was no induction tending to produce eddy currents *in* the coils. The answer was very simple. Lines of induction *within* the copper ring would produce a current of electricity *round* it. A difference of potential would only be set up in the thickness of the copper itself if the lines passed *through* its mass. The thing that was really of interest was the question as to whether, in order to avoid this eddy effect, the thick wire should be wound outside. He thought that in a perfect closed circuit transformer the driving circuit, whichever that might be, ought undoubtedly to be on the inside. Taking leakage into account it was, generally speaking, best to keep the thick wire coils as far away as possible from the core. Then came the question, whether if they had a hundred, or a thousand, or a million alternations per second, the same thing held. It did not hold accurately, but for a hundred alternations per second, or for ordinary transformer work, he thought there was very little doubt that it did. He was even not sure that the eddying in the thick wire coils was of any real importance. It was Lord Kelvin who called attention to it, and he took refuge under the ægis of his name in saying that it was worthy of consideration. Another thing he was quite certain in saying at the present moment was of no importance yet might at some future time be of importance—what would happen if they multiplied their alternations—suppose they ran up to millions per second? What would the electric force then come to with alternations at the rate of a million per second? The electric force would become very large, something like a million of million times what it would be with one alternation per second; and consequently if they had ten millions per second, they would be coming to a quantity which would very rapidly wipe out the 10^{-21}, and they found in Leyden jar discharges in which they had alternations at the rate of millions per second, the lines of force due to electric displacements, which Maxwell supposed to exist, became of importance. The Hertzian wave was generated. Therefore, if their alternating dynamos ever came to the point of alternating at the rate of tens of millions per second, they would have induction produced in all circuits in the neighbourhood; but until they did use those very rapid alternations he supposed it was not worth while paying attention to the matter.

*Mr. WEEKES said that experiments made at the works of Messrs. Johnson and Phillips had shown that they could neglect the eddy currents in the thick wire; he did not think that it made very much alteration whether they put the thick wire inside or the thick wire outside. Mr. Weekes went on to describe some experiments made at the Central Institution on the effects which followed switching a big condenser off a 100-volt circuit, and they had come to the conclusion that the whole phenomenon of the high potential difference left on the condenser depended on the arc at the switch. They also experimented on the electric arc. They had an ordinary arc which was regulated by hand, and there was a coil in series with it with a moving iron core, so that they could draw the core out and increase or decrease the self-induction. With the core right in, the lag was 47deg.; they then gradually drew the core out, and it decreased to 21deg. They found that if the arc was made of hard carbon the result obtained was altogether different. In fact, instead of the angle decreasing as they pulled the core out, it actually increased. At first they could not quite understand that, and thought it could not be the self-induction effect. The volts on the hissing arc were higher than the volts on the steady arc. Analysing these results they got the following peculiar result:—With the arc silent the electromotive force required to overcome the self-induction of the arc was 12·5 volts, and the electromotive required to overcome the resistance and the back volts of the arc was 33 volts. But with the hissing arc, and the same current of 14·9 amperes, the self-induction rose to 40 volts, and the back E.M.F. + C.R. fell to 22 volts.

*Prof. PERRY said he had been asked by the President to say something about the drop in transformers, that part of the drop due to magnetic leakage. Until the President sent him a note to the effect that he (the President) thought the members of this Institution would like to hear a short explanation of how the drop occurred, he thought that every member of the Institution was already aware of the reason. He had already published what he thought was a simple enough explanation, but perhaps the Paper had not been read. He had proved in a Royal Society Paper that in all calculations on transformers except one, namely, where they wanted to calculate the current supplied to an unloaded transformer, it made no difference whether they took into account hysteresis, eddy currents, and so on; the results were the same as if constant permeability were assumed. Assuming this, and no magnetic leakage or condensers or choking coils, everybody knew that the result was "the secondary current is the same as if it were produced in a circuit of resistance $R_1 (N_2/N_1) + R_2 (N_1/N_2)$ by the primary voltage V_1". Now, the simplest way of defining *magnetic leakage* was to say that a fraction of the induction due to the primary current escaped the secondary coil, and a fraction of the secondary escaped the primary. Let the sum of these fractions be called x. Evidently, then, the leakage produced the same effects as two little choking coils would do, inserted in the primary and secondary circuits. Hence R_1 and R_2 were no longer mere resistances, but contained self inductions. In fact, "the secondary current is the same as if it were produced in an imaginary circuit of resistance $R_1 (N_2/N_1) + R_2 (N_1/N_2)$, and self-induction $M x$ by the primary voltage V_1." This was quite an easy rule to remember. M was the mutual induction, or $M = N_1 N_2 \frac{a \mu 4\pi}{\lambda 10^9}$, where a = section of iron in square centimetres, μ = say, 2000, λ = average length of induction lines in iron. In a 1,500 watt Mordey transformer, $M = 3{\cdot}22$, $R_1 = 27$ ohms, $N_1 = 460$ turns, $R_2 = {\cdot}067 + \rho$, where ρ = external resistance of secondary, being 10 ohms at full load. The time-constant s of a circuit, meant its self-induction divided by its resistance, and here it is $3{\cdot}22\ x \div (2{\cdot}7 + 19{\cdot}17\ \rho)$. Its effect was to diminish the current $200\ s^2 \pi^2 f^2$ per cent. when not too large, and to produce a lag of $360\ sf$ degrees. Here f was the frequency. Evidently the drop due to leakage was proportional to the square of the load. Taking $x = {\cdot}01$, drop at full load in this Mordey is $5{\cdot}567 \times 10^{-5} f^2$ per cent., and lag was $0{\cdot}06 f$ degrees. He was only putting in other language what had been published by him two years ago. He referred to a series of experiments made by Prof. Ayrton on the increased drop with greater frequency in Mordey and Swinburne transformers, and pointed out that the effect in the Swinburne was not necessarily greater, although x was greater, because in the Swinburne M was less, and it was the term $M x$ which was important The fundamental fact was that any induction for either coil which escaped the other was exactly as if they had a little choking coil in the first.

*Mr. HAYCRAFT said there was one point of considerable interest towards the end of Dr. Fleming's Paper. Mr. Mordey had already referred to it. It was that of current rushes and rises of pressure in transformers on switching on. At the Central Institution last year they were using a Ferranti alternator, the frequency being 188 on a circuit consisting of a transformer shunted by a condenser. The secondary of the tranformer was open, and an electrostatic voltmeter was placed across it. The condenser circuit was broken accidentally. It was immediately afterwards re-made. They found that the fuses had gone. The same thing

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happened afterwards with a smaller capacity. Subsequently whilst some experiments were being made by Mr. Mather, who was transforming up from 50 to 2,000 by a Mordey transformer, and the current was being supplied at very low frequency by a Gramme machine used as an alternator, the fuses suddenly went, and the electrostatic voltmeter fell to zero. This occurred twice, and on examination they found that the brushes of the Gramme were loose. The transformer was a Mordey, excited by current drawn from two opposite points of the Gramme armature, which was running as a motor, and the Gramme field-magnets were separately excited by three or four cells. In one of the cases the voltmeter was seen, and the observer stated that the electrostatic voltmeter rose to a little above 2,000 and then fell to zero. In all their experiments they were transforming in the opposite direction to Dr. Fleming—namely, transforming *up* from 50 to 2,000 volts. He had made some further experiments with Messrs. Woodhouse, Bailey, and Clift. A set-up dynamometer was used to detect current rushes. The rushes were so violent that the movement of the pointer could be heard all over the room. He might mention that this Gramme current was not like the ordinary alternating current; at any rate, the electromotive force curve was not a sine curve. He took the ratio of the maximum of the E.M.F. to the square root of the mean square. The maximum was simply the electromotive force across the brushes, the square root of the mean square given by the Cardew voltmeter on the main; the ratio was 1·95. They next substituted a Ferranti alternator, and repeated the experiment. The frequency was 144; the low volts were made 50 on open circuit. A spark gap was adjusted to 2,270 volts; it sparked on making. In another case the gap was tested to 2,350 volts alternating without sparking, but at the 166th make a spark passed. The gap was across the secondary of the transformer. This was one of several such experiments. A set-up low-reading electrostatic voltmeter on the primary terminals showed no rise of pressure in any case. He might note that at the frequency of 144 there were practically no rushes of current except, of course, when sparks passed. Their general conclusion was that current rushes in the primary were very frequent at low frequencies; at 100 and above they could hardly detect them. Also that the effect does penetrate to the secondary, producing considerable rises of pressure.

* Mr. SPARKS said that the rush of current was first noticed, to his knowledge, in 1886, but no measurement of intensity of the rush was made until that made by Dr. Fleming in 1891. Mr. Mordey pointed out at the last meeting that the rush was most likely owing to the defect of some special type of transformer. Now the rush was most noticeable in a transformer in which the iron was worked at a high induction.

If they took the five transformers mentioned by Dr. Fleming, the induction was very high indeed. He thought Dr. Fleming's explanation of the cause of the rush was the right one. They had made since 1890 tests by the split dynamometer method; they agreed so completely with Dr. Fleming's, that there was no doubt that ordinary electrical people would see that extremely practical results could be obtained with care and selection of the instrument.

* Mr. ARTHUR WRIGHT said one valuable thing about Dr. Fleming's Paper was that it was written without much introduction of mathematics, thus showing how much could be done in alternating-current work without any reference to the self-induction coefficients or the sine curve mathematics of the old school; the introduction in their stead of permeability, and the mean induction, he believed, was all that was necessary for practical purposes. Self-induction ceased to be an understandable term when the sine curve went out. As he designed the Ferranti 1892 transformers, he was very glad to find that the measure of the watts came out very nearly as calculated. In the 20-H.P. transformer, he designed it to have 1·4 per cent. iron loss. He saw Dr. Fleming found it equal to 1·3. He believed this must be due to there being more iron put into the transformer than he designed. He thought it was rather unfortunate that Dr. Fleming should have taken the 1885 5-H.P. size. Certainly it was the worst transformer Mr. Ferranti had ever built. If Dr. Fleming had taken the 10-HP. and the 15-H.P., and made as complete tests as with the 5-H.P., he would have marvelled at Mr. Ferranti's great skill in designing in those days when nothing was known about the loss in iron. The great improvements in modern transformers were apparently entirely due to the adding of more copper. In an 1892 20-H.P. there was something like four times as much copper as one of 1885. Dr. Fleming mentioned the centre of the "Hedgehog" core having an induction of 10,000. He supposed that meant maximum induction; he should like some information on the point, for that seemed abnormally high. He also mentioned that about 30 cubic centimetres in most transformers meant one watt loss. From his (the speaker's) experience he found it generally took 120 or 110 cubic centimetres to give one watt loss. Dr. Fleming hoped that very soon they would be able to get 90 per cent. at 1-10th load; this seemed only a question of money. The way to design transformers had been known a very long time, but it was the excessive cost of the high efficiency transformer that was the difficulty; to diminish that 1½ to 1 per cent. loss would almost double the cost of the transformer. However, it seemed to him that even with the 98½ efficiency transformer there was no room inside a circle of a mile and a-quarter radius for permanently connected transformers, owing to the continual iron loss. The 20-H.P. high-efficiency transformer with its 1¼ mile feeder actually costs in up-keep £50 per annum. He thought that Dr. Fleming's Paper ought to bring the fact more prominently before engineers, that it was of little use going in for higher efficiency transformers, and that they had better study cutting them out when not required. He had been fortunate enough to supply a town on the two systems, and he knew that it took 25lb. of coal per unit sold on the high pressure system; while it now took on the low pressure system only 9lb. working in the same area, and supplying the same number of units. That must show that something ought to be done at once to improve the efficiency of the alternate current system if it had to live against the direct current competition.

BOOKS, &c., RECEIVED.

"Annual Report of the Commissioner of Patents for the year 1891." (Washington: Government Printing Office.) 800pp., 4to.

"Some Observations upon the Conductivity of a Copper Wire in various Dielectrics." By F. Sanford. (California: Palo Alto University.) 40 pp., paper covers. Price 50 cents.

"Standard Electrical Dictionary." By T. O'Conor Sloane, Ph.D. (London: Crosby Lockwood and Son.) 600 pp., demy 8vo.

"How to Manage the Dynamo." By S. R. Bottone. (London: Whittaker and Co.) Post 8vo. Price 1s.

"Electrical Experiments." By G. E. Bonney. With 144 illustrations. (London: Whittaker and Co.)

"Journal of the Institution of Electrical Engineers." Edited by F. H. Webb. Vol. XXI., No. 101. (London: E. and F. N. Spon.) Price 4s.

"Telegraphic Connections." By Charles Thom and Willis H. Jones. Illustrated. (London: E. and F. N. Spon.) 60 pp., demy 8vo.

"Transformers." By Caryl D. Haskins. Illustrated. (London: E. and F. N. Spon.) 150 pp.

"Proceedings of the Academy of Natural Sciences of Philadelphia, 1892." Part II. (Philadelphia: Academy of Natural Sciences.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 20th.

LONDON CHAMBER OF COMMERCE.

12 noon. Meeting at Botolph House, Eastcheap, to discuss the new Railway Rates, Sir A. K. Rollit, M.P., in the chair.

SOCIETY OF ARTS.

8 p.m. Howard Lecture II. "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S

OLD STUDENTS' ASSOCIATION.

8 p.m. Meeting at the Central Institution. Paper to be read: "Central Station Notes," by W. Brew and P. G. Ledger.

ROYAL INSTITUTION.

9 p.m. Evening Discourse:—"Liquid Atmospheric Air," by Prof. Dewar, F.R.S.

TUESDAY, January 24th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed:—"Gas-Power for Electric Lighting," by J. Emerson Dowson, M.Inst.C.E.

WEDNESDAY, January 25th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Fine Arts in Relation to the Sanitary Condition of our Great Cities," by Wyke Bayliss, F.S.A.

THURSDAY, January 26th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Presidential Address by W. H. Preece, F.R.S.

FRIDAY, January 27th.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "Japanese Magic Mirrors," by Prof. S. P. Thompson, F.R.S.; (2) "The Perception of Colour," by W. F. Stanley, F.G.S.; (3) "Recent Determinations of Molecular Refraction and Dispersion," by Dr. J. H. Gladstone, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Students' Meeting. Paper to be read: "The Disposal of Town Refuse by Burning, and the Application of the Heat thereby Generated," by Arthur S. Butterworth, Stud.Inst.C.E.

SOCIETY OF ARTS.

8 p.m. Howard Lecture III. "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Just Perceptible Difference," by Francis Galton, F.R.S.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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HOPKINSON'S THREE-WIRE PATENT.

The judgment which was delivered by Mr. Justice ROMER on Saturday last establishes for the present the validity of a patent for one of the most important inventions in connection with the distribution of electrical energy. We purposely refrain from calling it an important patent, for now that it is worth avoiding there is but little difficulty in avoiding, or perhaps it were better to say evading it. It may seem strange that we should contemplate the deliberate evasion of a patent which is admitted on all hands to embody in the most honest manner a deliberate and clear invention of high importance, an invention, too, of one of our foremost and most respected men. Hardly less strange was it to find in the Court an array of experts engaged in dressing up various bits of ancient history to look like anticipations. Engineers, professors, and electricians were ranged against one inventor who had been, if anything, too early in the field. Some explanation was needed to account for the quibbling about arcs and alternators by men who might well have been expected to acknowledge the patent, and to pay reasonable royalties without grudging. The explanation is not far to seek. Dr. HOPKINSON was permitted by one of those odd expedients of law to play the part of a plaintiff, and not only to sustain it throughout, but to bring with him an important array of retained counsel, the whole strength of the Chancery bar. Long ago the patent had been sold to an American company, who have established a branch in this country. With their legitimate business we have nothing to do, it being quite outside the present subject; but they bought this patent from Dr. HOPKINSON for the purpose of levying royalties. It was a perfectly simple business transaction, and we have nothing to say against it. They were not the plaintiffs, for if they had been the defendants could have secured the important counsel by their prior retainers. Thus Dr. HOPKINSON became plaintiff. The exact

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position was lucidly explained by Sir RICHARD WEBSTER in his opening speech. "The patent in question is now equitably "owned by the Westinghouse Company, but the legal estate "is still vested in Dr. HOPKINSON, and the Court of Appeal "has decided that the action should be brought in his name." This being the situation, it was not surprising that the associated supply companies should have made an effort to resist the tax. Having lost the fight it is at least satisfactory to know that the Westinghouse Company do not intend to throw London into darkness, nor do they intend to enforce the usual penalty that the apparatus used by the defendants shall be delivered up to them. All that the supply companies have to do is to disconnect the middle wires from the dynamos, and if they please to use a small battery, to take the balancing current. As a matter of fact, the two load curves of the St. James and Pall Mall Company are practically identical, and only a very few amperes pass along the middle wire to the station.

The temporary cessation of hostilities which followed immediately upon the production by Mr. J. D. F. ANDREWS of his diagram of the Sauchiehall installation was naturally considered by many to be only a prelude to the complete collapse of the action. In the end, however, the plaintiffs recovered from their surprise, produced most damaging rebutting evidence, and, as was the case with the dog which, "to gain his private ends, went mad and bit the man," it was the Sauchiehall anticipation and not Dr. HOPKINSON's patent that broke down. In spite of the manifold defects of English Patent Law and the manifest absurdity of submitting cases, which in nine instances out of ten involve but a small modicum of law and a large number of extra-legal technicalities, to the judgment of a non-technical gentleman learned in the law, it cannot be gainsaid that substantial justice has been meted out up to the present to the leading electrical patentees. On the one hand the Courts have decided that the Edison patent which contained the claim for "a high resistance filament of carbon within a receiver made entirely of glass, from which air has been exhausted" completely covered the invention of the incandescent lamp. On the other hand, the claims of GAULARD-GIBBS, BRUSH, and LANE-FOX, to have invented parallel distribution by means of alternate-current transformers, compound winding, and constant potential distribution respectively, have obtained but scant success. And the success which has now crowned Dr. HOPKINSON's endeavours to make good in the Law Courts his title to the invention of the Three-Wire System of Supply—a title which has never been seriously disputed outside their precincts—is yet another instance of our English propensity for obtaining correct results from imperfect data and by cumbersome methods.

Patent specifications are not, as a rule, remarkable for lucidity, unmeaning verbiage as well as vague claims abounding. But it is impossible to read the specification, an abstract of which we printed in our issue of November 4th, or to look at the figures illustrating the text, without a frank admission that we have here disclosed in all the plainness of every-day Anglo-Saxon the essential features of the modern three-wire system of distribution, in which arc lamps and motors and electric heaters, Mr. CROMPTON notwithstanding, are merely by the way, one in short which is intended to be used, not to run half a hundred lamps in a factory or a couple of spasmodic arcs at an exhibition, but to supply current to a number of houses connected to an extensive network of conductors. To imagine oneself "as in 1882" is a somewhat difficult feat, but no fair-minded electrical engineer who takes the trouble to perform it, is likely to deny that the idea of using three wires in the manner described by Dr. HOPKINSON was at that time both novel and useful. As Mr. Justice ROMER points out in the judgment, which will be found in another column, "it is a significant fact that Prof. SILVANUS THOMPSON (one of the defendant's witnesses) for the purpose of a lecture about this time prepared a diagram showing all the principal and newest systems or methods of lighting which were known or occurred to him, and yet it never occurred to him to suggest a system like the plaintiff's." Had the conflicting testimony of the "skilled witnesses of the greatest distinction," to which the judge alludes, succeeded in utterly confusing him, probably neither the experts nor anyone else would have been surprised. Such being the case, it would seem as if a system, which is liable to such abuse, were in some need of repair. We are constantly being told that inventors, or rather patentees, should be encouraged by all possible means, though for our own part we do not altogether see the necessity; but be that as it may, they should certainly be protected. If a little more common sense and considerably fewer legal abstrusities were present in our patent law, and the Court were invariably assisted by expert technical assessors, there would be fewer exemplifications of the so-called "glorious" uncertainty of the law, and patent cases might possibly depend rather on matters of fact that on the powers of legal athletes. As exhibitions of dialectical skill of a remarkably high order, actions for infringement are not to be surpassed, but they always leave upon the lay mind an uneasy sense that the validity of the patent in dispute is quite a subordinate item of the performance.

As an illustration of the desirability of having expert assessors on the Bench, we cannot do better than glance at the line of argument taken up by Sir HORACE DAVEY in his opening speech; a line of argument which, notwithstanding its great ingenuity, would not have availed him much in the presence of competent electricians. The opening sentences of Dr. HOPKINSON's specification state that the patentee's improvements relate principally "to maintaining the electromotive force in a system of conductors for an electric supply at a fixed potential," and that "if it be desired to maintain the potential constant at the delivery end, it is necessary to increase the potential at the supply end as the current increases." Further on we are told that the speed of the engine may conveniently be controlled "for the purpose of keeping the potential on *service main* conductors constant"; and, further on still, the use of *feeders* is alluded to. Even the improvement disclaimed—a meter—and the very title of the original patent—"Improvements in Distributing and Measuring Electricity. . . "—point the same way, namely, to a parallel house-to-house distribution. Nevertheless it was solemnly argued for the best part of two days (at how much cost per minute we should not like to say) that there was nothing in the specification which was not equally applicable to series arc lighting. The patentee, it was said, described an instrument for measuring "quantity of current." Well, what if he did? "That was the very thing that was wanted in a series system," in which it was also urged that "feeders" and "service mains" and "constant potential" were quite ordinary incidents in arc lighting. Another argument was that if people had used arc lamps *in series*, and also three-wires, then there could be no subject-matter for a patent covering a system of glow lamps arranged in parallel on *the* three-wire system. We repeat we admire the ingenuity displayed in these patent cases, but would prefer to see it transferred to other fields of activity. Moreover, Diagram J D A I, had it been given credit, would, in all probability, have been deemed indefeasible in law, although

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in the realm of common sense it does not seem to bear any distinct relation to Dr. JOHN HOPKINSON's Patent No. 3,576 of 1882, which it was intended to upset.

While congratulating Dr. HOPKINSON upon the substantial vindication of his claims to the invention of the three-wire system, we repeat it must not be forgotten that the decision which was given in Chancery Court III. on Saturday last seems to threaten the imposition of yet another burden upon the electricity supply business. So much ingenuity was, however, shown in endeavouring to prove that the three-wire system was neither novel nor useful, that it may be presumed those who have rendered themselves liable to a retrospective and prospective tax at the hands of a foreign corporation, will not be long before they succeed in reducing the one and evading the other. Engaged in a close competition with gas, hampered by the municipal purchase clause, confined within the four corners of Board of Trade regulations, the electricity supply business cannot certainly submit to further fines without a struggle.

REVIEWS.

Modern Mechanism. Edited by PARK BENJAMIN. (Macmillan & Co., London and New York.)

This volume appears to be based upon, or is supplementary to, Appleton's Cyclopedia of Applied Mechanics. It is arranged as a cyclopædia, and deals with American mechanism of the past ten years. The subject-matter, the authors' names, the spelling of the descriptions, and a title-page pasted in, show that the book is purely American. It contains articles on electric welding, by Prof. Elihu Thomson; on dynamos, electric transmission of power, and storage batteries, by Messrs. Martin and Wetzler; and on Niagara, by Prof. Unwin. Shorter articles on electrical subjects have been "prepared or supplied by" the following contributors: Electrical instruments, by Mr. Weston; electric motors, by Mr. F. J. Sprague and M. Nikola Tesla; the telegraph, by Mr. Edison; and electric light, by Mr. Hochhausen. The illustrations are numerous, and a large majority appear to have been reproduced with rather too much reduction from other publications.

The Standard Electrical Dictionary. By T. O'CONOR SLOANE. (London: Crosby Lockwood and Son, 1893.)

A first glance at the title of this book, and at the type with which it is printed, suggested that it was of American origin; So-called dictionaries, in reality miniature cyclopædias, are a common product of the United States. A second glance at the contents, however, suggested that it was an English work. Copious extracts from Prof. S. P. Thompson's work on the electromagnet, a Drake-Gorham steel-yard ammeter and a ring switch, Fleming's Daniell cell, Cockburn cut-out, Swinburne vacuum pump, and other instances of familiar articles are to be found, while the section on transformers is illustrated by the Ferranti and Hedgehog patterns alone. The spelling, too, is correct, with the exception of "armor" and "plow." Pursuing our quest, we found the imprint of Messrs. Hazell, Watson and Viney, London and Aylesbury. Our conclusion was that the book before us had been printed in England from American stereotypes.

As an electrical dictionary the work seems to be very good, and has no doubt been prepared expressly for the English market. We have on previous occasions admitted our inability to appreciate the use of such works, but this may be recommended to those who require them.

The Electrical Engineers' Pocket Book. Second Edition. By H. R KEMPE. (London: Crosby Lockwood and Co., 1892.)

We learn from the preface that nearly fifty new pages have been added to this pocket-book, and that they deal chiefly with dynamos, transformers, motors, tramcar systems, launches, &c. A trigonometrical table, giving degrees and quarter degrees, is provided. Neither the revision of the old matter nor the addition of the new paragraphs, accompanied though they be with the names of the authorities, incline us to alter the opinion expressed in our review of the first edition, namely, that Mr. Kempe might have compiled, and indeed might have written, an excellent telegraphist's note-book in about 160 pages, making a handy little book $\frac{3}{8}$in. thick. We doubt whether electrical engineers other than telegraphists, who, we believe, are included in the wider category, care to burden their pockets (if, indeed, pocket-books are thus carried) with instructions for fault-testing and lists of linesmen's tools, and whether the full-page diagrams of connections of dynamos are likely to be valued by anyone at all, unless he attempts to use a pocket-book as a text-book.

Munro and Jamieson's Pocket Book of Electrical Rules and Tables. Ninth edition. (London: Charles Griffin and Co., 1893.)

Among the additions to this pocket-book which are mentioned in the preface, we note that the authors are indebted to Mr. Glazebrook for Board of Trade instructions for preparing Clark cells and authorised values of the units, to Dr. Sumpner for notes on testing transformers, and to Mr. Swinburne for an article on coupling alternators in parallel. The rather formidable but well-intentioned list of symbols upon which Prof. Jamieson has bestowed so much care is to be found at the beginning of the book. We learn that they "have been submitted to a number of leading electricians of Great Britain, and have met with general approval and acceptance," but we fear that it is more easy to secure approval and acceptance than general use. If the tenth edition were printed on better paper and much larger type in the form of an ordinary book not smaller than foolscap octavo, it would form a most useful addition to the electrical text-books of the day; and that is saying a great deal.

Practical Physics. By W. F. BARRETT and W. BROWN. (London: Percival and Co.) Part I.

There are unfortunately in this country not a few physical laboratories in which a single demonstrator and an ever-vanishing professor are the sole sources of instruction to a numerous company of students. To such, and indeed to all physical laboratory classes, we most strongly recommend the handbook supplied by Prof. Barrett and his colleague. The want of a syllabus of instruction such as this is, we are sure, felt by both students, demonstrators, and professors. The practice resorted to in some large laboratories of supplying each student with written or printed directions for the experiment in hand has the demerit that it leaves the student in blank ignorance of the relation of that particular experiment to the ones which are to follow. But in many laboratories there is not even this amount of system, and the student is passed through a course of instruction which is far from being in logical order, or is left to devise experiments for himself. The present volume, which is the first of a series of three, deals with the measurement of the fundamental quantities—space, mass, and time—of force, and of the mechanical properties of matter in its three principal states. We should prefer to place Chapter VI., on the "Measurement of Force," before Chapter V., on the "Measurement of Fluid Pressure"; as we think this arrangement would be more logical, and on that account better understood by the student. With this small exception we know of no better course of practical instruction for an elementary physics class than is contained in this book. The subject-matter is arranged in short sections, each section dealing with some one experiment—first generally, then by numerical example; and a statement of the apparatus required precedes each section. Numerous small diagrams enhance the value of the book; and a collection of tables of physical constants is provided, in order that the student may verify the results of his own experiments. The introduction on matter and energy is exceedingly well written, though dealing with the subject more from the class room than from the laboratory point of view. The authors have repeated Maxwell's statement that the atoms of an element resemble "manufactured articles" in their perfect similarity. This conclusion, however, may turn out to be a hasty one; for, in the light of modern chemical research—such as that of Prof. Crookes, on yttria and other rare earths—it would seem highly probable that different groups of atoms of the same element may exhibit marked chemical differences

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Domestic Electric Lighting, treated from the Consumer's Point of View. By Ed. C. de Segundo. (London: Alabaster, Gatehouse, and Co.)

Contractors as well as householders are conscious of the general ignorance which prevails concerning ordinary details of electric lighting, and shilling book after shilling book is turned out for the purpose of dispelling some of the difficulties which surround the subject. It is in the interest of contrractors and supply companies that the public should have intelligent ideas about the common domestic use of electrical energy; but every handbook that we have yet seen contains a great deal too much science and too little common sense. Intelligent ideas about gas are equally necessary, but nobody cares about knowing the percentage of olefiant gas, the weight per cubic foot of the products of combustion, or the formula for the flow through pipes. There may be a distinction between the treatment of electric lighting from the consumer's point of view, and the treatment for the consumer's benefit and convenience. Whether the author has succeeded in the former, his acknowledged object, it is difficult to say; we think he, together with all others, has failed in the latter. In discussing the use of high pressures, he makes the suggestion that "the usual high pressure adopted . . . would kill any ordinary human being." This statement without proper qualification is distinctly unfair in a book which professes to deal impartially with different systems. The author very nearly arrives at a comparison between the cost of lighting by oil and by electricity, a comparison of much more importance to many householders than a comparison with gas; but his figures are hypothetical.

Among the many random suggestions which are made "from the consumer's point of view," we find the London Hydraulic Power Company's service seriously alluded to as a source of power for domestic lighting. The Davey motor is recommended, but nothing is said about the large amount of water required for condensation, nor is anything said about the smell of petroleum engines, which appear to be recommended for ordinary town houses. The author prefers wiring an old house to a new one, and asserts that "the best time to run the wires is just before the house is to be papered and decorated," rather than while the builders are still on the premises—as if it were a common practice to clear all the builders out before the decorators began their work. An "intensity" of current of 1,000 amperes per square inch is recommended, though the author finds it difficult to see why this should have been chosen. For the encouragement, if not the invention, of this and other blessings, we must look to a well-known insurance office. "Evidently the size of the conductor should be so proportioned," says the author, "that a given per cent. drop in the furthest lamp is not exceeded." What possible use to the unhappy consumer is this ridiculous "given per cent."? If this book is not to give him the information, what *does* it pretend to give? Advice about the use of primary batteries, perhaps—we wish him joy of them. Mr. Segundo could write a much better book than this if he were to try.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

BY PROF. W. CAWTHORNE UNWIN, F.R.S.

In opening the course of lectures, Prof. Unwin stated that he thought there was an advantage rather than a disadvantage in some one not particularly conversant with electricity being chosen to deliver such a series. There was a tendency now-a-days to give too much prominence to electricity, which still, however, relied in the end on boilers and engines. This undue prominence obscured the fact that there were other valuable methods of distributing power. The striking scientific success of the Frankfort-Lauffen experiment had somewhat obscured the fact that it was not intended to be examined from a financial point of view, the horse-power hour so delivered at Frankfort costing five times more than it did if generated on the spot in the ordinary way. Long-distance transmission was, indeed, not likely to be frequently useful.

* Abstract of "Howard" Lecture I.; delivered before the Society of Arts, January 13th

The origin of power-generating stations was that it paid in the long run in some cases to generate it centrally, and distribute it to individual consumers. A further reason for the establishment of central stations arose in this way: for good or for evil, population tended to gather into huge communities, in which the complex arrangement of social and industrial life led to a constantly increasing need of mechanical power for transit, for handling goods, for sanitation, and for various small industries. At first this need was met by the erection of scattered and independent motors, but this sporadic method of providing power was eminently uneconomical; especially was this the case where small motors were used, and where the work done was of an intermittent character. Then arose the question whether, by generating energy in an easily transportable form, the huge waste which went on could not be prevented. The problem was whether the economy due to concentrating the means of generating energy would pay the cost of the distributing arrangements. It was thought that just as in great towns it had become necessary to supersede private water supply with an abundant and common supply, and just as it had been found convenient to provide by municipal action for a general system of drainage, so it would probably be found convenient, and even necessary, to provide towns of a certain importance with some means of obtaining mechanical power in any desired quantity, and at a price proportional to the quantity of power used. This provided a wide field for the exercise of mechanical engineering talent, and led to many interesting developments. For the single purpose of working machinery it was found economical and remunerative, in spite of the enormous expense of laying mains in London streets, to carry out a system of supplying energy by means of sixty miles of hydraulic mains. Down to 1883 there was no system of distributing mechanical power of any kind. In 1888 there were 96 consumers taking power from the London Hydraulic Company's mains; four years later, in December of 1892, there were 1,676 consumers, and the quantity of power used had increased from a very small figure to six million gallons daily, and in no instance had the use of the power been abandoned in favour of any other system of working. A casual observer would not regard Geneva, with its 50,000 inhabitants, as the most likely centre for a great system of power distribution; yet at Geneva was the largest example of the development of power at a central station, and its sale as a merchantable commodity which had hitherto been executed. In 1871 Col. Turrettini applied to the Municipal Council for permission to place on the town mains a small pressure engine for driving the factory of the Geneva Society for the manufacture of philosophical instruments. In the event of finding that this method of working the factory succeeded, he asked the right to instal small motors in other parts of the town. Nine years later, in the year 1880, there were 111 water-motors supplied from the town mains, which were low-pressure mains, using 34 millions of cubic feet of water annually, and paying to the municipality a rental of £2,000 a year. The cost of the water was not low; it was charged at from 30 to 40 centimes per horse-power hour, or at the rate of from £46 to £48 per year. But even the high price did not prevent the use of power so easily obtainable. Since then a high-pressure system of distribution had been established, and power was now supplied more cheaply. The cost was about 0·7 of a penny per horse-power hour, or about £8 per horse-power per annum. In 1889 the annual income from water sold to factories on the low-pressure system was £2,085, and on the high-pressure system £4,500. The receipts on the high-pressure system were increasing at the rate of £850 a year. He would say a word or two on sources of mechanical energy. Wind power was used for driving ships and mills, but the intermittence of wind restricted its use to peculiar conditions. Tidal action might undoubtedly afford an enormous amount of mechanical energy; but at present the cost of embankments and machinery rendered its employment prohibitive from an economical point of view. Considered practically, there were only three sources of mechanical energy—the muscular energy of animals, the action of gravity on water falling from a higher to a lower level, and the heat derived from the combustion of fuel. By far the most important source of mechanical power was the consumption of solid fuel, chiefly in the various forms of coal. Coal was readily transportable, but the use of it was attended with certain inconveniences. Solid fuel must be burnt in an open furnace; that involved that from 20 per cent. to 30 per cent. of the heat produced by the combustion of the fuel was wasted in the chimney. Then the only easily practicable way of getting mechanical energy from solid fuel was by using steam power. Now, there was a fundamental disadvantage in transforming heat into mechanical energy by means of a steam-engine, in the fact that only about three-tenths of the original energy could by any possibility be turned into work. Next, the attendance required with an open furnace, and the difficulty of preventing smoke and of getting rid of ashes, were further disadvantages. Then there was gaseous fuel, and internal-fired gas-engines worked with a much greater temperature range than steam-engines. They had already given a thermal efficiency, as

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heat machines, double that of steam-engines of large size and good type, and the efficiency of a gas-engine in transforming heat into mechanical work was enormously superior to that of a small motive-power steam-engine. On the other hand, lighting gas was more expensive than a good calorific gas. The price at which ordinary lighting gas was sold was increased by two things: first, the need of an excessively large plant to meet the excessive fluctuations in the demand for light; and secondly, by the large distributing charges, necessitated in consequence of the enormous number of small consumers. But he thought there were other gases of low illuminating power which might be produced and distributed at considerably less than half the price of London gas, and in that case, used in a gas-engine, it would compete in cost with the use of ordinary solid fuel. Sir William Siemens strongly advocated the use of cheap gas as a motive-power, and lately Mr. Thwaite had proposed a plan for employing a gas of from 10 to 12 candle luminosity through the mains of the Compressed Air Company at Birmingham. It had been shown by measurement that a gas-engine would give an effective horse-power at a total cost, including all charges, not greater than the effective horse-power derived from steam-engines. There were 2,500 gas-engines in work in London, and it was difficult to predict whether they were going to any great extent to replace steam-engines. They possessed certain disadvantages, as they were much more restricted in size than steam-engines, and worked less economically at light loads.

Prof. Forbes had called special attention to the obtaining of energy from town or ashbin refuse. Besides the sewerage which a town had to get rid of, there were large quantities of refuse which could only be got rid of by burning; the burning of refuse had been found to be less costly than any other method of disposal. Here was a fuel that cost nothing, excepting in the machinery for utilising it. Various kinds of destructors had been used, and in most of them a large quantity of the products of combustion passed away at a high temperature and carried off a considerable quantity of heat in a form in which a great part of it might be easily utilised. If any use could be found for the energy so produced, a large deduction might be made in the cost of refuse disposal. An interesting Paper upon this subject was read last September at the meeting of the British Association by Mr. Watson, who stated that with the furnace heated to a temperature of about 2,000deg. there was disengaged something like 3,550 thermal units per pound of refuse consumed. This was about 24 per cent. of the evaporative power of good coal. Taking a destructor burning six tons a day, or 560lb. an hour, they would get, utilising the heat by generating steam, 1,113lb. per hour in ordinary conditions of steam working. That was equivalent to over 50 H.P., an amount of power which was quite important enough to be valuable. It appeared that the destructors were now worked with a steam jet. From another experiment made, also by Mr. Watson, it was found that this steam jet used about 250lb. of steam per cell. In practice the results were not always so good as in some of the experiments, but Mr. Watson in one case at Leeds actually obtained 15 H.P. per cell of the destructors, and had the boiler been more efficient this would probably have run up to 22 H.P. per cell of the destructor. He (the lecturer) had no doubt that what really could be done was something between the calculated value of 33 H.P. and the real value of 22 H.P. But the chief difficulty in using power from destructors was that, while they must be worked day and night at a constant rate, the demand for power was of a fluctuating character. It was because he had at a later stage to direct their attention to a means of absorbing heat that he had given a rather detailed statement of the heat value of destructors.

Coming now to steam power used in central stations, and the competition of central stations with the use of steam power outside, he wanted first of all to make one point clear, the chief secondary cause of loss or waste of heat. In motors worked by steam, with the range of temperature available, a steam-engine might, on thermo-dynamic principles, turn into dynamical work a proportion of three-eighths, while a gas-engine might turn into work half the energy supplied by the fuel. The principal cause of waste was essentially the same in both cases, the enclosure of the working fluid in a conductor of metallic walls. The loss due to this increased with the ratio of the admission surface in cylinder to the weight of steam used. In the steam-engine, therefore, the waste due to initial condensation must increase for light loads, because more surface was exposed per pound of steam used. The evil could be diminished, but not entirely overcome by the use of steam jackets; but it is always a cause tending to make engines which are too large for their work or too lightly loaded very uneconomical. In gas-engines it is necessary, in order to prevent the destruction of the cylinder, to cool it by a water jacket. Mr. A. Witz has shown that it is due to the cooling action of the cylinder wall that part of the gas is kept below the temperature of combustion. The cylinder wall, therefore, diminishes the efficiency of the engine by preventing the full development of the gas pressure at the beginning of the stroke, and by directly abstracting heat before the stroke is complete, as in steam-engines. The evil is greater the greater the area exposed to the gas at the moment of explosion, and this is why initial compression of the expansive gas in the gas-engine is necessary to good efficiency. The gas is reduced by pressure to a smaller volume, and is exposed to a small area of cylinder wall.

One curious method of economising heat in steam-engines had been proposed in connection with central-station work at Dresden. They proposed there to generate the principal part of their power by steam-engines; but they proposed to have gas-engines also—the gas-engines being used especially during times when the load was very light—during the night, and so on. They proposed to use the exhaust from the gas-engines to superheat the steam going to the steam-engines. In that way they would get a very convenient method of obtaining superheated steam, or steam at a higher temperature than saturated steam. He had no doubt, so far as economy goes, that would work very well.

Sir Frederick Bramwell clearly indicated in 1885 that where little power was required, a steam-engine was costly for the work it did, and that where a great amount of work was required intermittently, both the engines and boilers had to work under unfavourable conditions. On the wall the lecturer had placed a table of very careful calculations of experiments on the consumption of steam and of fuel in steam-engines of very various types. It would be seen that at full load they were able to get an indicated horse power with an expenditure of 1½lb. for a condensing engine, and 1¾lb. for a non-condensing engine. It was much more difficult to get the consumption of coal by engines in ordinary daily work. What was known showed that the ordinary consumption was greater than the consumption on special experimental trials. He had found that comparatively large pumping engines of the London Hydraulic Supply Company, which worked with a fairly steady load, and which should work with 2lb. of coal per hour, used 2·7lb. on a trial of many weeks.

Where they considered electric lighting stations, where engines had to do work which fluctuated very greatly, they got results far more unfavourable. Mr. Crompton had been good enough to give figures for the Kensington station, which had excellent Willans non-condensing engines, consuming under 2lb. of coal per effective horse-power hour. These engines were in 1886 using 7½lb. per effective horse-power hour, and in 1891 3·8lb. He believed in the lowest figure mentioned they had got to about as great an economy as they were likely to get at present. These results were not isolated. Probably in very few cases were electric lighting stations working at 3½lb. per horse-power hour; in some cases the consumption was double that. In the case of small, isolated motors, far worse results than that were obtained. He had a table showing the consumption of engines in Birmingham of from 4 H.P. to 24 H.P., and these were using from 8½lb. to 36lb. per horse-power hour. It was largely with such uneconomical small engines that central stations would have to compete in supplying power; it was due to the extravagant cost of these small engines that central stations could supply power, pay the cost of distribution, and have a margin of profit.

About the cost of ordinary large electric lighting stations something more need be said. The fuel consumption in such electric lighting stations was so excessive that some very competent engineers, who forgot that their opinions were based entirely on full load trials, were disposed to throw doubt on it. He believed, however, that the figures showing a very large consumption of fuel in central electric lighting stations were quite accurate, and to a great extent they might be fully explained. First, he would call attention to the conditions under which, probably, any central power station would have to work. He had placed on the wall a number of load curves showing the amount of power used at every hour of the day. First of all, were two curves for two different dates at the Kensington Court electric light station; then there were two curves for the London Hydraulic Power Company's station; and also three curves for the Gas Light and Coke Company's supply of gas. It must be remembered that the Gas Light and Coke Company were really a central station company supplying a kind of power, and the consumption of gas varied in the way shown in the curves. A line was shown for a very fine day in 1890, another for a foggy day in 1890, and a third for a fine day in 1891. A curve, the abcissæ of which represented time, and the ordinates the rate of supply of energy, was called a load curve. These were drawn commonly for 24 hours. Apart from seasonal fluctuations of demand, the day was the natural period in the work of the central station. A load curve might be drawn for a single machine, or a single steam-engine, or for the amount of energy taken at the moment by all machines, lamps, &c., in operation in a station. The influence of fluctuation in the demand for work, on the economy of work, had long been noted and allowed for; but it was due to Mr. Crompton to say that the use of the load curve in discriminating between different stations was first indicated by him. Mr. Willans, at the

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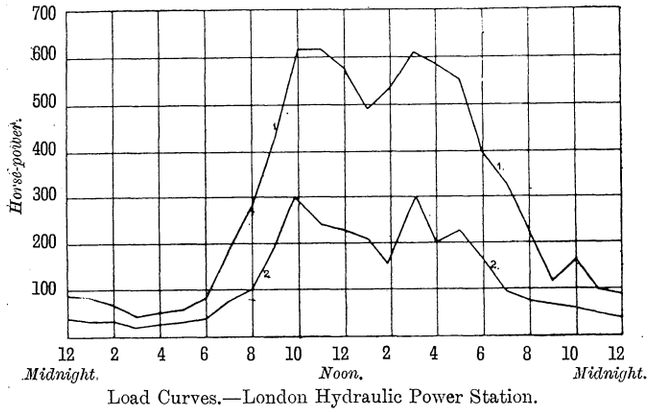
same time, showed how to determine exactly in certain cases, and approximately in all ordinary cases, the effect on economy of the fluctuation in the demand for energy due to one part, at all events, of an electric lighting station plant, namely, the steam-engine. He would point out that in the curves for the Hydraulic Power Company's station they had a tolerably steady day load; that was to say, they had a very large load, extending from something like nine o'clock in the morning to about seven in the evening. In obtaining the load factor they took the ratio of the area of one of those curves to the rectangle enclosing it, the rectangle expressing the work that would have been done if all the engines had been at work during the day. The



Load Curves.—London Hydraulic Power Station.

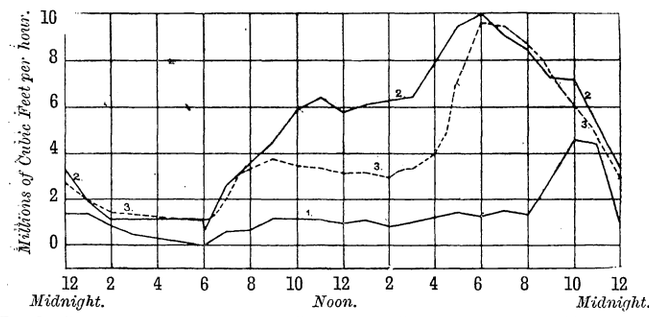
1887 Curve (2). Diagram Factor = ·41 for the Day.
1890 Curve (1). Diagram Factor = ·46 for the Day.

Diagram Factors for a Maximum Output taken at 650 H.P.—

$$1887 = \frac{125}{650} = \cdot 19. \qquad 1890 = \frac{306}{650} = \cdot 47.$$

rectangle came out in one case as 0·17, and 0·146 in 1891. In the other case the load factor was 0·19 in November and 0·3 in December.

Let them now consider the character of the work which had to be done at a central station, work which varied enormously in intensity during the twenty-four hours; and let them see how that affected the economy of production of power by steam-engines. First, he would call their attention to a point which he thought had been a little too much overlooked. Steam engineers had generally been content to reckon steam and fuel consumption on the indicated horse-power of their engines, and not on the effective or brake horse-power. That was due to the difficulty of determining the mechanical efficiency of engines in most cases. As the



Load Curves.—Gas Light and Coke Co. Curve 1.—June, 1890, Fine. Curve 2, Dec. 1890, Fog. Curve 3, Jan. 1891, Fine.

Diagram Factors for Maximum of 10,000,000.—1...·13. 2...·52. 3...·40.

friction of the mechanism of engines was comparatively small in full-load trials, it had been tacitly assumed or allowed that this was a quantity of no great importance, and that it did not very much matter whether they reckoned the work done in indicated or in effective horse-power. Now, the electrical engineer, having very exact means of determining effective power applied to his dynamos, had very naturally and rightly reckoned his steam-engines much more by their effective horse-power than by their indicated horse-power; and the first explanation of the high fuel consumption of engines working at very varying load was that the average mechanical efficiency was lower, he thought, than had been commonly supposed. The mechanical efficiency of engines at full load was probably 0·8 to 0·85 for small engines, and might reach at least 0·9 for large engines. It was otherwise, however, when working with a diminishing load. A good many experiments made lately showed that the engine friction varied but little with the load. Mr. Willans had told him that he found his friction quite independent of the load. Now, if at full load an engine worked at 100 indicated horse-power and 85 effective horse-power, with an indicated horse-power of 50, the effective horse-power would be 35 and the efficiency only 0·7, whilst, with an indicated horse-power of 25, the effective horse-power would be only 10, and the efficiency only 0·4.

Now, to deal with another point, the influence of mode of regulation of the engines on steam consumption. In the discussion on Mr. Crompton's Paper, Mr. Willans gave a very beautiful and simple rule, which, in the case of engines running at constant speed and regulated by varying the initial pressure, gave the amount of steam used for different loads. Mr. Willans' experiments were made on a special type of engine, and did not directly throw light on steam consumption in other types of engines. Unfortunately, Mr. Willans' later experiments had not yet been published. Prof. Cotterill had been able to calculate for one large class of engine the amount of condensation that went on in the cylinder under different conditions of working. This was the case of a simple engine which had not been jacketed. He (the lecturer) had used Prof. Cotterill's calculation of the condensation to determine the steam consumption in a series of engines working from full load to light loads, and regulated in different ways. The steam consumption was very much less when the engine was regulated by varying the expansion than when it was regulated by varying the boiler pressure. Obviously, from both those considerations, from both the influence of the mechanical friction and the influence of the back pressure, the efficiency of the engine diminished when it was worked at light loads.

The consumption of fuel in central lighting stations was not to be explained by any action in the engines. Where, then, was it that this large consumption arose? It arose nearly altogether from the irregular working of the boilers, and by far the worst part of the want of good economy obtaining in central station lighting was due to the waste of heat in continually heating up the boilers and letting them cool down again. The waste created by working against a fluctuating load was a necessary and inevitable waste if they had no means of storage. The very great fluctuation of demand for current in electric lighting stations, and the enormous waste which that fluctuation caused in the working of the steam boilers and engines had compelled electrical engineers more than any other users of power to seek after means of storing energy. The gas engineer, who, like the electrical engineer, distributed power from central stations, had to meet a demand almost as variable; but he was happy in the position of having gasholders capable of storing a large quantity, sufficient usually to meet the demand for 24 hours of a good working day, and he was able to work his gas-making plant at an almost uniform rate. If they took the consumption of gas to be 25 cubic feet per horse-power hour, then the cost of gas-holders was 5s. 6d. per horse-power hour stored. The cost of gas-holder storage, reckoned on the rate of supply, not on the capacity of the gasholders, was £6 per horse-power. This made the charge for a horse-power supplied continuously through the year about 10s. What was required for electric lighting was a system of storage which would cover any possible fluctuation of supply as well as the fluctuations if gas supply were met. The electrical station engineer would be very glad to have something equivalent to the gasholder, and for a time it was thought that that something had been found in the secondary battery. But the secondary battery was limited to continuous-current systems working with comparatively low potentials, and it had two serious defects compared with gasholders. One was that the rate of discharge was limited, whilst that of the gasholder was unlimited; the other was that while the gasholder gave back all the gas it took, the battery gave back only about four-fifths of the elec rical energy it took. The most that had been done had been to use batteries capable of storing one-tenth, or in small stations one-fifth of the daily supply of energy. It might be conceded that a small battery of that kind did virtually to some extent improve the load line, and at any rate enabled the station to be worked with greater comfort, but shutting down for 24 hours was not consistent with the most economical working of the engines and boilers, and that was one of the worst faults of a variable and unpredictable demand. From data given him by Prof. Ayrton as to the yield of Epstein cells, he (the lecturer) found that with those same storage battery cells, without allowance for building, acid, or erection, the lowest cost was about £8 per horse-power hour stored, as against 5s. 6d. in the case of the gasholder, and £20 per horse-power supplied, as against £6 for gasholders.

Secondary batteries being clearly a failure as electrical substitutes for the gas-holder, was there any other means of storage available? A short time since it would have been necessary to concede that there were no other means of storage of energy suitable to the requirements of central lighting stations which would not involve an even greater cost than the secondary battery.

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Mr. Druitt Halpin had worked out a method which he (Prof. Unwin) believed would play an important part in the future economics of the subject. The form in which energy was obtained in a central station was heat. Was it possible to directly store the heat? In a properly constructed holder for storing heat, with reservoirs packed together and presenting little external surface, the loss of heat might be made very small indeed. Heat to be stored must be given to some material body. Nothing could answer the purpose better than storage by heating water under pressure. Reduce the pressure and steam was generated instantly and in absolutely determinable amount, and explosively fast if reduced suddenly. The supply was given from the heated reservoir precisely as from the secondary battery, but without the same limits of rate of supply which occurred in the discharge from the secondary battery. The steam, if it were used in steam-engines, would give the supply of mechanical power which was wanted. Mr. Halpin's general idea, therefore, was this :—The heat, in the place of being used at once, was communicated to a quantity of water in boilers, and the heated water was stored until the heat was wanted. If the temperature of the water were high enough, they could get the energy back, as it was wanted, in the form of the energy of steam, and this they could get in the quantity in which, and exactly when, it was required. So much for the general idea. Now let them examine the matter quantitatively. Mr. Halpin proposed that the heat reservoirs should be under a boiler pressure of 250lb. absolute pressure per square inch when fully charged, corresponding to 265lb. atmospheric pressure. The temperature of the water would be 406deg. He proposes that his steam-engines should be worked with steam at 130lb. pressure, corresponding to a temperature of 347deg. Whenever the temperature in the heat storage reservoirs was above 347deg., they would supply steam to the engines automatically at any rate required ; 14¼lb. of heated water in the storage reservoirs would give 1lb. of steam. Suppose, to allow for radiation and steam losses, they took it that 16lb. of heated water in the storage reservoir was required to give 1lb. of steam at 130lb. pressure. A simple cylindrical reservoir, 8ft. in diameter and 30ft. long, an ordinary-sized boiler, would contain 84,000lb. of heated water. Such a reservoir of water once heated up to 406deg. would deliver 5,250lb., or 2½ tons, of steam at 130lb. pressure. The steam consumption for electrical work in good engines might be taken at 18lb. per horse-power hour in condensing, and 25lb. in non-condensing engines ; hence, one of Mr. Halpin's reservoirs would store heat enough to supply 286 effective horse-power hours for work with a condensing engine, and it would supply 210 effective horse-power hours if worked with a non-condensing engine. So much for the thermo-dynamic quantities. At present there appeared to be nothing to hinder the use of heat storage in that way. They required a boiler of no alarming size to store a quite considerable amount of thermal energy. Now, to look at the financial side of the question, one of Mr. Halpin's reservoirs, erected with appendages and with ample allowance for building, would cost on estimates he had no reason to doubt £470 ; consequently, the cost of storage, reckoned on the energy stored, would be for an effective horse-power hour £1·64, if the plant was a condensing one, as it ought to be, or £2·24 if it was a non-condensing plant. It had already been seen that the cost of gasometer storagewas 5s. 6d., and that of battery storage £8 per horse-power hour. Therefore, whilst Mr. Halpin's method cost a good deal more than gasholders, it was considerably cheaper than secondary battery storage.

LEGAL INTELLIGENCE.

Hopkinson v. St. James' and Pall Mall Electric Light Company (Limited).

On Saturday morning last Mr. JUSTICE ROMER delivered his judgment in the above action. A full report of the proceedings will be found in *The Electrician* for November 4th, 11th, and 25th, and December 2nd.

JUDGMENT.

The only point for decision in this case is whether the plaintiff's patent is valid, for if valid, infringement is not denied. The decision on this point depends upon certain questions, not of law, but of electrical science, in my opinion more suitable for the consideration of an expert in that science than of a legal tribunal. I have, however, been assisted by the evidence of skilled witnesses of the greatest distinction, and though, unfortunately, as generally happens in patent cases, the experts on the two sides do not agree, I have been enabled to come to a conclusion with regard to the objections taken to the patent, and that conclusion is that the objections fail and that the patent is valid.

In dealing with the objections I will first consider those taken to the second claim in the patent, being the claim which relates to the invention now known as the three-wire system, and which is the invention used by he defendants, and in respect of which relief is sought in this action. On this part of the case it is of the utmost importance to determine what, according to the true construction of the specification, is the invention claimed by the patentee. And to understand the specification, which is a document of necessity addressed to and framed for the consideration of the small circle of persons acquainted with the difficult subject to which it refers, the following facts should be borne in mind. At the date of the patent there were two known systems of distributing electricity for the purpose of electric lighting, to which the patent was practically directed. I am aware that, theoretically, and in its terms, the patent was not confined to the purposes of lighting, but extended to any purpose requiring the consumption of electricity in a system where the electricity is supplied at a fixed potential ; but I am satisfied that this extension is of no practical importance for the purposes of my judgment, when it is remembered that consumers of electricity generally (such as motors) can only be used with the plaintiff's invention when the electricity is supplied at a fixed potential, and I shall, accordingly, hereafter only refer specifically to lighting, though it must be understood that I intend in my subsequent observations to include the more extended purpose of the patent; and, where relevant and proper, the necessary extensions of phrase to cover such extended purposes must be taken as intended, though for the sake of brevity and clearness, I may speak only of electric lighting. The two systems I have referred to are in the evidence before me, and may properly be spoken of shortly as the parallel and the series systems. These two systems differ in principle. In the parallel system of lighting, which chiefly concerns incandescent lamps (though arc lamps may be used, but with difficulty, and not so usefully), the supply of electricity is at a fixed potential with varying current. The system derives its name from the parallel wires, which tap the main service conductor, along which the electricity flows from the dynamos, and join the other main service conductor, down which the electricity flows back to the dynamos. On these parallels the lamps are hung, and the current varies as more or less of these parallels are used for the purpose of lighting the lamps on them. In the series system, used chiefly for arc lights, the lamps are hung in series along the main conductor, and the supply of electricity is at a fixed current, while the potential varies as more or less lamps are burnt.

The first question that arises in the case before me is, whether the invention I am now considering was by the specification intended, and shown to extend to both systems, or to be restricted to the parallel system. For reasons, which I will hereafter give when examining the specification in detail, I am satisfied that the claim was confined to the parallel system. And I may now shortly state what the invention was. Before the date of the patent the parallel system was not only well known but had been much improved from its first stage, which has been called the simple parallel. In the simple parallel there was no connection between the parallels except by the main conductors, and the consequence was that, if one lighted lamp on any parallel had to be turned off, all the lamps on that parallel had also to be turned off. The improvement on this was called the compound or multiple parallel, and consisted in placing a wire, which joined the middle points of the parallels, so that on each parallel there occurred a lamp or lamps on each side of this intermediate wire. By this arrangement the lamp or lamps on one side of any parallel might be turned off, and yet leave the lamp or lamps on the other side of that parallel still burning. But even this compound parallel system had a great defect, arising from the fact that the turning off of lamps from one side only of the middle wire had the effect of increasing the brightness of the lamps remaining burning on that side and diminishing the brightness of the lamps burning on the other side. So that in practice, in a system of electric lighting, lamps kept varying in brightness from time to time as other lamps on the system were turned off or on, and this fluctuation of the lamps was a considerable drawback to the use of the system, especially in private houses. The patentee discovered the means of remedying this by a contrivance as simple as it was useful. He joined the intermediate wire to the wire connecting the two dynamos working in series, and the thing was done. For it was found (speaking shortly and not with scientific accuracy) that the difference between the electricity used on the two sides of the middle wire which caused the difference of brightness under the old compound parallel system, passed away down the central wire to the dynamos under the inventor's system, and ceased to exist as a disturbing element in the intensity of the burning lamps, and thus the brightness of the two sides was kept equalised and steady. The system so perfected, and which, as I have said, is now generally spoken of as the three-wire system, was of great practical utility, and, in lighting on a large scale, permitted the main copper conductors to be comparatively small without risk of bursting lamps, thus effecting a considerable saving in copper (which was, for practical work a great desideratum), and also a saving in the expenditure of electrical energy. The advantages of the discovery, of course, increased as more parallels and lamps were used, and were of considerable practical importance only in the case where several lamps and parallels were used, and became minimised when only two parallels were worked.

I will now examine the specification in detail in order to see that the contention on the part of the plaintiff is established, that the claim in the patent is confined to the parallel system. Now it is true that throughout the patentee does not use the term "parallel" to define the system he is dealing with. I believe this to be because he preferred to use the more appropriate scientific terms to describe the system rather than the popular term. But, in my opinion, when the specification is read with care and fairness, and well understood, it is clear that the patentee is thereby confining his claim to the parallel system. He shows throughout that he is dealing only with a system in which the potential is to be kept constant at the places where the electricity is to be supplied, and in which the current varies as more electricity is required to be used on the different wires that tap the main conductor—that is to say ; that he is dealing only with the parallel system, for on the balance of evidence it is clear that the characteristics I have named denote the parallel system and only that system. At the commencement of the specification (page 3 of the print, lines 7 to 10), where he refers in general terms to his inventions, he shows that the

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system he is dealing with is one where the electro-motive force is supplied at a fixed potential. Now that is a phrase well-known to electricians (see *inter alia* evidence of Defendants Witness, Mr. Swinburne, 7th day, pages 35 and 36.) Moreover, I think that the words "such conductors" at line 9 mean "conductors for an electric supply at a fixed potential." It is possible, however, that the words may mean merely "conductors for an electric supply," and I therefore pass on, only observing that the sentences immediately following (and in particular the phrases at lines 12 to 17 and 24 to 25), appear to me to support the view I have taken as to the meaning of the words "such conductors" in line 9. Then at lines 9 and 10 and 31 to 38, the patentee describes what his invention is and its special advantages substantially, as previously pointed out by me in this judgment. At lines 9 and 31 he shows that one of the advantages is economizing the cost of the main conductors, and I may add that the very expression "main conductors" implies branch conductors which do not really exist except on the parallel system. At lines 9 to 10 he shows that this can be done "consistently with efficiency and safety," that is, as I understand it, with efficiency so as not to disturb the brilliancy of the lights, and with safety because, on this system, there was no risk of bursting the lamps by over pressure on any particular lamp. Then at lines 35 to 38 he shows that the object and effect of his third wire is to bring back to the dynamos the excess of electricity required for the lamps on the one side of the central wire, over that required for the lamps on the other side. I may now pass on to page 5, line 32, where the patentee proceeds to describe in detail the particular invention I am now considering, merely remarking, in passing, the observations at page 4, lines 44 to 53, as clearly referring to the parallel system. Now the detailed description at page 5, lines 32 to 48, when fairly read, in my opinion, shows clearly that the patentee was referring to the parallel system only—many of the expressions used as well as figure 5 being inapplicable to the series system. Then when I come to the second claim at page 7, lines 17 to 21, being his claim in respect of the invention I am now considering, I find it clearly made with reference to his detailed description at page 5, lines 32 to 48, and to Fig. 5, which, as I have before said, in my opinion, refer to the parallel system only. Moreover, in a question of this kind, depending, as it does, on what meaning electricians would attach to the technical phrases used in, and the wording of, the specification, I am entitled to take into consideration the views of the experts called as witnesses before me. With regard to this I need only say that, in my judgment, on the balance of the evidence, which is to some extent conflicting, it establishes that the specification, to an electrician, would show that the parallel system only is the one referred to by the patentee. But, indeed, on this point there is not so much so difference as might be expected, as the defendants' experts generally admit that the patentee was thinking of the parallel system, though they are not agreed with the plaintiff's experts, that he has with sufficient clearness in his specification confined his claim to that system. And some of the statements made by the defendants' experts are very significant as supporting the plaintiffs' case; as, for instance, Mr. Swinburne, seventh day, at pages 24, 25, 37, and 38.

Having come to the above conclusion as to the meaning of the specification, I now proceed to consider the objections to the claim. The utility of the invention cannot be disputed; but it is said for the defendants, first, that the invention has been anticipated; and, failing this, secondly, that having regard to the state of knowledge at the date of the patent, there was no sufficient merit, discovery, or novelty in the invention to sustain or form the proper subject of a patent. As to the first objection there are in substance three alleged anticipations relied on by the defendants—namely, those which may be shortly referred to as the Sauchiehall, the Alexandra Palace, and the Inchicore installations. A few others were referred to in the evidence, such as the installation on the steamship "City of Berlin," but these did not substantially differ from the Alexandra Palace and Inchicore cases, and need not be separately considered by me. Now, if the defendants' case as to Sauchiehall had not broken down, an anticipation would have been established. But on the whole evidence as to this, I am satisfied that there was no anticipation, and that the installation at Sauchiehall was not the plaintiff's three-wire system at all, but at most merely a case of the ordinary multiple parallel when the middle wire is not connected with the dynamos. There were two witnesses for the defendants (Andrews and Town), whose testimony, if it could have been accepted, would have established that the third wire was connected with the dynamos. Sir Horace Davey, in his summing up, referred also to a witness McKillop, but in justice to that witness I am bound to say that taking his evidence as a whole, he did not purport to say from his own knowledge that the third wire was connected with the dynamos.(See in particular his cross-examination, sixth day, at bottom of page 132). Now, as to Andrews and Town, I am sorry to be obliged to say that I cannot give credit to their testimony on the point. This Sauchiehall case broke down, and may be dismissed from further consideration. Then, as to the Alexandra Palace case that was, in my opinion, no anticipation. The following are the conclusions I came to from the evidence before me taken as a whole. This Alexandra Palace installation was not a case of the parallel system at all. It was really a mere case of two arc lamps in series with a common return between them, to the dynamos. When both lamps were burning they were burnt in series on one main conductor, and the whole electric current went along the main conductor through the two lamps, and for all practical purposes no electricity passed down the return or central wire. When one lamp only was burnt, the central wire (which was as thick as the main conductor) operated as part of the main conductor, and the electric current went along this one conductor only, through the lamp, back to the dynamos. There was no tapping, and certainly there were no parallels. There was no saving of copper in the way and of the kind effected by the plaintiff's invention. The third wire was, as I have already said, in fact, of the same thickness of copper as the main conductor, and such saving of copper as was effected was only such as is always obtained when a common return is used; that is to say, that instead of having four main conductors to burn two arc lamps separately, you have three only because of the common return. The central wire cannot be said fairly to carry away excess of electricity between lamps on one side and lamps on the other within the meaning and spirit of the plaintiff's invention and specification. For all substantial purposes the central wire either took back the whole current or none. The practical advantages of the plaintiff's invention were not, or were certainly not all, obtained in this installation. And I think it is not a fair objection to the novelty of a process which is intended to be, and which is, of great use, when applied to a system comprising many things, to say that the case of one has not been expressly excluded by the inventor, and that as the application of the process to the case of the one, so far as it could be applied to the one, was known, therefore the process has been anticipated, though the utility of the invention practically disappears when the case of the one is considered. If such an objection were allowed there could never be a valid patent for many important discoveries, as for instance many discoveries in connection with multiple telegraphy.

Then, as to the Inchicore case. That in principle is not distinguishable from, and does not go beyond, the Alexandra Palace case. The only difference is that instead of one lamp on each side of the central wire there were several lamps. But the lamps were in series—the same number on each side—and as before, either all the lamps were burnt in series on a main conductor, in which case substantially no current passed down the central wire, or one set of lamps was burnt in series, in which case the central wire became part of the main conductor, and substantially all the current flowed down it. In this case, as in the Alexandra Palace case, one of the essentials of the plaintiff's system was absent, namely, the joining of the middle points of bridges or parallels to one another. All the remarks I have made with regard to the Alexandra Palace case, in fact, apply to this, and I need not repeat them. It follows that the alleged anticipations fail.

Then, as to the second point, that there was no real invention made by the patentee. The case is put most strongly for the defendants in the following way. It is said that, taking the Inchicore case, you could easily turn the series lighting into parallel, and that to do this required no invention, and that if this were done you had the plaintiff's invention. It is also said that taking the known compound parallel system it required no invention merely to connect the third wire with the dynamos, especially as this had been done in the common return, and in the Alexandra Palace and Inchicore cases. But I think these views fallacious. No doubt now that the thing is done it is very easy to understand, and becomes obvious to all. But I do not think that it was obvious until discovered, or that it could be arrived at without thought and experiment. An electrician who knew all that had been done up to the date of this patent, and who set himself down to try and cure the known defects of the existing compound parallel system, would by no means, as of course, have hit upon the plaintiff's invention. In particular I think that it would probably never have occurred to him to regard the Alexandra Palace and Inchicore installations, which were series systems, as being likely to lead to a solution of the problem, or to try the effect of turning the Inchicore series lamps into lamps on parallel. Certainly in my opinion he could not have come to the conclusion that such an attempt would result in success without investigation and experiment, especially when it is borne in mind that the Alexandra Palace and Inchicore lamps would not have burnt in parallel. And a convincing proof that the plaintiff's discovery was not obvious lies in the fact that there were skilled electricians who at this time knew of the series and parallel systems, and some of whom had about this time to put up installations on the parallel system in which it would have been of great advantage to use the plaintiff's invention, and yet it never occurred to any of these electricians to use it, and the invention remained undiscovered by them. Take, for example, the case of defendant's witness, Mr. Crompton (5th day, page 16), who put up the Alexandra Palace installation, and of Mr. Siemens', who put up the Inchicore installation. The fact is that electricians, knowing the compound parallel system, and having the Alexandra Palace and Inchicore installations before them, were on the verge of making the plaintiff's discovery, and yet, though they were all eagerly searching for novelties and improvements, they never made it, And it is a significant fact that Prof. Silvanus Thompson (one of the defendant's witnesses) for the purposes of a lecture about this time prepared a diagram showing all the principal and newest systems or methods of lighting which were known or occurred to him, and yet it never occurred to him to suggest a system like the plaintiff's. (See Exhibit, S.P.T. 1). For these reasons I think the second objection fails, and I have thus dealt with the principal objections to the patent. But there are one or two minor points taken on behalf of the defendants with which I must now shortly deal.

It is said that the plaintiff's specification is insufficient, inasmuch as the patentee says his system is applicable to the case of alternate currents, and the defendants allege that to work dynamos in series in alternating currents they must be rigidly coupled, and that a workman is not told by the specification to rigidly couple the dynamos, and would not know that he ought to do so. Now on this point there is considerable conflict of evidence, but on the whole I am satisfied that the objection is not substantiated. I think that any workman of ordinary skill who would be employed to put up the dynamos to be used according to plaintiff's specification would know that the dynamos to be worked in series with alternating currents must keep time, and that the ordinary method of effecting this would be rigidly coupling the dynamos. The fact is that for many years prior to the patent the dynamos had been rigidly coupled in practice, and at the date of the patent it was a somewhat novel discovery, that as an exception to the general rule rigid coupling might be dispensed with when the dynamos were not in series. I need only add that a portion of Lord Kelvin's evidence on this point (third day, at page 23), relied upon by defendants' counsel, has, I think, been misunderstood. I think Lord Kelvin was there considering the case of an ordinary workman with n experience or knowledge as to dynamos. I do not think he meant to sug-

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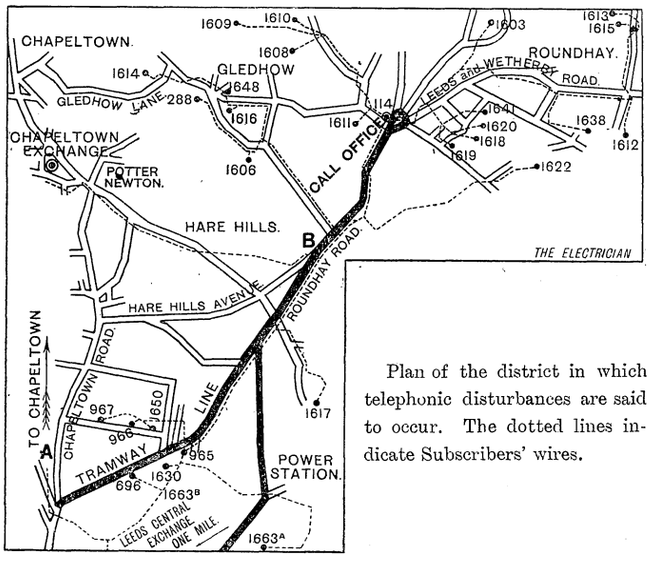
gest that a workman of ordinary skill—such a man as would naturally be employed in putting up dynamos—would have experienced any doubt or difficulty in putting up the dynamos so as to make them work efficiently in series with alternating currents. But if he did, then I think on the balance of evidence, as a whole, that he was mistaken in this part of his testimony.

The above substantially exhausts all the objections taken to the plaintiff's invention that is the subject of this action. But the defendants say the plaintiff's first claim—which concerns what I may call the potential measuring machine—is bad, and so the plaintiff's patent must altogether fail, even though the second claim by itself would be good. But the defendants have failed to satisfy me that the first claim is bad. In the first place, they say that the invention claimed is not useful. On the balance of the evidence before me I am satisfied that it is a useful invention, and can be used to advantage, though owing to a variety of circumstances it may not have been used commercially in its simple form as described in the patent up to the present time. The defendants' only other objection to this first claim is based on the allegation that the machine will not work as a practical machine with alternating currents owing to locally induced currents thereby caused. On the balance of the evidence before me I am satisfied that it will work. I think, moreover, the specimen of this machine made for the plaintiff was fairly made according to the specification, and that specimen certainly worked well. No doubt if you are perversely ungenerous enough to sit down and see how you can make a machine which, though normally in accordance with the plaintiff's invention, yet will not work, you may succeed. The model produced by defendants shows this, but that model I do not regard as fairly made in accordance with the plaintiff's invention and specification.

Having now dealt with all the objections against the plaintiff's patent urged before me, and shown that in my judgment they fail, I grant to the plaintiff the usual relief sought by him against the defendants as infringers, with costs.

The National Telephone Company (Limited) and Another v. Graff Baker.

The hearing of this action was resumed on Thursday last week before Mr. Justice Kekewich. Counsel for the Plaintiffs: Sir Richard Webster, Q.C., M.P.; Mr. C. M. Warmington, Q.C., M.P.; Mr. J. Fletcher Moulton, Q.C.; Mr. Nath. Micklem, and Mr. R. W. Wallace (instructed by Messrs. Waterhouse, Winterbotham and Harrison). Counsel for the Defendant: The Solicitor-General (Sir John Rigby, Q.C., M.P.); Mr. W. R. Bousfield, Q.C., M.P.; and Mr. Alfred Dunham (instructed by Mr. Clarance Leighton). Mr. E. Morton Daniel (instructed by Mr. F. W. Kite) held a watching brief on behalf of the Thomson-Houston International Electrical Light Company.



Plan of the district in which telephonic disturbances are said to occur. The dotted lines indicate Subscribers' wires.

The report of the Referee (Mr. Edmund Macrory, Q.C.) was read by Sir Richard Webster. The Referee stated that in accordance with the instructions of Mr. Justice Kekewich he, in company with Mr. Henry H. Cunynghame (barrister-at-law), Mr. W. H. Winterbotham (solicitor), and Mr. Swinburne, made a number of experiments on the 6th and 7th inst. at Leeds. The experiments were made both while the tramcars were running and when they were at rest. During the experiments there was a coating of snow over part of the line, which it was suggested might increase the disturbance on the telephone wires. The experiments were made at twenty-one out of the twenty-four cases of alleged disturbance mentioned in the plaintiffs' particulars. Most of these experiments were duplicated, *i.e.*, were made when the tramcars were running, and repeated when the tramcars had stopped. In the first experiments Mr. Cunynghame and Mr. Macrory, with Mr. Winterbotham and Mr. Swinburne, Mr. Leighton and Mr. Dalzell (the plaintiffs' manager at Leeds), were together at the Leeds Exchange, and telephoned to the attendant at the Roundhay call office (No. 114 on map, which we reproduce from *The Electrician* of December 23rd), and also to Sir James Kitson (No. 288). The noise of the tramcars interfered very much with hearing what was replied, and evidently interfered with the respondents hearing messages. The noise occasioned by the running of the tramcars was easy to recognise. It was a whirring sound like that made by a card when held against the teeth of a rapidly rotating cog-wheel. Sometimes it was uniform like the rushing of water from a tap, sometimes it assumed a musical note rising and falling like the sighing of the wind among the trees. It was sometimes for a short time quite silent. After having tested from the Leeds Exchange, tests were made from Chapel Town Exchange, and also from the Roundhay call office. The disturbance was such as to interfere with the hearing messages when the tramcars were running. A test was made from the telephone at Dr. Jessop's, Roundhay Mount (No. 1,603). Here, after communicating with Mr. Cunynghame at Chapel Town Exchange, and thoroughly testing the effect of the tramcars upon the telephones, both when they were running, and when they were stopped, the telephone was put through to the office of the plantiffs, Oxford-court, London, the course of the wire being from Dr. Jessop's to Chapel Town Exchange (from Roundhay call office to B on map along the defendant's line), thence to Leeds Exchange, thence through Manchester to London. This experiment was first made at 12 o'clock on Saturday, 7th inst. Mr. Winterbotham's voice was recognised in Oxford-court by Mr. Sinclair, and Mr. Sinclair's voice was recognised by Mr. Winterbotham, neither of those gentlemen being otherwise aware of the presence of the other at the respective ends of the wire. Mr. Swinburne afterwards held a long conversation on scientific matters with Mr. Sinclair. This took place while the tramcars were stopped, and Mr. Macrory listened to the conversation through a telephone-receiver switched in for the purpose. The same experiment was repeated after the tramcars recommenced running, and while the tramcar was in motion it was impossible to hear conversation, but in the intervals of stoppage the voice came out quite clearly, again becoming inaudible as the tramcar began to run. A similar experiment was made in conversing through to Blackburn, and with similar results. In conclusion, Mr. Macrory stated that his experiments enabled him to form a decided and accurate judgment, and that in his opinion the plaintiffs' telephonic system was seriously interfered with by the works of the defendant, the disturbance, in some cases being so great as to render speech entirely unintelligible. In other cases speech was to some extent audible, but an effort on the part of the listener was required to distinguish the words transmitted, and there could not be a doubt but that the effect produced by the working of the defendant's tramcars and line was such as greatly to interfere with the efficiency of the telephone by creating noise, which in all cases impaired, and in some cases entirely destroyed, the power of transmitting speech.

Mr. EDMUND MACRORY, Q.C., examined by Mr. BOUSFIELD, stated with reference to the snow that Mr. Leighton called his attention to it, and said, "I should like you to make a note in your report that there was snow on the line at the time." Mr. Leighton said, it might increase or diminish the disturbance, suggesting that it broke the contact between the wheel and the line of the tramway through which the return was made. He certainly did see coruscations of light from the make and break that was going on when the tramcar started. On the Friday there was practically no snow. On the Saturday there were several inches. The attendants of the line brushed the snow off. There was not much difference in the disturbance on the Friday and on the Saturday.

Mr. JAMES SWINBURNE, recalled, and cross-examined by Sir RICHARD WEBSTER, with reference to his previous statement that the working of the cars caused no substantial interference with the commercial utility of the telephone system, adhered to that opinion. Both on Friday and especially on Saturday last, he should certainly admit that the disturbance was very serious. He suggested the snow as an abnormal cause. Witness admitted that he had not superintended personally the installation of any tramway. The difficulty with the double overhead wire at junctions was not a question of reversal of polarity in the motor. It was a question of having a positive lead and a negative lead together, and arranging so that the trolley on the positive lead could follow its course, and the trolley on the negative lead could follow its course, without bringing the two positive and negative leads into electrical connection, and without breaking the circuit to the motor. He certainly thought that there was a difficulty in carrying the trolley over a break of two feet. Witness was then cross-examined at considerable length, as to the proper width of slot in the case of an underground conduit system of traction.

Re-examined by Mr. BOUSFIELD, witness stated that the telephone speaking itself both on Friday and Saturday, seemed much smaller in sound, except when one particular transmitter (Hunning's) was used. Then the sound at witness's end was so loud that though Mr. Macrory had a telephone at his ear and several of the other observers had telephones at their ears, witness, who had no receiver at all, could hear what was said. The effect of the snow on the contacts would be to make them bad. The difficulties he had mentioned applied to the conduit system with two conductors in it.

M. BRUNO ABDANK ABAKANOWICZ, examined by Mr. BOUSFIELD, said that he was a consulting engineer residing at St. Maur, near Paris. On May 9, 1892, he went to Leeds to inspect the defendants' tramway with Mr. Swinburne, and made certain experiments with the view of ascertaining the nature and cause of the disturbances in the telephones. The result of the experiments was that conduction played a small part in it. The disturbance caused by the cars would always be a disagreeable noise, but one could carry on conversation generally. The necessary alterations in the plaintiffs' system, in order practically to remove the disturbance would be very small ones; doubling several of the subscribers' wires, putting in a few transformers. The method of doubling back the wires and earthing them near the Exchange, if adopted in Leeds, would practically abolish electro-magnetic induction, Having regard to the length of the routes in Leeds, electrostatic effects would be of no importance. It was practical to work an exchange partly with metallic circuits and transformers, and partly without metallic circuits. It was an ordinary practice in tele-

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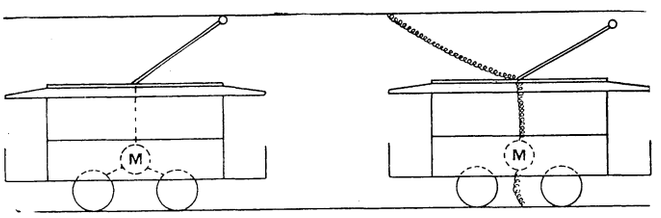
phonic work. Witness then described an experiment made to prove that the noise on the telephone lines did not come from contact between the trolley and the overhead wire, and between the wheels of the car and the rails. (*See* diagram B. A. A. 3). He compared the noises in the telephone when the car was running without the trolley and wheel connection, with the noises there had been when the car was running with the trolley, and he could not find the slightest difference. He considered telephones upon single wire system with earth return unsatisfactory instruments. The single wire traction system was almost universal in America. Witness was then examined on the Vevey double overhead slotted tube line, which he thought could not practically be applied in Leeds for the purpose of electric traction, for the reason that the road there was so complicated. He tested the telephones at Vevey with the result that although the inductive effects were almost *nil*, the leakage was sometimes considerable, and the telephone people had been obliged to double the lines going from Montreux to Vevey. He had been to Buda-Pesth, and seen the system applied there. He did not observe any crossing of any complexity. The width of the streets at Buda-Pesth where the tramway ran was unusually great. He did not think the Buda-Pesth system applicable to Leeds.



I. II.

Diagram B.A.A. 3.—I. shews the car with the ordinary contact, the current being received through the trolley arm and discharged through the wheels. II. shews the trolley arm disconnected, and the wheels disconnected from the motor, the connection in this instance being made by means of two flexible conductors—one between the trolley wire and the positive pole of the motor, and the other between the negative pole of the motor and the rails.

After cross-examination by Mr. MOULTON, and re-examination by Mr. BOUSFIELD, Witness withdrew.

Mr. STEPHEN SELLON, examined by Mr. BOUSFIELD, said he had given a great deal of attention to tramway traction. He had carefully examined the Leeds tramways. Prior to the contract between the defendants and the corporation he was employed to negotiate with the Board of Trade with reference to the system which should be adopted. He fully explained to them that was proposed. In his opinion the Leeds tramways had been carried out in a very first-class manner, both in construction and equipment. He could confirm Mr. Abdank's evidence with regard to the experiment with reference to the effect of contact between wheels and rails, and between trolley and wire. He had visited Buda-Pesth and Northfleet. There were no complex crossings in the Buda-Pesth system. Witness was then examined on a model (S. S. 2) intended to illustrate an application of the conduit system to Boar Lane, Leeds.

Mr. BOUSFIELD: Do you yourself think that the conduit system at Buda-Pesth is one which is practically applicable to the requirements of Leeds?—If you could eliminate a great many difficulties which appear, to my view of thinking, at Buda-Pesth, it might be applicable, but, to my mind, a good many of them are not easily eliminated, and I do not see how they would be at the present moment.

WITNESS was then examined in detail as to the possibility of working on the Buda-Pesth system, but with a ¾-inch slot instead of a 1-inch slot. In his opinion the result of reducing the dimensions of the slot would materially increase the friction, and would tend to wear away the collector much quicker. He did not think the Northfleet system presented a way out of the difficulty. He had always looked upon the application of the series system at Northfleet as a failure of mechanical working. It failed while he was there each time. The failure was due to the spring-jacks being knocked down by the plough and the contact disabled. The Blackpool system was one of two conductors of the same polarity, the return being by the rail. It would affect the telephones of the neighbourhood. As to the Birmingham battery cars, up to now they had not been a commercial success, the cause being the deterioration of the battery. He had visited the installation, and knew most of the officials in connection with it, and he had also got the report of the Birmingham Central Tramway Company.

Mr. JUSTICE KEKEWICH: We want to know what you yourself have seen, not what somebody has reported.

WITNESS: What I have, in my opinion, to prove the point, is the Directors' Report.

Mr. JUSTICE KEKEWICH: I do not want the Directors' Report; for aught I know (I do not want to suggest that it is so), it may be a cooked up report in order to declare a false dividend. What do I know of it?

Mr. BOUSFIELD: My friend's plan of Buda-Pesth may be cooked up perhaps, but we have not suggested such a thing. One could not conduct a case if one objected to such things.

Mr. JUSTICE KEKEWICH: You certainly could not conduct a case if you put in Directors' Reports as accepted statements of facts.

Mr. BOUSFIELD: I will not press the matter after your Lordship's expression of opinion.

WITNESS, in continuation, stated that he knew for a fact that they had been using E. C. C. cells in Birmingham; they had now discarded them, and were trying Epstein cells.

Cross-examined by Sir R. WEBSTER, Witness said it was very possible that when asked questions in 1890, as engineer to the Wellingborough Tramroad Bill, he protested against answering electrical questions on the ground that he was not an electrical engineer. He made his plan of Buda-Pesth in August, 1892. He made it for the purpose of his own information as to what the electrical tramway at Buda-Pesth was. He did not make it for the purpose of showing electrical connections. It was probably necessary that there should be certain junctions to get the trams on to the lines at all. In Blackpool, his idea as to the success of the reduction of the slot was that it was due entirely to the fact that they were able to have two conductors, one on each side of the conduit. If they had not had two conductors he thought they would have had great difficulty in even getting an electrical connection. As a general tramway engineer he had been consulted about the Thomson-Houston system. There was an interference with the telephone at Leeds, but not in such a way as to put a stop to conversation.

Re-examined by Mr. BOUSFIELD, Witness said he was not an electrician, but he did not think it involved much acquaintance with electrical principles to understand how the cars were driven by a current of electricity supplied by a dynamo to wires outside, but he should not like to be cross-examined on electro-static induction.

Mr. ROBERT WINTHROP BLACKWELL, examined by Mr. BOUSFIELD, stated that he was engaged in business in London as an electrical engineer. He had been General Manager and President of the Bentley Knight Electrical Railway in New York. In 1883 he had constructed a short trial line of 200 yards in length in Cleveland, Ohio, on the series conduit system. In 1885 he built in Providence a short test line with double conductors in an iron conduit. In 1886 he constructed a line at Woonsocket, about two miles in length, using two double overhead conductors. It might fairly be said that the only practical commercial system that remained to-day was the single overhead conductor system. He should regard the working of any complication on anything but a single trolley wire system as hopelessly impossible, commercially; that was to say, it would be accompanied by so many troubles that the switches could not be maintained with anything like satisfaction to the public, the keeping of the conduits clean and properly drained out was an extreme difficulty; for instance, in an enormous conduit of three or four miles, he had to keep a man for each length of a mile merely cleaning out. The width of slot in America which used to be used was ⅜ to ⅞; that was the usual slot to begin with, but it invariably reached an inch, and at places where curves occurred they took as much more as they could get without being interfered with by the powers. Of course, the slots used in the old days were arranged so that they could be widened at will. In Boston a waggon wheel was caught in the slot and the team ran away. He had to buy the team and waggon. In all the conduit lines he had spoken about it was necessary to have special police to keep the boys off; and for at least a month or so after the opening of each line it was a constant struggle to keep it in operation at all, solely on account of interference by the boys He worked for, practically, a year or a year and a-half, on the question of getting a switch which could be used for double overhead conductors, and having failed, eventually took up all switches on the line, and gave up their construction, so than whenever two cars met, the drivers of the cars exchanged trolleys, rather than turn the cars. That was a most clumsy contrivance, involving stoppage of both cars, but they found the switch to be useless. The Vevey system was utterly impossible for Leeds.

Cross-examined by Sir RICHARD WEBSTER, Witness stated that he was retained in the interest of electric traction by certain firms in England who were constructing under his advice. The Thomson-Houston Company was an antagonist of his and practically drove him to the wall in 1890. He never examined the Leeds system, with an eye to the present suit. Taking the Leeds tramway as it existed, he did not suggest there was any difficulty whatever in establishing it on the double overhead wire system, though he should not be willing to estimate the added expense. If they submited to any expense, there was also no difficulty whatever in working the Leeds line on the conduit system.

Mr. CLARANCE FRANK LEIGHTON, examined by Mr. BOUSFIELD, stated that he went to Stockholm and investigated the telephone system. There were two exchanges. There was the Government Exchange and the Exchange of the Almanar Company, with between 8,000 and 9,000 subscribers. The wires all ran to a central tower. They were in course of changing from earth-returns to metallic returns. When he was there they had changed rather more than 2,000 of the earth-returns to metallic returns. He went outside the Exchange and examined the method of stringing the wires upon the poles in different parts; they crossed the metallic circuit wires once in every five poles. He spoke on the telephone to various subscribers. The Government Exhange was entirely metallic. It had about 1,200 subscribers. The Government insisted on the Almanar Company changing their wires to metallic circuits. As things were, partly with earth returns, and the Government Exchange having metallic returns, the subscribers intercommunicated. The metallic return was taken to earth at the Exchange.

Mr. MOULTON: I do not want to ask anything.

Mr. JUSTICE KEKEWICH: How many more witnesses have you?

Mr. BOUSFIELD: I have Prof. Forbes and Prof. Silvanus Thompson.

The Court adjourned.

FRIDAY, JANUARY 13TH.

On the hearing of the case being resumed, Mr. BOUSFIELD stated that Prof. Forbes was ill, and would not be able to attend and give evidence.

Mr. JOHN SERJEANT WISE, examined by Mr. BOUSFIELD, said he was an American lawyer, and had made a special study of the question

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of disturbances between telephones and tramways. Witness lived in Richmond, Virginia, where a disturbance arose between the telephone and the electrical railway. The matter was entirely set right by the adoption of the Maclure or "trunk return" system of telephony. Witness gave evidence as to growth of the metallic circuit system of telephony in the States, and as to American electric street railways. The Madison Avenue cars, on the Julian system, ran by his door every day. They came out generally with a storage battery, and went back with a mule. To-day the twelve cars of that system were "banked," and for sale. There was no doubt of the fact that up to the present time, according to the intelligence and experience of American electricians and engineers and tramway men, the single trolley was the only system that had been developed as a success commercially and mechanically and electrically.

Prof. SILVANUS PHILLIPS THOMPSON, examined by Mr. BOUSFIELD, stated that he had had experience of the plaintiffs' telephone system in London. At the time when he was a subscriber, the disturbances were so great that he ceased to be a subscriber. He could never make himself heard. It was simply useless to him. He had talked more recently over a London Exchange from various points in London, and the communication to-day was certainly better than it was He had long held that the only rational way to lay out any telephone system in any town or city, not to speak of scattered districts, was to give every subscriber a metallic circuit back to the exchange.

Sir RICHARD WEBSTER : You have been demonstrator and lecturer, and have had very considerable electrical experience now for a great many years, and have written books on the subject, and endeavoured to teach people, as much as you could, what you yourself knew ?—Yes.

You have been, I must not say a disciple, because you are perhaps more entitled to be priest, you are another apostle who has advocated the return wire ?—Consistently, for a great many years, I have advocated the use of the return wire for telephonic purposes.

People are very deaf still ?—Some people are.

And I am afraid the majority ?—Oh, no ; the majority are very fast converting their lines.

Witness was then cross-examined at length as to the efficacy or otherwise of doubling telephone wires past disturbing circuits ; the relative strengths of telegraph, electric light, and electric traction currents ; the use of condensers and transformers on telephone circuits.

Mr. OSCAR TERRY CROSBY, examined by Mr. DUNHAM, said that he resided at Boston (U.S.A.), and was vice-president of the American Institute of Electrical Engineers, and had been an officer in the Engineer Corps of the United States Army. He was now the general manager of the railway and power transmission departments of the General Electric Company. It had been the fate of the double-trolley installations to be supplanted by the single-trolley system. The double-trolley system had ceased to be used because it was more difficult to instal originally, on account of the greater number of parts that had to be used, and because it was found exceedingly unreliable in its daily operation.

Mr. JOHN CHARLES CHALMERS, examined by Mr. BOUSFIELD, said that he happened to read Lord Kelvin's evidence about the electric lighting of the tunnel trains near Glasgow, and the consequent telephone disturbance. He had had to do with the four telephones affect d by that particular disturbance. He doubled the wires back for a considerable distance, and earthed them some distance from the line of electric disturbance. It was almost a perfect cure.

Cross-examined by Sir RICHARD WEBSTER, Witness stated that he had not read Mr. Sinclair's evidence in this matter nor that of Mr. Dalzell. They were all private wires, and did not go to the exchange at all.

This concluded the case for the defendants.

Mr. JUSTICE KEKEWICH said that, broadly speaking, there were three questions before the Court : first, whether the telephonic system of the plaintiffs was to any material extent disturbed by the operations of the defendants ; secondly, whether the plaintiffs could themselves, by adopting a system different reduce it to a negligible quantity ; and, thirdly, whether, assuming that there was a disturbance, the defendants were relieved from the ordinary obligation of British subjects of so conducting their operations as not to interfere with their neighbours. As regards the first, he was satisfied, from the evidence, and particularly from Mr. Macrory's report, that there was a material disturbance. As regards the second question, he had yet to be persuaded that it arose at all. If his view were correct, the result was that the body of evidence adduced by the defendants, to show that the plaintiffs by adopting an entirely new system might avoid interference, was no answer to their claim. The third question was a momentous one, and to his mind had been all along and still was, the only real question in the case, namely, whether the defendants were entitled to do that which they were doing, admitting for the purpose of argument that it was a serious interference with the plaintiff company's works.

The SOLICITOR-GENERAL, in reviewing the evidence, said the case was one of nuisance, not depending, so far as the plaintiffs were concerned, upon statute law at all. They came forward to claim a common law right. What was a common law right ? It was a right to be protected from a nuisance. What was a nuisance ? A nuisance was an interference with an easement, or an interference with real property, but involving the possession of that property. The mention of the dates would satisfy his Lordship that there could be no easement. Telephonic communication was not known in England, at any rate, 20 years ago ; there could not be anything in the nature therefore of immemorial usage, there could be nothing in the nature of an enjoyment which would by prescription give rights against any person at all. They had had cases in which attempts were made to have, for instance, the current of air to a windmill, to have the current of air to drying grounds, to have the right to water, not flowing in a defined channel, to have all these things protected on the ground of ancient user, or of user throughout a sufficient length of time. The only negative easement in any way dealt with by the Prescription Act was the negative easement of light, which, founded originally on the idea of Grant, now had a statutory foundation, and became an indisputable right after the lapse of 20 years' user. What was there in the present case in the nature of interference with any right of property other than an easement ? What was there in the way of interference with the rights of real property, or any property possessed by the plaintiffs, or any of them that could come under the definition of a legal nuisance ? Let them consider the case of two adjoining landlords, owners in fee, who possessed large estates, on one of which it was begun to carry on the business of sending messages by telephone without any right derived from statute to do this, but doing it simply in the capacity of landowner, and side by side, the owner of the other estate, equally without in any way invoking Parliamentary authority, desired to use his land by running for his own purposes a tramway upon it. He submitted to his Lordship that in such a case the fact that the one owner, the plaintiff, had established on his own land a system of telephonic communication would not in the slightest degree interfere with the right of the neighbouring owner to establish on his land a system of electric traction, although it might materially and substantially interfere. A man was not to be treated as the owner of property in the sense that there could be allowed no kind of interference with it. Over and over again it had been laid down that he must only claim to use his property in one of the ways known to the Common Law. If that were so, the case was really at an end. Unquestionably from the time when Leeds had been a town, and from all the ages before that under which the earth was subject to the same physical conditions, there had been electrical disturbances propagated from one piece of land to another in a way that even yet was not understood. There was no right of property in these electrical phenomena. Perhaps of all others the closest analogy was that of underground water. The earth was a reservoir of underground water, and a man had a perfect right to sink a well upon his own land and to draw to himself by that means not only the water which originally at the time of sinking the well was upon his own property or came there in the natural course of things without his assistance, but to draw from neighbouring properties whatever water they had, provided only that was done by simply getting into his well the water that percolated through in a natural way. So far as they knew, the earth might be treated as a common reservoir of electricity. With regard to this Telephonic Company, assuming them to be the owners of every inch of land over which their wires went, upon which their poles stood, what right did they get by the expenditure of money on their installation to interfere with the operations of a neighbouring landowner ? The case of the well appeared to him to be for this purpose exactly parallel. When did the exclusive right arise ? Was it the first man who spent the money who controlled the other ? If so, the right of the Telephone Company was perfect before ever they transmitted in the way of commerce a single message. Was that in accordance with the Common Law idea ? It was only when they came to instruments of great delicacy that anyone could tell that there was interference. But could it be said that the use of a delicate instrument on one's land was in any way to interfere with the *primâ facie* rights of a defendant on his land ? It was now established that to a great extent nuisance must be determined by the surroundings, that was to say, that one could not have in a business quarter where there were factories, making a noise with steam hammers, and so on, the same degree of quiet or the same enjoyment of property as one would have in a country place. What did that involve ? It involved that the question of nuisance was to be tried more or less on the balance of what was reasonable and fair. But the plaintiffs in the case had a very different position from that of the landowner that he had imagined hitherto as plaintiff exercising the fee simple over the property. It had not been attempted to be made out, nor could it, of course, be that the Leeds system of telephones was in any one instance carried out from end to end with any wire on the property of the plaintiffs. They carried, not because they had any right to do it, but because no one had interfered with them, not because they had any Parliamentary right or any right by way of grant, to carry their wires from their Exchange to different parts of Leeds. Therefore, they were in a totally different position from plaintiffs who had the fee simple of all the land intervening between the Exchange and a subscriber's house. They made use of property which was not theirs at all, simply because no one had interfered with them. A right of that kind was a right in the sense that no one objected—there was no harm done—but how could it be the basis for an action of nuisance ? In the actual case sensitive feelers, such as never existed until the last twenty years, were set up, which placed the Telephone Company in a novel relation to all owners of land in the neighbourhood. There were numerous cases that had been decided in America, which, in so far as they depended upon the same principles as English Common Law, might be illustrative and useful. But what made those cases of less importance was, that the plaintiffs, though they were uniformly defeated, yet came forward in a totally different and in a much more advantageous position than the plaintiffs in the present case. In America it was always a conflict between two charterers. So far as he knew, the case now before his Lordship was the first case in which any telephone company had set up such a claim as was here set up at Common Law. Never had it been suggested before, so far as he knew, that at Common Law a claim like this could be supported. His Lordship knew well that here there was nothing but the Common Law remedy. There was no charter, no statutory power, all that existed was that the Postmaster-General, as representing the Crown, had a monopoly of telegraphic communication. Telephonic communication was telegraphic communication, and it would be an infringement of the Postmaster-General's monopoly, if the business of telephonic communication were carried on without his license. In the present case they had his license which preserved them from attack on the part of the Crown, but it gave no authority as against anyone else. They were simply trade adventurers, carrying on a business in so far as they were permitted to do so, but without any shadow of legislative authority at all. He had heard it said that in the Observatory at Greenwich the Astronomer-Royal was interfered

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with in some of his nice observations and experiments by persons exercising the ordinary rights of property at a considerable distance from him. Had it ever been thought that by reason of the delicacy of the instruments, even by reason of their national importance, or on any ground at all, there was any right to restrain them in the ordinary use of property which did not amount under ordinary circumstances to a nuisance? The learned counsel then dealt at length with previous judgments in analogous cases (*Reinhardt* v. *Mentasti*, 44, Chancery Division, page 685; *Bamford* v. *Turnley*, *Gaunt* v. *Fynney*, *Robinson* v. *Kilvert*, 41, Chancery Division, page 88.) With regard to the sending of ordinary telegraphic messages, the interference with that would not have been a nuisance; therefore, properly the Postmaster-General had got inserted into the Provisional Orders a condition that his clients should not interfere with him. Then they did not interfere with him. They had had one of the principal officers of the Post Office in the box. It was only because this business of the telephone was a hundred or a thousand times more delicate than even the delicate operation of telegraphy that any question arose upon it. The learned counsel then proceeded to quote from judgments in the United States Courts bearing on the case (*Railway Company* v. *Telegraph Association*, Ohio *State Reports*, Vol. 48, page 390).

The Court then adjourned.

TUESDAY, JANUARY 17TH.

On the hearing of the case being resumed, Mr. BOUSFIELD stated that the Solicitor-General was unable to resume his argument. Mr. Bousfield then continued the argument adducing further judgments bearing on the action. After Sir Richard Webster, Mr. JUSTICE KEKEWICH announced that he would give judgment as soon as his other duties permitted.

A full report of the proceedings will appear in our next issue.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December* 30, 1892.

The Underground Rapid Transit Franchise.—The Rapid Transit Franchise was offered for sale at the New York City Hall yesterday noon. A number of city officials, together with prominent street railway men, were present, and great interest was manifested in the result of the sale. When the secretary of the Rapid Transit Commission asked for bids there was no response for some little time, when finally Mr. W. Noland Amory, of New York City, offered $500 for the franchise and one-half of 1 per cent. per annum on the gross receipts, which he estimated at $50,000 per year. No other bids were received, but Mr. Amory made a second bid of $1,000, and paid the commissioners a $100 deposit on that amount. If his bid was accepted he was prepared, he stated, to deposit $1,000,000 in five days, but he would not name his backers. The Rapid Transit Commissioners took these bids into consideration, but promptly passed a resolution refusing to accept them, on the ground that they were not advantageous to the public and the City of New York. The Commissioners were greatly disappointed that no other bids were received, and it is generally considered that the underground system which has been so carefully worked out by them, will not be constructed. The Commissioners now will probably be compelled to devise some rapid-transit scheme by means of elevated structures, which will not involve so large an outlay of capital, and will prove a more profitable investment.

Electric Traction in New York.—The Board of Aldermen has granted the Union Railway Company a franchise to extend its lines south of the Harlem River, and to use the trolley system. This will be the first trolley road in New York City south of the Harlem River, and the granting of the franchise has caused considerable comment, as public opinion seems to be against the introduction of this system into the city, and most of the large dailies take every occasion to denounce the trolley in the strongest possible terms.

The West End Street Railway.—The large new car stables of the West End Street Railway at Everett, Mass., were destroyed by fire on the night of December 24th, resulting in the death of four *employés* and a loss which is estimated at $135,000. The fire, according to the testimony of the engineer in the boiler room, was caused by a sudden back draught as he threw the furnace doors open. The flames spread quickly, and the men in the building had barely time to escape; a few of them rushed back in order to save some of the property, but four of them were killed in consequence of the act. The building was of wood 80ft. wide, 283ft. long, and 38ft. in height, and had been constructed for the purpose of storing electric cars.

The Milwaukee Street Railway Company.—The plant of this Company was destroyed by fire on the morning of December 28th, and the loss is estimated at over $500,000. A bomb was thrown into the main building causing a tremendous explosion, and in a few minutes the structure was in flames. In the car shed there were fifty new electric cars, and nearly all of the summer cars owned by the Company. The machine shops were built during the past season, and fitted with the finest machinery. Every effort is being made to capture the incendiary, and a large reward is offered. This is one of a series of fires which began on October 29th, and which has now resulted in a loss of nearly $2,000,000 worth of property.

The Edison Lamp Litigation.—The general counsel for the Edison Electric Light Company filed a Bill in the United States Circuit Court last week asking for an injunction to restrain the Westinghouse Electrical and Manufacturing Company from manufacturing and selling incandescent lamps that infringed the Edison patents. The Bill alleged that since the injunction granted by the United States Circuit Court of Appeals the manufacture of these lamps had merely been transferred from the shops of the Company restrained to those of the Westinghouse Company. The Court granted an injunction with provisions similar to those which had already been granted by the Court of Appeals.

NEW YORK, *Jan.* 7, 1893.

The Westinghouse Lamp.—The new Westinghouse lamp has not yet materialised. As your readers have been kept informed regarding the expectations of the American public, they will remember that the lamp was at first promised for December 1, 1892, it being necessary at that time, just after the decision in the lamp suit had been rendered, to give the public to understand that the adverse decision would in no way affect the Westinghouse lamp business. A little later, however, it was learned that the lamp would not be placed upon the market until January 1st, and the retail prices were announced. So that it was assumed that all the processes of manufacture had been arranged in detail, and that the Westinghouse stock-room was rapidly filling up with the new lamps. The latest announcement, which has been something of a surprise to the expectant public, is to the effect that the new lamp contains an attenuated nitrogen gas, and that it will be placed upon the market "early in January." There can be no question that this latest announcement has made the public rather sceptical, and those acquainted with the situation, as well as the general public, are beginning to wonder what all this delay and change of base on the part of the Westinghouse Company means. Very much adverse criticism has been stirred up by the announcement that the Company has seen fit to trot out the old idea of a nitrogen lamp. It is, however, pointed out by some that the announcement specifically states that the atmosphere within the lamp is "attenuated," and that probably the very smallest possible quantity of nitrogen is used, so that the Company avoids the possibility of being cornered by the General Electric Company for using a vacuum lamp. The periodical rumours concerning the consolidation of the Westinghouse and General Electric Companies have again been given wide circulation, but have been as promptly denied by nearly all parties concerned. There are some, however, who still insist that a consolidation will take place, and that in the near future, and also insist that the dilatory policy of the Westinghouse Company in bringing out this new lamp is a part of the game which it is necessary to play in order to secure the consolidation on desirable terms.

Electric Motors in Machine Shops.—The application of motors to tools is receiving considerable attention among practical engineers in this country. A number of inventors are at work designing motors which are compact, dust-proof, and self-regulating, adapted to direct attachment for the operation of lathes, drill presses, shop saws, planers, and other machine shop tools. There can be no question that

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motors of this kind will, if adapted to the standard tools now in use, find very wide application, and will become immensely popular. It is expected that the numerous plants of this kind that will be in operation at the World's Fair will give a more widespread circulation to the possibilities and capabilities of this application of the electric motor than could otherwise be obtained, and for that reason it is thought that the business in this line during the next two years will be placed very substantially upon its feet.

CORRESPONDENCE.

A DIFFERENTIAL WATTMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In accordance with your invitation, I send you some comments on Mr. Kennelly's differential wattmeter, described in last week's *Electrician*.

So much interest in the subject of dynamometer wattmeters for measuring power in alternating-current circuits has been raised by Dr. Fleming's Paper on "Experimental Researches on Alternate-Current Transformers," recently read before the Institute of Electrical Engineers, that the experience of others in the production of a satisfactory instrument is, at present, particularly valuable. In choosing the differential principle Mr. Kennelly has doubtless taken a step in the right direction, and if the inconveniences attending his arrangement can be sufficiently minimised, we may expect the differential wattmeter to be the wattmeter of the future. A further development we may hope to see carried out, is a combination of the differential principle with Dr. Sumpner's method of testing transformers, described in *The Electrician*, July 1, 1892, in which only the power wasted in the transformer leads and testing apparatus is abstracted from the mains.

Mr. Kennelly's instrument will be very valuable for the tests for which it was designed; but one would expect trouble in using it, for making zero adjustment is apt to give the suspended parts a pendulous motion, especially where long suspensions are used. The period of this instrument would also be rather great, being not less than 6 seconds or probably nearer 10 seconds.

The chief disadvantage, however, is the necessity of using auxiliary coils to balance the residual induction of U and *l*, or L and *u*, respectively. By proper relative adjustment of the coils on the instrument and their connections these auxiliaries could be dispensed with, provided the shaft which connects the upper and lower suspended coils is sufficiently rigid to prevent appreciable twist; for although the suspending wire is only subjected to the difference of the two torques due to the two dynamometers, the connecting piece takes the full torque of the lower pair of coils. In the case mentioned in § 4 (of paper) the latter is about 30 times the former. Disturbance by leads might have been lessened by using larger numbers of turns in the fixed coils. It is also important to arrange the thin flexible wires which lead the currents to and from the swinging coils so that they exert no resultant deflecting moment on those coils.

In alternating current wattmeters (especially differential ones) the presence of metal in the form of cases, terminals, &c., is highly objectionable on account of eddy currents generated therein affecting the swinging coils, and the multitude of binding posts near the coils may prove a source of error. For the same reason, the shaft which connects the two swinging coils should not be of metal.

The four sets of windings in each dynamometer give the instrument a very wide range, but the statement in § 7 that it can be used for any transformer of ordinary type up to 100 kilowatts seems very doubtful. Even if the secondary pressure be 100 volts the current will be 1,000 amperes, and this gives a current density of 80,000 amperes per square inch even if the thickest coil be used. The instrument would therefore be burnt up if left on for a short time.

The table of resistances, inductances, &c., of the several coils would be very valuable if they could be trusted, but they do not seem to be very reliable. For example, U 3 has 28 turns of No. 15 wire, resistance 0·0388, inductance 0·055, ∴ time-constant, *i.e.*, *inductance* resistance, 0·00142; whilst L2 has the same number of thicker wire, viz., No. 13, but its resistance is given as 0·22 and inductance 0·052, which gives a time-constant of 0·00024. Apparently the resistance is wrong; probably it should be 0·022. But even if this correction be made the other numbers are not very accordant.

It would have been interesting if the construction of the non-inductive resistances put in series with the pressure coils had been described in detail, for on this the accuracy of the instrument mainly depends. With a 20,000 ohm coil in series with a swinging coil whose inductance is 6·6 millihenrys one is hardly likely to get an error due to lag (see end of § 10). It is error due to lead that is more likely to occur, owing to the capacity of the non-inductive resistance more than overbalancing the inductance of the swinging coil. To prevent this the resistance would need to be made in a special way.—Yours, &c.,

T. MATHER.

THE PRICE OF ELECTRIC SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been much interested in your recent correspondence on methods of charging, and as the problem of profitable electrical supply so widely differs from that of water or gas, it is not surprising that the existing legislative methods of charging leave much to be desired. The adaption of electrical energy to lighting, cooking, heating, and motive-power has so much to recommend it from the sanitary point of view that it is rather surprising no suggestion has been made to introduce an Act making its use compulsory, and to levy a rate on all householders, based on the rateable value of the premises. This would probably introduce a welcome change in the condition of life: for even the hairdresser would derive benefit, as bald heads would no longer be caused by the fumes and noxious vapours of gas; the doctor's bills could be paid by postal orders or stamps instead of heavy cheques; the coal merchant would have to take down his mystic announcements of "selected cobbles," "Silkstone," and "Wallsend;" and the decorator could devote more time to art, as whitewash and arsenical wall papers could be replaced by silk or other drapery. In the absence of such a healthy legislation other means have to be devised for allowing the enlightened user to show his appreciation of the benefits received by charging him at a rate per unit, and registering his consumption by a meter which attains an integrity unknown to the gas Ananias. It is clear that this rate per unit ought in some way to be adjusted according to the quantitative and qualitative consumption of each customer, and your columns show many ingenious suggestions to attain this end; but I venture to think that in your travels from Brighton to Manchester, throwing in the Scott meter and Kennedy maximum indicator, you have had a smooth journey along a road clear of obstacles which will appear in practice. The adjustable meter you describe in your issue of December 16th has much to recommend it, and the points adduced in its favour appear too modest, for a slight addition to the mechanism would create a new diversion in the household, and enable economy to be studied. I allude to the possibility of attaching a bell or gong, arranged so as to strike when the actuating magnet is excited from the station. In careful households the result would be interesting, for the cook would rush upstairs to her mistress, "Please, mum, the meter's struck nine times the last half-hour, and that means fourpence a unit; may I turn on the kitchen fire?" Of course, this refers to a progressive household which has ceased to destroy coal in order to heat the chimney and make ash in the grate; but servants still speak of the electrical heater as "the fire." The responsibilities of the Central Station superintendent would certainly be increased by the adoption of this meter, for the mysteries of the kitchen and general illumination would only be practised during the periods of meter retardation, and the station revenue would

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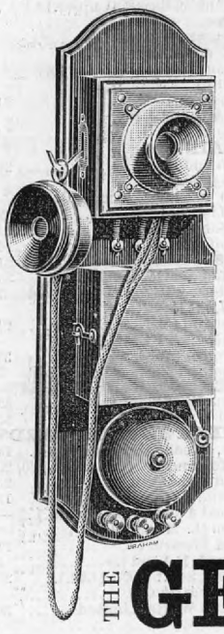

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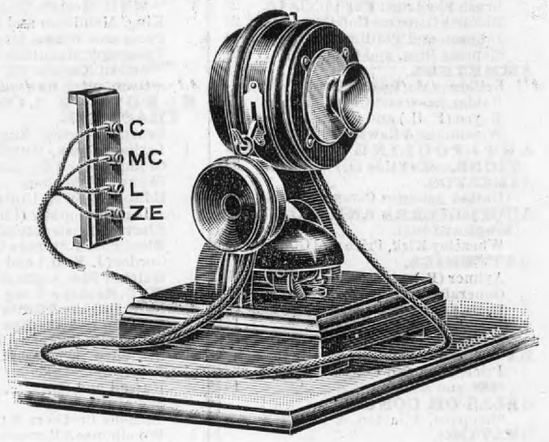

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Lorrain (J. G.) 24

PLATINA SCRAPS.
Jamieson (W. & J.) 14

PORCELAIN.
Doulton and Co. 21

POROUS CELLS.
Epstein Electric Accumulator Co. (Limited) 2
Price, Son and Co 23
Stiff and Sons 14

SOCKETS.—General Electric Co.. 21
Poole and White, Limited..... 30
Woodhouse & Rawson United Ltd 7

STONEWARE
Doulton and Co. 21

STORAGE BATTERIES.
Elec. Power Storage Co. (Ltd.).. 31
Woodhouse & Rawson United Ltd 7

SUPPLIES FOR CABLE SHIPS.
Indestructible Paint Co. 33
Duncan Wallet and Co. 33

SWITCHES & SWITCHBOARDS
Ashton, Green, Mathews & Co. 14
Crompton and Co. (Limited) ..20, 29
Dorman and Smith 23
Drake and Gorham 13
Electrical Accessories Co. (Ltd.).. —
Ericsson (L. M.) and Co. 6
General Electric Co. 21
Holmes (J. H.) and Co. 4
Laurence, Scott & Co. (Ltd.).... 23
Nalder Bros. & Co. 5
Poole and White, Limited..... 30
Reyrolle (A.) ..... —
Statter (J. G.) and Co. 24
Verity (B.) and Sons 10
Woodhouse & Rawson United. Ltd 7

TELEGRAPH ENGINEERS.
Latimer Clark, Muirhead & Co.. 1
Elliott Bros. 25
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 19
Johnson and Phillips 1, 14
Sax (Julius) 23
Siemens Brothers & Co. (Ltd.).. 27
Telegraph Manufacturing Co. .. 28
Theiler (M.) and Sons 24

TELEGRAPH PAPERS.
Waterlow and Sons (Limited) .. 16

TELEPHONES.
Berend (O.) & Co. ..... —
Collier-Marr Telephone & Electrical Manufacturing Co. Ltd. —
Consolidated Telephone Construction & Maintenance Co, Ltd 11
General Electric Company..... 21
King, Mendham and Co. ..... —
Telegraph Manufacturing Co.... 28
Western Electric Co. 12

TRANSFORMERS.
Brush Electrical Engineering Co. 25
Gülcher Elec. Light & Power Co. 23
Johnson and Phillips 1, 14
Laurence, Scott & Co. (Ltd.).... 23
Siemens Brothers and Co. (Ltd.). 27
Swinburne and Co. ..... —

TRANSMITTERS.
General Electric Co., Ltd. 21

TRAVELLING CRANES.
Electric Construction Corp., Ltd. 26
Marshall, Fleming and Jack.... —

TURNERS.
Bonnella (D. H.) and Son 2

VARNISHES.
Bigsby & Co. 2

VENTILATING ENGINEERS.
Blackman Ventilating Company 17

VOLTMETERS.
Crompton and Co. 20, 29
Drake and Gorham 13
Goolden (W. T.) and Co. ..... —
Royce (F. H.) and Co. 24
Siemens Bros and Co. (Ltd.).... 27
Swinburne and Co. ..... —
White (James) 5
Woodhouse & Rawson United Ltd 7

VULCANITE.
Harburg India Rubber C. Co. .. 2
Moseley (D.) and Sons.. ..... —

WIRE (Covered or Uncovered)
British Insulated Wire Co. (Ltd.) 10
Latimer Clark, Muirhead & Co.. 1
Felten and Guilleaume 1
Fowler-Waring Cables Co., Ltd. 8
W. T. Henley's Teleg. Works Co. 1
International Okonite Co., Ltd.. 6
Johnson and Phillips 1, 14
Laing, Wharton and Down 9, 23
London Electric Wire Co. 23
Phillips Bros. 23
Phosphor Bronze Company 25
Poole and White, Limited..... 30
Siemens Brothers & Co. (Ltd.).. 27
Telegraph Manufacturing Co.... 28
Western Electric Co. 12
Woodhouse & Rawson United, Ltd 7

WIRE-COVERING MACHINES.
Johnson and Phillips 1, 14
Poole and White, Limited..... 30
Weems (J. and W.) ..... —

WOOD (*See* CASINGS).

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CONTRACTORS FOR CENTRAL STATIONS
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MANUFACTURERS OF
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TRANSFORMERS, SWITCHBOARDS,
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STEAM ENGINES
HORIZONTAL, VERTICAL, PORTABLE AND FIXED.
SPECIALLY SUITABLE FOR
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Illustrated Catalogues, Photos, and detailed Information free on application.

INSULATORS
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ALSO BATTERY JARS, PRIMARY AND SECONDARY, AND POROUS CELLS.
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ADDRESSES.

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Electric Lighting—Domestic and Public. Estimates Free on Application.
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THE LONDON ELECTRIC WIRE COMPANY, Ltd., ANCHOR WORKS, PLAYHOUSE-YARD, GOLDEN-LANE, LONDON, E.C. (Late of Wenlock-buildings, Ironmonger-row, E.C.
Specialities—Covered Wires of all descriptions for Electrical Instruments, Dynamo Machines, Bell and House Work, &c. Fancy Paraffined Wires specially prepared for Telephone and other indoor connections.

ADDRESSES.

LAURENCE, SCOTT & CO., Ltd., Electrical Engineers, Manufacturers, and Contractors, Gothic Works, NORWICH. Telegrams: "GOTHIC, NORWICH." See Advt., page ii., in last & next issues.
Specialities: THE SCOTT-SISLING SYSTEM is the best for all installations using accumulators; Circular sent on application.
THE NORWICH DYNAMOS are amongst the very best, Electrically and Mechanically. Numerous repeat orders prove superiority.
THE NORWICH SHIPLIGHTERS never give trouble.
SCOTT'S PATENT METER is accurate through a wide range.
COMPLETE CENTRAL STATIONS for Light and Power.
SCOTT'S PATENT INSTANTANEOUS FUSES are the best.

PHILLIPS BROS., Electrical Wire Manufacturers, The Lea Telegraph Works, HACKNEY WICK, LONDON, E., late of Macintosh-lane, Homerton Established 1870. Telephone No. 5422.
Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c. Patent Non-Inflammable Insulation for Incandescent and Arc Lighting and Dynamo Machines.

PATERSON and COOPER, Electric Light and Power and Telephone Engineers. EUROPEAN WORKS, POWNALL ROAD, DALSTON (Near Haggerston Station) Contractors to H.M. Government, Leeds Corporation, &c.
Specialities—Phœnix Dynamos, Pilsen, Phœnix, and Clark-Bowman and J. F. Arc Lamps, Cardew's Voltmeter, Paterson's Electromagnet Am- and Voltmeter, Ayrton-Perry Am- and Voltmeters, Wallace Diamond Carbons, Switches, Safety Junctions, and Fittings for Arc and Incandescent Lighting. (Removed from 76, Little Britain, since Nov. 16, 1885.

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Constant Current.
Constant Potential.
Combined Plant.

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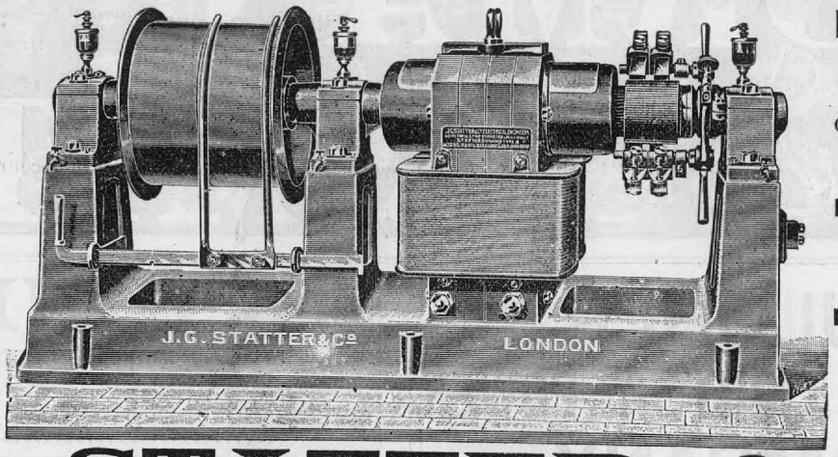

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&c., &c., &c.

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68, Victoria Street, Westminster, S.W. Works: Millwall, E.

ROYCE & CO. Hulme, MANCHESTER.

CARBONS 11 m/m by 12in. SOLID COPPERED, **For Brush and other Lamps.**

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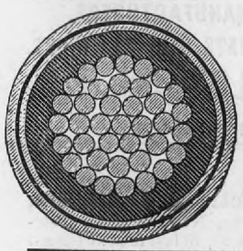

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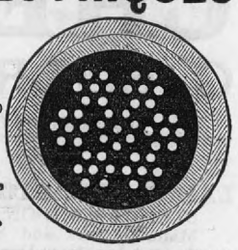
Special highly-insulated CABLES for High-Tension Alternate Currents, As used at Vienna, Innsbruck, Lucerne, Vevey, Montreux, Cologne, Monaco, &c.



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DISINFECTANTS AND APPLIANCES.

Used by more than 2,000 Boards of Health and Hospitals.
Gold Medals, Calcutta, 1883-4; Paris, 1885; Antwerp, 1886; Ostend, 1888.
For use at the Home and Foreign Stations of Telegraph Companies and on Board ship
"Valuable Antiseptic and Disinfectant."—*Times.*
"Safe, pleasant, and useful."—*Lancet.*

PAMPHLET ON APPLICATION.

THE SANITAS CO., LTD., Bethnal Green, London, E.

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largely depend on a process of selective acceleration of the meter.

On a future occasion, if you will allow me, I hope to add my suggestions for a method of charging.—Yours, &c.,

FRANK BAILEY.

17, South-street, Manchester-square, W.

ELECTRIC TRACTION AND LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is indeed a pleasure to congratulate English engineers who "do not need the assistance of Americans to show them how traction work should be done" (*The Electrician*, Vol. XXX., No. 757, p. 68). Although the novelty of Mr. Dickinson's trolley-rig might be questioned by those familiar with the Old Daft Road (P. Knoxville and St. Clair) at Pittsburgh in the early days of electric traction in this country, let us *hope* that the side trolley will prove a success, but let us await the verdict of a year hence.

As to the art of electric lighting (see your p. 107), why would it not have been a wise, if not an *ordinary English*, precaution to have used a *double pole switch* in the store?

Is it possible that you could have been misinformed as to stoppage of electric cars during thunderstorms, as per your leader on page 127, which reads:—"It is a *common custom* in the Western States to *stop all* the electric cars as soon as a thunderstorm begins," &c.? This will certainly be news to American engineers, for there are at least three lightning arresters on the market which can be relied on to protect the car motors perfectly, while this number could be increased were instruments admitted which, while offering protection to the motor, are themselves destroyed in giving it. Two of the protectors referred to have been procurable for at least three years past.—Yours, &c., J. STANFORD BROWN.

Camden, N.J., January 5, 1893.

["In many of our cities and towns, particularly in the "Western sections of the country, it has been common practice "during thunderstorms to shut down the plant, pull down the "trolleys, and wait till the storm shall have spent itself."—"Alexander Jay Wurts, *Electrical Engineer*, New York, November 16, 1892, p. 480.—ED. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is now in the press, and will shortly be ready. Firms and others who have not returned the slips asking for information are requested to do so *immediately*. The price of the Directory and Handbook will be as before: *Subscription*, 5s.; after publication, 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

TENDERS INVITED.—The Corporation of the Borough of Kingston-upon-Thames invite tenders for the construction, supply and laying down of the necessary plant and mains for the supply of electricity in the borough in accordance with the specification. Plans and form of tender to be obtained from Mr. Harold A. Winser, Town Clerk, after Tuesday next. Further particulars are given in our advertisement columns. Tenders must be in not later than February 11th next.

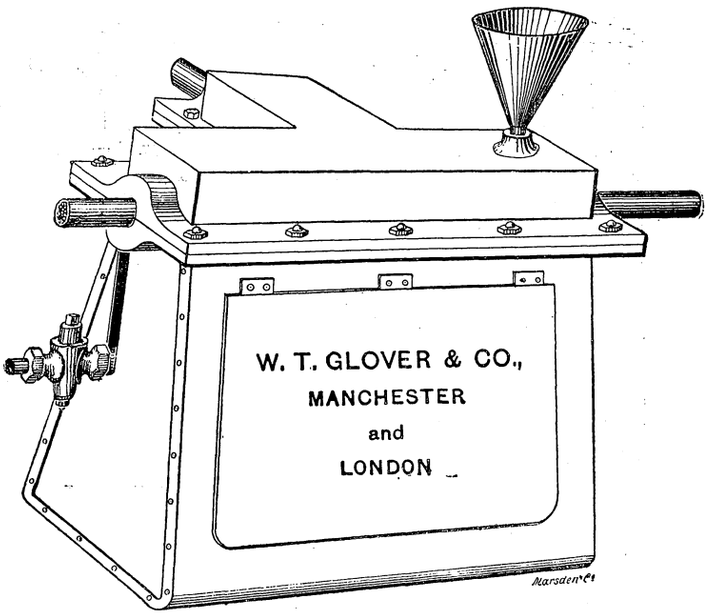
SALE BY AUCTION.—Messrs. Wheatley Kirk, Price and Goulty announce in our advertisement columns that they have received instructions from the liquidator to sell by auction, in detail, on February 1 and 2, at the Globe Works, Whitley-street, Rochdale-road, Manchester, the whole of the plant of Messrs. Thomas Barraclough and Co. (Limited), in liquidation. Catalogues may be obtained, gratis, from the liquidator, Mr. Alfred Tongue, of 44, Brown-street, Manchester, or from Wheatley Kirk, Price and Goulty, Albert-chambers, Albert-square, Manchester, and 49, Queen Victoria-street, London, E.C.

SALE OF ELECTRIC TRAMCARS, DYNAMOS, &C.—A notice appears in our advertisement columns that Mr. John Jameson Truran, of 184, Gresham House, Old Broad-street, London, E.C., will receive offers for the sale by private contract, subject to the approval of the Court, of the electric tramcars, dynamos, working plant, tools, and sundry stores, used by the Electric Tramcar Syndicate (Limited), in connection therewith, and for the English and other letters patent connected with the undertaking. Tenders to be in by the 28th inst.

APPOINTMENT VACANT.—The Heckmondwike Local Board of Health require an engineer in connection with their electric lighting scheme. Particulars appear in our advertisement columns.

EDISON AND SWAN COMPANY.—It is gratifying to learn that pressure of business has necessitated the re-opening of the South Benwell Works, Newcastle-upon-Tyne, which have been closed for a considerable period.

GLOVER'S OPEN-AIR JOINTING APPARATUS.—We give below an illustration of an apparatus for making vulcanised joints, for which Messrs. Walter T. Glover and Co., of Salford, claim that ordinary or T joints can be vulcanised without bending or in any way altering their form. The apparatus has been in use for some time, and has, we understand, worked successfully. Full printed instructions for using the apparatus are issued by Messrs. Glover and Co., and can be obtained on application.



CATALOGUES.—Messrs. Ernest Scott and Mountain send us a catalogue of electric mining machinery, dynamos, motors, &c., which may be said to take its place amongst the numerous excellently printed calagogues which are now being prepared. The list includes complete instructions for fixing and working, approximate estimates and other useful information. Several examples of pumps and other appliances for mining machinery are illustrated and described.

——— Messrs. Cuttriss, Wallis and Co. (Limited) have just issued a new catalogue of their manufactures, which gives prices and particulars of the "Student's" dynamo, of the "Eclipse" and "Elmwood" dynamos and motors, and of the "Elmwood" gas-engine, which the Company claim is admirably adapted, combined with a special dynamo manufactured by the firm, for charging accumulators. Illustrations are given of the patent "dental" motor, and testimonials from users accompany the list.

——— Messrs. Mackey, Mackey and Co. forward us their illustrated catalogue of electro-medical and electro-surgical appliances, containing a very large number of illustrations of instruments, the majority of which seem to be adapted for electro-surgical use. As every surgeon seems inclined to invent his own instrument, there is an admirable choice of appliances for those who are liberal-minded enough to take advantage of the recent developments which have been made in this direction. Messrs. Mackey, Mackey and Co. are European agents for Messrs. Waite and Bartlett, of New York.

MESSRS. PYKE, HARRIS, AND CO. (LIMITED).—This firm have in hand the wiring and fittings for the electric light installation at the New Zealand Government Offices, Victoria-street, S.W.

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FAILURE.—The following list of creditors is issued in the failure of James K. D. Mackenzie, electrical engineer, of Broadway-chambers, Westminster :—

Brougham, Hon. R., London	£600	0	0
Johnstone, J. B., London	54	0	0
Hayes-Eadler, Mrs., London	45	0	0
Kayler, Thomas, London	624	0	0
Mackenzie, Lady, London	100	0	0
Matheson, Sir Kenneth, London	250	0	0
Milne, T., London	55	0	0
Neate, Charles, London	750	0	0
Pam, Frederick, London	100	0	0
Rawson, F. L., London	125	0	0
Bankers' claim	60	0	0

And creditors of £30 and under.

DISCLAIMER.—In reference to the formation of the firm of Roger Dawson (Limited), we have received the following from Mr. Rashleigh Phipps :—"I notice in the electrical and building papers a statement that the Company styled 'Roger Dawson (Limited)' has been formed to acquire the business of Rashleigh Phipps and Dawson. As this is calculated to be detrimental to my interests, I beg to inform you that, although, under the terms of the dissolution between myself and Mr. Dawson, the property and assets of the late firm of Rashleigh Phipps and Dawson are assigned to him, the deed provides that neither partner shall use the name of the other in any shape or form whatever. I am now carrying on business at No. 102, Oxford-street, under the style of Rashleigh Phipps and Co., electrical engineers, and my business will be in no way affected by the Company which has been formed."

TESTING FACILITIES FOR GLASGOW AND DISTRICT.—The necessity for the periodical testing and overhauling of chains, slings, and other lifting and hauling gear, is now very generally admitted, and many users of such appliances make it a rule to have them officially tested and examined, and, if necessary, repaired at regular intervals. The Glasgow Anchor and Chain Cable Testing Company point out that the advantage of this is evident, as by it no doubt accidents are prevented, and when such do occur, the possession of certificates showing that the gear has been properly tested, and at suitable intervals, is generally a sufficient defence to employers against charges of neglect. They notify that new testing machinery, appliances, &c., at Lloyds' Proving House, are complete for efficiently carrying out the above work. They have now added to the above establishment a new Wicksteed's machine, which has all the improvements up to date.

ELECTRIC LAUNCHES.—The Thames Electric and Steam Launch Company, of which Mr. W. S. Sergeant is general manager, report that business is satisfactory. A large steam launch, of 73ft. beam, which the Company have on the stocks, is to be fitted throughout with the electric light, and is of special design, suitable for navigating the Thames, and canals in France, Belgium and Holland. This launch has been designed and moulded throughout by Mr. Sergeant. In addition, the Company are preparing a number of launches for the next season on the Thames, including two gigs for sailing, rowing, or electric propulsion. The Company's buildings and improved slipway at Twickenham are now completed.

AWARDS.—Messrs. Johnson and Phillips have been awarded a gold medal for dynamos at the recent Kimberley Exhibition. The machines were exhibited by Messrs. Edlin and Stevenson, who are Messrs. Johnson and Phillips' general agents in South Africa. ——Messrs. Ernest Scott and Mountain (Limited) have been awarded gold medals for the electric lighting of the Sheffield Trades Exhibition and of the Lincoln Trades Exhibition.

ELECTRIC HEATING AND COOKING.—Messrs. Crompton and Co. are issuing illustrated circulars giving particulars of their apparatus for heating, cooking, and other domestic purposes. Trade applications for these circulars should be addressed to 148, Brompton-road, S.W.

ELECTRIC NOVELTIES.—Messrs. Squire and Co., of South Molton-street, send us a sample of their night lamp, for which a charge of 2s. 6d. is made. The little lamp is of 1 c.p., and to prevent fusing a piece of fine wire is supplied. Care is necessary in using the lamp, and printed particulars are supplied.

CALENDARS FOR 1893.—The Commercial Cable Company issue a useful hanging pad calendar, showing their cable routes, and giving a considerable amount of information regarding cable rates, &c.

ELECTRO-HARMONIC SOCIETY.—A smoking concert will be given at the St. James's Hall Restaurant, Regent-street, W., on Friday next, the 27th inst, at eight o'clock.

ABERDEEN.—Mr. M'Whirter, of Glasgow, who has in hand an installation of the electric light at the Palace Hotel, Aberdeen, recently made an experiment with the electric light in the Denburn Valley, which has given such satisfaction to the railway company in the district that the whole of the main platform at the north end of the Denburn Valley station is, we understand, to be supplied with the electric light.

BELFAST.—Messrs. Siemens Bros. and Co. (Limited) have received a contract from the Harbour Commissioners to supply the necessary plant and apparatus required for the electric lighting of the quays on the County Down side of the harbour, including the Hamilton Graving Dock.

BIRMINGHAM.—A dinner was given last week by passengers using the electrical section of the Bristol-road tramway route to the drivers, conductors, and depot *employés*, the chair being taken by Mr. T. B. Goodyear, assistant traffic manager.

BLACKPOOL.—At the last meeting of the Town Council various recommendations by the Electric Lighting Committee came up for discussion, more particularly a contract recently given to Mr. E. Taylor for laying down iron street pipes for an electrical installation, and replacing and relaying the footway. It was urged by several members of the Council that, as Mr. Taylor's tender was not the lowest, it should not be accepted. After some considerable discussion the recommendations of the Committee, under which the Corporation themselves will do the work, were adopted.

BOMBAY.—In reference to the paragraph which appeared in our issue of the 13th inst., p. 311, it should have been stated that all the electrical power transmission plant for the Mannockjee Mills was both designed and supplied by Messrs. Charlesworth, Hall, and Co., whose Indian agents are Messrs. Wadia and Sons.

CHURCH LIGHTING.—S. Peter's, Hatton-garden, one of the most artistically decorated Roman Catholic churches in London, is to be lighted electrically.

CRYSTAL PALACE.—The National Cycle Show opens to-day, and a vast collection of cycles of all kinds will be on view.

DERRY.—We understand that the plans for lighting the City of Derry, which have been prepared by Mr. Blake, have received the approval of Dr. John Hopkinson, the expert called in by the Corporation.

DEWSBURY.—At the last meeting of the Town Council the minutes of the Lighting Committee were adopted. These included the report and specification of Mr. W. H. Preece, in which he recommends the establishment of the central station at the old gas works in Bradford-road, Dewsbury, and that provision should be made for the supply of current to 10,000 lamps, and also that the plant should be so arranged as to admit of easy extension at a future time. The Town Clerk was instructed to advertise for tenders for the work required to be done on the basis of Mr. Preece's specification.

ELECTRICAL TRADES UNION.—Mr. A. J. Walker, general secretary, informs us that this Union has now twenty-nine branches spread over the country.

HAMMERSMITH.—At the last meeting of the Vestry, it was decided to make experiments with the view, if possible, to use the refuse of the parish in generating electricity.

HECKMONDWYKE.—At the last Local Board meeting the Chairman of the Electric Lighting Committee moved that Mr. Hutchinson, C.E., should be appointed to prepare plans, specifications, &c., in connection with the Board's scheme for lighting the town with electricity. This resolution was, however, negatived, and it was decided to advertise for an engineer to prepare the necessary documents. (*See* advertisement columns.)

ILFORD.—The Brush Company are reporting to the Local Board on the question of lighting the district by electricity.

ISLEWORTH.—At the last meeting of the Heston and Isleworth Local Board it was agreed to appoint a committee of the whole Board to consider the defective supply of gas and its continued high price, and also to consider the desirability of obtaining electric or other light for the district. Should the electric light be selected, water-power will probably be utilised.

KIRKCALDY.—The Brush Electrical Engineering Company (Limited) are asking the Police Commissioners to sanction their application for a Provisional Order for the electric lighting of this town. After discussion it was agreed to remit the matter to the Roads, Streets and Bridges Committee to consider and report. The local Gas Company has, we understand, power under its articles to supply the electric light to the district.

LONDON INSTITUTION.—Prof. Silvanus Thompson delivered an interesting lecture to the members of this Institution on Thursday last week, this being the first of a series of lectures on Electric Lighting.

NANTWICH.—At the last meeting of the Local Board, meetings of the Lighting Committee and the special Sub-committee on electric light were fixed. These Committees have not previously met.

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NEWCASTLE-UPON-TYNE.—At their last meeting the City Council agreed to the application of the Newcastle-upon-Tyne Electric Supply Company (Limited) for permission to apply to the Board of Trade for a Provisional Order, authorising the Company to supply electricity for all public and private purposes within the area of the City and County of Newcastle-upon-Tyne.

NEW ROMNEY.—A discussion arose at the last meeting of the Town Council as to the advisability of introducing the electric light. The price of gas in this district is 5s. 10d. for public lighting, and in excess of that amount for private consumers; and Mr. Hick, a member of the Council, strongly supported the introduction of the electric light in opposition to the Gas Company. It was resolved to form a committee for considering the expediency of lighting the town by electricity. The Gas Company have addressed a letter to the Council giving notice of termination of their contract for lighting the town by gas, which expires in May next.

REDDITCH.—The Local Board have under consideration the question of introducing the electric light. It has been complained that the reduction in the price of gas promised by the Gas Company has not been made. The proposal regarding the electric light was carried.

SOUTHAMPTON.—It has been decided to instal the electric light in the new buildings of the Free Library. The report of the Subcommitte appointed to consider the matter states that experience proves that whereas, when gas is used in such buildings, it is necessary to repaint and redecorate every three years, when the electric light is substituted, this period is extended to ten years. The damage to books is estimated in the report to be 40 per cent. of the total wear. The proposal to adopt the electric light was carried.

THE ROYAL ACADEMY.—The schools of the Academy in the basement of Burlington House are being provided with the electric light, and Messrs. B. Verity and Sons are proceeding with the work, the necessary alterations being under the supervision of Mr. P. H. Calderon, R.A.

SOUTHEND.—At the last meeting of the Town Council the recommendation of the Pier Committee that an additional engine, boiler, and dynamo be purchased, at a cost of about £780, in connection with the Pier Electrical Works, was approved. Mr. Alderman Hemmann took the opportunity of suggesting that the time had arrived when a considerable extension of the electric light could be made in the town and district. The discussion of this matter was, however, deferred, and a proposal to purchase a new set of tramcars for the pier was defeated.

SWANSEA.—Messrs. Wm. Foster and Co. (owners of the Morfa Copper Works, and who have recently taken over Pascoe and Grenfell's great works at Upper and Middle Bank, Swansea), in order to provide communication between the manager and heads of departments in the works, which are situate on either side of the River Taw, have taken out the old telephone wires which were stretched across the stream, and instructed Mr. John Legg, electrician, of Swansea, to put down a telegraph cable in the bed of the river, which has recently been successfully accomplished. The Silvertown Company have supplied the cable, and the work has been carried out to Messrs. Foster and Co.'s entire satisfaction. Gower-Bell telephones of the Government pattern have also been installed in the various departments.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

December 20, 1892.

23,453. C. D. ABEL. London. Improved method and apparatus for regulating the speed or expenditure of power in vehicles propelled by electrical energy, in particular that supplied by accumulator batteries. (La Société Anonyme pour le Travail Electrique des Métaux, France.)

23,460. H. T. BARNETT. London. Improvements in electro-motors.

23,501. H. H. LAKE. London. Improvements in devices for electrically playing stringed musical instruments. (J. Vose, United States.)

December 21, 1892.

23,539. W. L. SPENCE and D. STEWART AND CO. (LIMITED). Glasgow. Improvements in, or in connection with, dynamo-electric machinery.

23,579. A. ZÖBEL and F. BUCHMÜLLER. London. Improvements in electric incandescent lamps.

December, 22, 1892.

23,658. H. EDMUNDS. London. Improvements in the armouring, covering, or protecting of electrical cables and the like.

23,674. H. T. HARRISON. London. Improvements in distributing electricity and means or apparatus for the purpose.

23,675. J. S. RAWORTH. London. Improvements in the construction and arrangement of switches for use in connection with electric generators, specially applicable to alternators and their exciters.

December 23, 1892.

23,678. R. A. WORMELL. Croydon. Improvements in electrical measuring instruments.

23,680. D. G. FITZGERALD. London. Improvements in voltaic cells used as standards and for testing purposes.

23,733. E. T. PARKER. London. Improvements in and apparatus for the manufacture of chlorine and alkali by electrolysis of compounds thereof and anodes to be employed therein.

23,750. A. HOUGH. London. An improvement in plates for secondary batteries.

December 24, 1892.

23,773. R. NIEWERTH. London. Improvements in electric smelting and in furnaces therefor.

23,774. R. NIEWERTH. London. Improvements connected with the obtainment of the electric arc for lighting and other purposes, and in apparatus therefor.

23,783. J. PLUMMER. Midlothian. Improved electric incandescent or glow lamp.

23,788. S. O. COWPER-COLES and THE LONDON METALLURGICAL COMPANY (LIMITED). London. Improvements in electro-plating.

23,805. R. BOMBE and F. SCHUCHHARDT. Glasgow. A new or improved automatic electric switching device for use with arc lamps.

23,821. A. J. BOULT. London. Improvements in electrode-supporting combs for electric batteries. (Mannheimer Gummi-Gutta-percha and Asbestfabrik, Germany).

December 27, 1892.

23,861. T. COCKERILL. Manchester. Improvements in switches and connections for electric circuits.

23,902. C. E. L. BROWN. London. Improvements in alternate-current motors.

23,906. F. H. PRENTISS. London. Improvements in incandescent lamps for electric lighting.

23,919. T. CRANEY. London. Improvements in, and relating to, electrolytic apparatus.

December 28, 1892.

23,957. H. H. LAKE. London. Improvements relating to reflectors for arc lamps. (C Cooper, Germany).

December 29. 1892.

23,985. A. MARR. Manchester. Improvements in telephonic transmitters.

23,988. J. MAIN. London. Improvements in electric arc lamps.

24,008. A. L. SHEPARD. London. Improvements relating to electric lamps, and to apparatus connected therewith.

24,009. G. CROMPTON and J. CHAMBERS. London. Improvements in the manufacture of pipes, or conduits for electric cables or other purposes, and in the means or apparatus employed therein.

December 30, 1892.

24,071. E. L. C. Schiff. London. Improvements in the application of an electric current in the boiling or evaporating of solutions or liquids.

24,088. H. H. LAKE. London. Improvements in or relating to dynamo electric machines. (E. L. Zalinski, United States.)

24,098. C. E. L. BROWN. London. Method of, and apparatus for, starting non-synchronous single-phase alternating current motors.

December 31, 1892.

24,127. F. KING. London. Improvements in secondary batteries.

24,147. C. WARREN-BRADFORD. London. An improved automatic circuit closer for telegraph keys. [Date applied for under Patents Act, 1883, Sec. 103, May 31, 1892, being date of application in the United States.]

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

21,354. ARON. Measuring electric currents.

21,766. SCHUCKERT and WACKER. Measuring expenditure of electrica energy.

22,854. PLACET and BONNET. Electrolysis of metals.

15,749. DE NORMANVILLE. Electric arc lamps.

22,429. SINGER. Varying resistances of electric current.

1892.

491. HULTMAN. Underground conduits for electric wires.

1,459. WHITE and others. Dynamo-electric machines.

1,878. DAVIS and CROMPTON. Protecting electrical conductors.

2,198. THORNTON and LATIMER, CLARK, MUIRHEAD, and Co. (Limited). Culverts for electric mains.

17,169. KELLNER. Electrolytical decomposition of metallic salts.

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18,516. PICARD and TANIÉRE. Electro deposition of metals.
18,538. WALLACE. Underground conduits for electric conductors.
18,844. KOLLER. Dry cells or galvanic batteries.
19,927. KÖRNER. Lighting railway cars by electricity.
568. BAMBERG. Electric incandescent lamps.
1,786. PINNA. Tanning by electricity.
2,393. GRIGGS. Using electricity as medicinal agent.
2,690. TIPPING. Electric arc lamps.
2,722. SHEPARD. Electric switches.
3,291. PAYNE. Tubular electrical conductors.
3,300. BARLEY. Connecting electrical conductors.
7,095. SUGDEN and SANDY. Electric arc lamps.
7,237. PATERSON and FURNEAUX. Commutators for dynamo-electric machines, &c.
11,779. BRAUN. Carbons for electric arc lamps.
18,399. WHITEHEAD and DOXEY. Telescope switch and ringing key.
19,655. O'NEILL. Heating by electricity.
19,671. POLLARD. Conducting electricity.
19,768. WESTBROOKE. Thermometers for closing electric circuits.
20,621. WILSON and SCHWAB. Electric burglar alarm.

COMPANIES' MEETINGS & REPORTS.

Eastern Telegraph Company (Limited).

The following is the report and accounts of the Directors of this Company for the half-year ended September 30, 1892, to be presented to the forty-first half-yearly ordinary general meeting of the shareholders, to be held at Winchester House, E.C., on Thursday next, the 26th inst., at one o'clock :

The revenue for the period amounted to £352,891. 0s. 7d., from which are deducted £98,797. 11s. 3d. for the ordinary expenses and £37,636 9s. 7d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £4,927. 7s. 7d. for income-tax, there remains a balance of £211,029. 12s. 2d., to which is added £661. 7s. 7d., brought from the preceding half-year, making a total available balance of £211,690. 19s. 9d. From this balance there have been paid :—

Interest on Debenture and Debenture Stock.....	£28,274	13	3
Dividend on Preference Shares	20,474	2	2
Two interim dividends of 2s. 6d. per share each on Ordinary Shares.....	100,000	0	0
	£148,748	15	5

Leaving a balance of £62,942. 4s. 4d., which is carried forward to the next account.

The revenue includes £33,431. 1s. 5d. dividends for the half-year upon the Company's shares in the Eastern and South African, the Black Sea, the Direct Spanish and the African Direct Telegraph Companies.

Since the last general meeting the Government of New Zealand has agreed that this Colony shall be included in the arrangement for reduced through rates to and from certain of the Australiasian Colonies and has joined with those Colonies in the guarantee. The guaranteeing Governments found that the reduced tariff during the first year resulted in greater loss than they anticipated, and to meet their wishes the Associated Telegraph Companies agreed to an increase of 9d. per word in the rates for ordinary telegrams. The new tariffs came into operation on the 1st inst.

In December last the Directors offered to the holders of the Company's Five per Cent. Debentures, redeemable at par in 1899, the option of exchanging their security for the Four per Cent. Mortgage Debenture Stock of the Company. The holders of the debentures have largely availed themselves of the opportunity thus given to them of acquiring this permanent security.

In accordance with the provisions of the Articles of Association, two of the Directors, George Garden Nicol, Esq., and John Denison Pender, Esq., retire by rotation at this meeting, and, being eligible, offer themselves for re-election. The auditors, Mr. Henry Dever and Messrs. Welton, Jones and Co., retire, and offer themselves for re-election.

Direct United States Cable Company (Limited).

The following is a report of the Directors of the Company for the six months ended December 31, 1892, to be presented at the 31st ordinary general meeting to be held at Winchester House, E.C., on Friday next, at 12 o'clock noon :—

The half-year's revenue, after deducting out-payments, amounted to £43,629. 6s. 1d., as compared with £45,402. 0s. 8d. for the corresponding period of 1891, being a difference of £1,772. 14s. 7d. against the half-year under review.

The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £18,982. 3s. 7d., leaving a balance of £24,647. 2s. 6d. as the net profit, making, with £3,730. 8s. 1d. brought forward from the previous half-year, a total of £28,377. 10s. 7d. For the corresponding period of 1891 the working expenses and other payments amounted to £17,672. 16s. 5d.

Interim dividends of 3s. 6d. per share for the quarter ended September 30, 1892 (paid October 24, 1892), and of 3s. 6d. per share for the quarter ended December 31, 1892 (payable January 28, 1893), together amounting to £21,248. 10s., have been declared, and, after setting aside £4,000 to the reserve fund account, the balance of £3,129 0s. 7d. on the revenue account has been carried forward.

During the period under review, repairs have had to be made in both sections of the Company's cables at a cost of £6,301. 15s. 2d., which has been debited to the reserve fund account as heretofore, the balance of which, with the above addition, stands at £260,298. 6s. 1d.

A new station has been opened by this Company, in conjunction with the Western Union Telegraph Company, at 39, Mark-lane, London, E.C., where additional facilities are afforded both to the cabling public in that locality and to the Companies concerned.

The new permanent buildings at Ballinskelligs will shortly be completed

St. James' and Pall Mall Electric Light Company (Limited).

The following is the report of the Directors for the year ended December 31 last, to be submitted at the ordinary meeting to be held at the Company's central station, Carnaby-street, Golden-square, W., on Tuesday next, the 24th inst., at 3 p.m. :—

Owing to difficulties with regard to ancient lights and other matters, it was found impossible to complete the northern central station within the time contemplated. It is now, however, practically finished, and complete with sufficient machinery for the supply of 20,000 8-c.p. lamps, which, when necessary, can be augmented by further plant, raising the capacity of the station to 65,000 8-c.p. lamps. The two stations are already connected by the Great Trunk main, and within a very short time they will not only be able to run concurrently, but will be able to relieve each other should necessity arise.

The Directors are pleased to be able to report that the plant at the Southern Central Station is in perfect order, and fully maintains the efficiency and economy noted last year. It has, unaided, produced the income shown in the accounts. The Directors have devoted great attention to the curtailment of all unnecessary expenditure, in which they have been ably seconded by the officers and staff of the Company. Their policy has, however, been that of maintaining the buildings, plant, and mains of the Company in the highest state of efficiency. They are not only advised, but their experience has satisfied them, that to earn continuous dividends in a business of this character, liable as it is to many risks, and dependent on the correct handling of multitudinous details, it is essential that the whole of the Company's works and mains should be thoroughly maintained in every respect.

The whole of the compulsory mains are now laid, and this, together with the amounts required for the completion of the new station, has caused a large capital expenditure during the year, which has as yet produced no corresponding income. The Directors are happy to state that the works have been completed at a cost well within the estimates, and they do not anticipate that any further capital will be required unless a demand should arise for current in excess of the Company's present capacity.

The question of the "redemption fund," inaugurated last year, is one which has been prominently brought to the attention of the Directors by certain holders of founders' shares, who consider that the amount is improperly taken from "revenue account," and should be divisible as profit amongst the shareholders. This question was before the meeting of the members of the Company last year, when the creation of the fund was approved *nem. con.* The Directors, therefore, recommend that this policy be maintained, believing that it is one which will meet with the continued approval of the shareholders. In their judgment, the establishment of this fund is prudent, and they are advised that it is in strict accordance with law.

The Directors regret to announce that the action brought against the Company by Dr. John Hopkinson for the alleged infringement of his three-wire patent has been decided against the Company. Pending the consideration of whether the Company should appeal, they are glad to be able to state that they have completed arrangements whereby they will be in a position to continue the supply of current without interruption, and without further use of the patentee's system. The Company will not have to bear the whole of the costs of the action.

The net earnings of the Company during the past year have amounted to £14,598. 19s. Of this sum, £5,997. 10s. was distributed in July last in payment of an interim dividend at the rate of 5 per cent. per annum for the half-year ending June 30, 1892, on the Ordinary shares, and at the rate of 7 per cent. per annum on the Preference shares. The balance £8,601. 9s., together with the undivided profits of £22. 12s. 2d. from last year's account, leaves £8,624. 1s. 2d. now to be dealt with. The Directors propose to divide this amount as follows :—

(*a*) By payment of a dividend at the rate of 7 per cent. per annum on the Preference shares for the second half of the year	£3,500	0	0
(*b*) By payment of a dividend at the rate of 9½ per cent. per annum for the second half-year on the Ordinary shares, making, with the interim dividend paid in July last, a total distribution of 7¼ per cent. for the year	4,745	5	0
(*c*) By paying a dividend of £3. 3s. per share on the Founders' shares.....	315	0	0
(*d*) Amount to be carried forward to Ordinary shareholders' undivided profit account	59	7	0
(*e*) Amount to be carried forward to Founders' undivided profit account	4	9	2
	£8,624	1	2

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The Directors have carried £1,000 to increase the Redemption Fund, which, with the addition of interest received during 1892, now stands at £2,029. 6s. 4d., and which is accumulating by annual additions towards representing loss of capital at the expiration of the term covered by the Provisional Order. The Directors are advised that the amounts provided in the accounts for depreciation are sufficient and ample for all purposes.

The Directors regret that Mr. Charles Showell, one of their number, found it necessary to resign his seat on the Board owing to his numerous engagements. They elected Mr. Gerald W. Balfour, M.P., brother of the Chairman, to fill the vacancy thus created, being of opinion that his services would be of great value to the Company. Sir John H. Morris, K.C.S.I., and Mr. Gerald W. Balfour, M.P., retire under Clause 79 of the Articles of Association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and, being eligible, offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322, *&c., &c.*]

HERCULITE AND ELECTRICAL MANUFACTURING COMPANY (LTD.).—This Company was registered on January 11th, with a capital of £12,000, divided into 4,000 £10 per cent. Cumulative Preference and 8,000 Ordinary Shares of £1 each. The objects are to adopt and carry into effect an agreement between James Lang, the Herculite Manufacturing Company (Limited), and Ernest J. Lunnon (the liquidator thereof), and this Company, for the purchase of the assets of the Herculite Manufacturing Company (Limited); to carry on the business of manufacturers of, and dealers in, the moulded article for the compound of which Mr. James Lang has taken out a provisional specification, Patent No. 3,240 (1892), and to carry on the business of electricians, engineers, ironfounders, blacksmiths, glass-blowers, and manufacturers.

PRINTING TELEGRAPH AND CONSTRUCTION COMPANY, OF THE AGENCE HAVAS (LIMITED).—This Company was registered on January 12th, with a capital of £130,000, in £5 shares. The objects are to acquire by purchase, or on royalty or otherwise, the exclusive or non-exclusive or limited right to use or vend within the Republic of France, and to grant licences for the using and vending of all or any of the inventions relating to printing telegraphs, whether covered by patent provisional specification or not; to enter into and carry into effect (1) an agreement already prepared and expressed to be made between Robert D. Radcliffe and Laur von Viben-Smith and the Company, and (2) an agreement between the Agence Havas, Robert D. Radcliffe, and Laur von Viben-Smith and the Company, with or without modification, but so that so long as such agreement shall be in force the sum of £20,000, part of the Company's capital, shall be appropriated and applied only in the manner and for the purposes specified in such agreement, except with the consent in writing of the Agence Havas; and to carry on in France, in conjunction with the Agence Havas, the trade or business of transmitting the news of the day to subscribers, and to buy, sell, and deal in all things incidental to improvements in telegraphy in France.

PYKE, HARRIS AND COMPANY (LIMITED).—This Company was registered on January 10th with a capital of £30,000 divided, into 1,400 "A" shares of £5 each, and 4,600 "B" shares of £5 each. The objects are, to carry on the business of electrical engineers then carried on by Messrs. Pyke and Harris, and to acquire, work, use and deal with in the following patents relating to the United Kingdom, viz.:—Nos. 11,503 of (1868), 3,900 (1890), 4,004 (1890), 22,785 (1891), 21,541 (1891), 17,818 (1891), and Provisional Protection, 19,222 (1892), and to carry on the business of manufacturing, repairing, selling and dealing in electrical machinery. Edward Prentice and L. S. M. Pyke are Managing Directors of the Company for a period of five years. Remuneration, £350 each per annum, together with a bonus of 5 per cent. per annum each upon the net profits, after the payment of a 10 per cent. dividend.

MISCELLANEOUS.—HARVEY STEEL COMPANY OF GREAT BRITAIN (LIMITED), iron and brass founders, mechanical, electric, and general engineers, &c.; capital, £180,000, in £10 shares.——HIRST, BROOKE AND HIRST (LIMITED), dealers in electrical, chemical, and scientific apparatus; capital £40,000, in £5 shares.——WELDLESS CHAIN COMPANY (LIMITED), iron and brass founders, mechanical, hydraulic, and general engineers; capital, £100,000, in £10 shares.——WILLIAM ACKROYD AND BROTHERS (LIMITED), iron and steel manufacturers, engineers, builders of steam, electrical gas, and other engines, &c.; capital, £130,000, in £10 shares.

ART WORKSHOPS (LIMITED).—A petition has been presented for the winding up of this Company, and is down for hearing at the Royal Courts of Justice, Strand, to-morrow (Saturday).

CROMPTON ELECTRIC SUPPLY COMPANY OF AUSTRALIA (LIMITED).—The annual return of this Company made up to January 1st has been filed. The Company was registered on June 18, 1889, with a capital of £50,000, divided into 9,500 "A" and 500 "B" shares of £5 each. At the time of making up 3,115 "A" and 500 "B" shares were taken up, of which the "B" shares were issued as fully paid—to Viscount Torrington (150); George Harrison and Alfred H. Whiffen, of Sydney, N.S.W. (200); and John F. Albright (150). Upon the 3,115 "A" shares the full amounts have been called, resulting in the payment of £15,020, and leaving £555 in arrears.

CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY COMPANY (LTD.).—The annual return of this Company, made up to January 4th, has been filed. The Company was registered on June 30, 1883, with a capital of £100,000, in £10 shares, as "The Electric Construction and Maintenance Company (Limited)." By special resolution passed November 18, 1889, and duly confirmed, the name of the Company was changed to "The Electric Installation and Maintenance Company (Limited)." By special resolution passed December 3, 1891, and duly confirmed, the name was changed to its present title, and each of the £10 shares was subdivided into ten £1 shares. At the time of making up 31,850 shares were taken up, of which 17,430 were issued as fully paid. Upon the remaining 14,420 shares the full amounts have been called, and all calls (£14,420) paid. The shareholders include the Electric Construction Corporation (9,270 shares), J. E. H. Gordon (2,889), J. E. H. Gordon and Co. (1,056), Fowler-Waring Cables Company (1,040), Richard Hornsby and Sons (1,500), and J. Spencer Balfour (383).

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY (LIMITED.).—The first annual return of this Company, made up to December 27th last, has been filed. Out of a capital of £15,000, divided into 14,950 ordinary and 50 founders' shares of £1 each, 3,836 ordinary and 50 founders' shares have been taken up. Of these, 851 ordinary shares have been issued as fully paid, although no agreement explaining such issue has as yet been filed. Upon the 50 founders' shares the full amount has been called, and upon the remaining 2,985 ordinary shares 16s. per share has been called, resulting in the payment of £2,350. 10s., and leaving £361. 5s. in arrears. This payment includes £262 paid in advance of calls, and also £11. 15s. forfeited on two founders' and 116 ordinary shares.

OXFORD ELECTRIC COMPANY (LIMITED).—The first annual return of this Company, made up to December 23rd last, has been filed. Out of a capital of £100,000, in £5 shares, 94 shares have been taken up, and the full amount called, resulting in the payment of £412. 10s., and leaving £57. 10s. in arrears. A note at the end of the return states that, "in addition to the above shares, 6,800 shares are appropriated for the payment, on completion of the works in progress, under contract of August 13, 1891, made between this Company and the Electric Construction Corporation (Limited), London, E.C."

UNIVERSAL ARC LAMP SYNDICATE (LIMITED).—The statutory return of this Company, made up to November 30, 1892, has been filed. Out of a nominal capital of £3,000, in £1 shares, 2,865 shares have been taken up. Upon these shares a call of 1s. 6d. per share has been made, resulting in the payment of £228. 15s., which, however, includes the sum resulting from the payment of the £1 per share on 15 shares.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY (LIMITED).—The annual return of this Company, made up to December 15, 1892, has been filed. The Company was registered on April 22, 1890, with a capital of £70,000, in £1 shares. At the time of making up, all the shares were taken up, of which 56,756 have been issued as fully paid. Upon the remaining 13,244 shares the full amounts have been called, and all calls (£13,244) paid.

WILLIAMSON ELECTRICAL AND ENGINEERING COMPANY (LIMITED).—The annual return of this Company, made up to December 22nd last, has been filed. The Company was registered on September 13, 1889, with a capital of £5,000, in £10 shares, to carry on the business of electricians, electrical and general engineers, and contractors, in New South Wales and elsewhere. By special resolution passed July 3, 1891, and confirmed July 21, 1891, the capital was raised to £25,000, in £10 shares, by the creation of 2,000 new shares. At the time of making up 500 shares were taken up, the full amount called, and all calls (£5,000) paid.

WOODFIELD SYNDICATE (LIMITED).—The annual return of this Company, made up to January 2, 1893, has been filed. The Company was registered on May 16, 1891, with a capital of £12,000, divided into 10,000 "A," 1,000 "B," and 1,000 "C" shares of £1 each. At the time of making up all the shares had been taken up, the full amount called, and all calls (£12,000) paid.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The following dividends will be recommended by the Directors of this Company at the meeting of the proprietors on the 27th inst.:—(1) A balance dividend of 17s. 6d. per cent. on the ordinary consolidated stock for the year ended December 31st; (2) a balance dividend of £1. 15s. per cent. on the preferred stock for the same period; both payable on the 28th inst., less income-tax. There will be a sum of about £737 carried forward. These dividends, with those already paid, will amount to £2. 15s. per cent. on the ordinary consolidated stock, and £5. 10s. per cent. on the preferred stock for the year 1892. The transfer books will be closed from the 13th to the 28th inst.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended January 15th were £1,007, as against £836 for the corresponding period of last year, being an increase of £171. The total receipts for half-year amount to £2,005, against £1,694 in the corresponding period of 1892, being an increase of £311.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Directors of this Company announce the payment of an interim dividend of 3s. 6d. per share, free of income-tax (being at the rate of 3½ per cent. per annum)

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for the quarter ended December 31st last, the dividend to be payable on and after the 28th inst. £4,000 is placed to revenue, and £3,129 carried forward.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended January 13, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,664.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended January 15th were £2,522, as compared with £2,371 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 11.	Price Wednesday, Jan. 18.	Rate per Cent. Yielded.	Dividend Due.	Business done during week ending Jan. 18. Highest	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	51½ 52½	52½ 53½	4 13 6	Jan., Apr., July, Oct.	53¼	51⅝
£2,876,140	Stock	25/0	Do. Preferred	92½ 93½	94½ 95½	5 9 10	" "	95	93
£2,876,140	Stock	5/0	Do. Deferred	11 11½	11⅜ 12⅜	..	" "	12⅛	11½
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11 11½	11 11½	5 13 1	Mar., June, Oct., Dec.	11⅜	..
£68,200	£100	5%	Do. 5 per Cent. Bonds	101 104	101 104	4 16 2	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	104 108	104 108	4 12 7	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175 180	175 180	3 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½ 12½	11½ 12½	6 19 2	February and August	..	..
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2 3	2 3	5 6 8	April and October	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11½ 11⅝	11½ 11⅝	5 19 2	Jan., Apr., July, Oct.	11⅝	11½
400,000	10	2/6	Eastern xd	14⅜ 15	14⅝ 14⅞	4 7 5	" "	14 15/16	14⅜
70,000	10	6%	Do. 6 per Cent. Preference xd	16 16½	16 17	3 10 7	" "	16½	..
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	110 113	1 0 113	3 10 10	May and November	112¼	111¼
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension xd	14¾ 15	14¾ 15	4 13 4	Jan., Apr., July, Oct.	14 15/16	14 13/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	111 114	111 114	3 10 2	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102 105	102 105	4 15 2	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101 104	101 104	4 16 2	" "	103½	103
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103 106	103 106	3 15 6	February & August	..	..
180,227	10	1/3	Globe Telegraph and Trust xd	9⅜ 9⅞	9⅝ 9⅞	4 16 2	Jan., Apr., July, Oct.	9⅞	9⅝
180,042	10	6%	Do. 6 per Cent. Preference xd	15 15½	15 15½	3 18 8	" "	15 3/16	15
150,000	10	5/0	Great Northern	18¾ 19¼	18¾ 19¼	4 8 4	Jan., April, and July	18⅜	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104 107	105 108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	44 46	44 46	5 8 8	May and November	44¾	..
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108 111	108 111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October	..	..
3,381	£100 Cert.	30 0	Submarine Cables Trust 6%	117 122	117 122	4 18 4	" "	120	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	101 104	101 104	4 16 2	March & September	101½	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	101 105	101 105	7 12 5	June and December	..	..
88,321	10	6d.	West India and Panama	1½ 1⅝	1⅝ 1⅝	..	" "	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½ 10⅝	10½ 10⅝	5 11 7	May and November	10⅜	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8⅛ 9⅛	8⅛ 9⅛	6 6 4	" "	..	..
£30,000	100	5%	Do. 5 per Cent. Debentures, 1907	104 107	105 108	4 12 7	June and December	..	..
64,242	15	3/0	Western and Brazilian	7½ 8	7⅛ 8	5 13 2	" "	8	7⅞
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5½ 6	5⅝ 6¼	6 0 1	" "	5 15/16	5⅞
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾ 2¼	1¾ 2¼	..	" "	2 1/16	1⅞
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106 109	106 109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106 109	106 109	5 10 1	" "	109	106½
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	100 103	100 103	5 16 6	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
22,500	14/0	1½d.	Consolidated Telephone Const. & Maintenance	1 1/16 1 3/16	1 1/16 1 3/16	7 16 5	May and November	..	..
20,000	£1	4½d.	Oriental (11s. paid)	1 1/16 1 1/16	1 1/16 1 1/16	7 18 2	Yearly	..	..
454,747	5	2/6	National	4½ 5	4⅝ 5	6 0 0	June and December	5	4 1/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 15	14 15	4 0 0	" "	15	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13¾ 14½	13⅜ 14½	4 4 3	" "	14 1/16	..
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	4½ 4⅝	4½ 4⅝	..	..	4⅝	4⅜
726 477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	111 113	111 113	3 9 8	January and July	112¼	112⅝
48,000	£10	..	New Telephone, Limited (£4 paid)	4⅜ 5	..	..	..	..	..
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	10¾ 11½	11⅜ 12⅛		..	12	10⅞
20,000	£10	..	Do. 6 per Cent. Preference	5½ 5¾	7¾ 8¼	2 18 2	..	8	5⅝
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	5 5¼	5 5¼	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	1½ 2⅛	1⅝ 2⅛	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5⅛	5 5⅛	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	6 6⅛	6 6⅛	..	January and July	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	3⅝ 3⅞	3⅞ 4⅛	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5⅛ 5⅜	5⅜ 5⅝	..	March	..	..
111,000	5	..	London Electric Supply	5/8 7/8	5/8 7/8	..	..	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6¾ 7¼	6¾ 7¼	..	..	7	6¾
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5 6	..	..	..	..
18,680	£5	2/6	St. James' and Pall Mall	7⅜ 8½	7½ 8	..	..	..	..
7,900	£5	7%	Do. 7% Preference	8¼ 8⅝	8¼ 8⅝	4 0 0	..	8⅝	8 1/16
42,853	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 10 0	..	5 15/16	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/9 3/5	Brush Electrical Engineering	3 3½	3⅛ 3⅜	..	..	3½	3 1/16
69,996	2	6%	Do. 6 per Cent. Preference	2¼ 2⅜	2¼ 2⅜	4 16 0	..	2 3/16	2⅛
£125,000	Stock	..	Do. 4½ per Cent. Debentures	100 102	101 103	..	..	102	101
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July	5⅜	..
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	1⅜ 2¼	.. ..	..	..	..	..
45,000	10	12/0	Electric Construction	2¼ 2⅜	2¼ 2⅜	..	..	2⅜	2¼
70,000	2	10/0	Elmore's Patent Copper Depositing	1/2 3/4	3/8 6/8	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha & c., Works	21½ 22½	21½ 22½	5 11 1	February & August	22⅜	21⅞
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/9 4/3	4/0 5/0	..	..	..	..
78,949	5	4/2⅝	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	3⅜	3 5/16
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July	46⅜	4t½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July	..	..
..	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	¾ 1¼	..	..	..	..
..	£5	8%	Do. Preference (fully paid)	¾ 1¼	.. ..	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	.. ..	.. ..	..	..	..	..
600,000	Stock	½%	Do. Stock	35 38	35 38	1 6 3	May and November	36½	..

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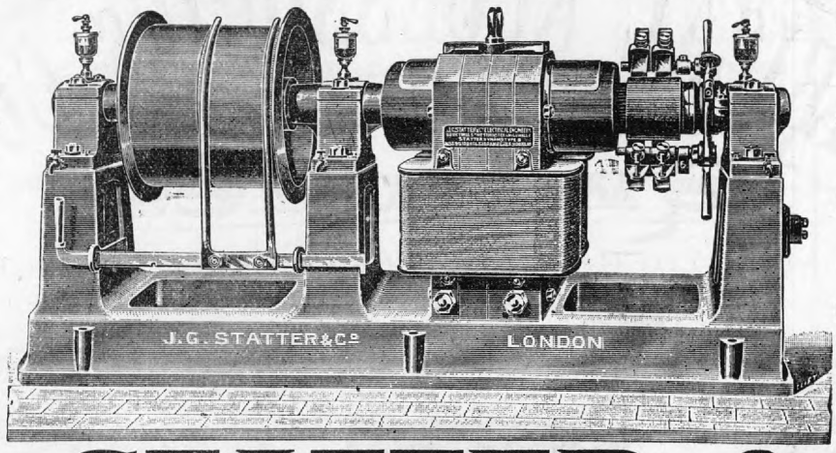

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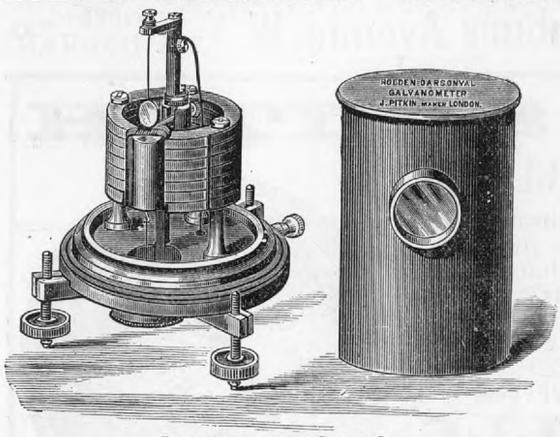

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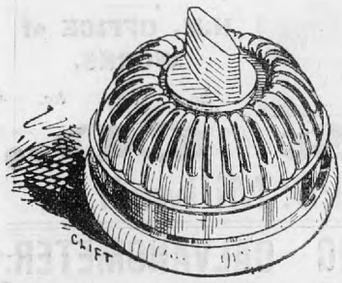

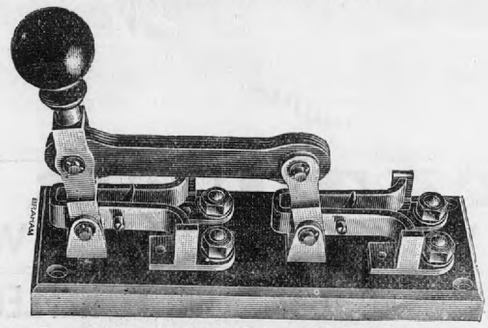

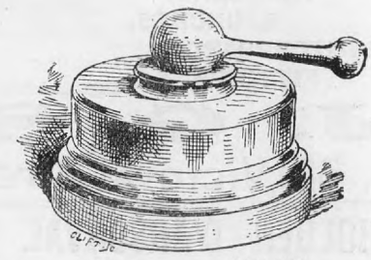

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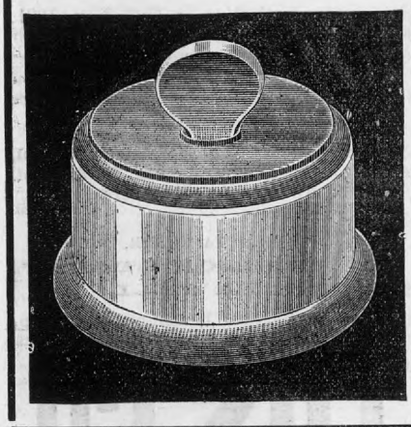

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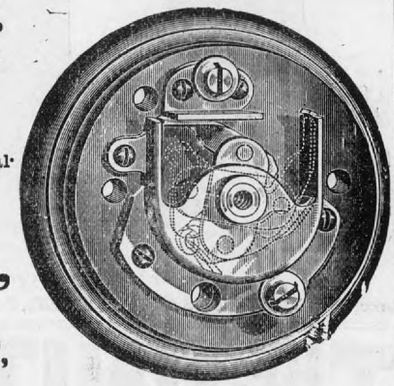

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And Albert Square, MANCHESTER.

SALES BY AUCTION, &c.

FEBRUARY, 1st and 2nd, 1893.

Re Thomas Barraclough and Co., Limited (In Liquidation).

TO ELECTRICAL CABLE and TELEGRAPH WIRE MANUFACTURERS.

WHEATLEY KIRK, PRICE AND GOULTY have received instructions from the Liquidator to SELL BY AUCTION in detail, on WEDNESDAY and THURSDAY, 1st and 2nd, February, 1893.

Commencing at Eleven O'clock prompt each day, at the GLOBE WORKS, WHITLEY STREET, ROCHDALE ROAD, MANCHESTER, the whole of the PLANT AND MACHINERY,

A Valuable and Special assortment of PATTERNS and DRAWINGS for TELEGRAPH and ELECTRIC CABLE MACHINERY,

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Catalogues may be obtained, gratis, from the Liquidator, Alfred Tongue, Esq.; of Messrs. Edwin Collier and Co., Chartered Accountants, 44, Brown-st., Manchester; Messrs. Crofton and Craven, Solicitors, 36, Brazenose-st., Manchester; or from Wheatley Kirk, Price and Goulty, Albert Chambers, Albert Square, Manchester and 49, Queen Victoria-st., London, E.C.

NOTICE.

ELECTRIC LIGHTING: CITY OF LONDON.

THE CITY OF LONDON ELECTRIC LIGHTING COMPANY (Limited) hereby Gives NOTICE that, unless prevented by unforseen circumstances, ELECTRIC ENERGY will be LAID ON within the next few months in the areas specified below:—

Consumers will be connected up in the order of application, provided they are ready to receive current when the Company is ready to supply. To enable the Company to make timely provisions all applications should be sent in as early as possible. The Company will not guarantee to supply all consumers within these areas during the present year unless application be made before the 31st March next.

1. Nicholas Cole Abbey sub-area bounded on the
   N. by St. Paul's-churchyard and Cannon-street,
   E. by Friday-street and Bread-street-hill.
   S. by River Thames.
   W. by St. Andrew's-hill and Creed-lane.
   Finsbury-circus sub-area bounded on the
   N. by South-place, Eldon-street and Liverpool-street.
   E. by Bishopsgate-street, Without.
   S. by London-wall and Wormwood-street.
   W. by Finsbury-pavement.
3. Salisbury-square sub-area, bounded on the
   N. by Fleet-street.
   E. by New Bridge-street.
   S. by The Embankment.
   W. by The City Boundary.
4. Billiter-avenue sub-area, bounded by Leadenhall-street, Fenchurch-street, and Gracechurch-street.
5. Farringdon-street sub-area bounded on the
   N. by Holborn Viaduct.
   E. by Old Bailey.
   S. by Ludgate-hill.
   W. by St. Bride-street, Shoe-lane, and St. Andrew's-street.

A further list of sub-areas will shortly be issued.
Forms of applications and all particulars can be obtained at this office.

By order,
DAVID COOK, Engineer and Manager,

1, Great Winchester-street, E.C.
21st January, 1893.

BOROUGH OF NOTTINGHAM.

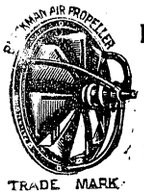
The CORPORATION of NOTTINGHAM are prepared to receive TENDERS for the SUPPLY and ERECTION of BOILERS at the Electric Station, Wollaton Street.

Specifications can be obtained on application to the Electrical Engineer, Guildhall, A fee of one guinea will be charged for the specification which will be refunded on the return of the specification accompanied by a bona fide tender,

Tenders must be delivered to me at the Guildhall not later than THURSDAY, February 16th, 1893.

By order,
SAM GEO. JOHNSON, Town Clerk,

Guildhall, Nottingham.
24th January, 1893.



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Candidates must have had some experience in Engineering Workshops, and possess certificates from the Electrical Engineering Department of some Technical School.

Applications in which candidates' ages must be stated, accompanied by copies of the necessary certificates to be endorsed "Improvers for Electric Light Works," to be delivered to me on or before 10 a.m. on THURSDAY, February 9th next.

F. HARMAN LEWIS, Borough Electrical Engineer.

Electric Light Station, Hull.

ELECTRICIAN.—A firm of manufacturers about to convert into limited liability require an Electrician, with commercial experience, as director and engineer. Investment required £1,000, suitable remuneration.—Address, "VOLTS." care of Evan Streachan, Advertising Agent, 295, Strand.

MESSRS. JOHNSON & PHILLIPS require a CHIEF DRAUGHTSMAN for their Electric Light Department. Applicants must have filled a similar position, and be thoroughly conversant with the Design of Modern Dynamos and other Electrical Apparatus, and be capable of superintending the manufacture. Apply by letter, giving testimonials, experience, and salary required, to the Works, Charlton, Kent.

WANTED by a London Electrical Firm, an experienced out-door REPRESENTATIVE with good connection.—Apply with particulars of previous occupation and remuneration expected to No. 1152, *Electrician* Office, Salisbury Court, Fleet Street, E.C.

WANTED, a WORKING FOREMAN to take charge of Electric Light Wiring and Fixing Fittings; constant job for a reliable man.—Apply by letter, with references and full particulars and salary required, to "W.S." 188, Walton Street, Chelsea, S.W.

ELECTRICIAN (19½) desires SITUATION. Competent to assist in erecting Lighting Installations and preparing plans for same. 3 years' experience, excellent testimonials.—P. PASK, 23, Mawson Road, Cambridge.

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Miscellaneous Advertisements, Plant Wanted and for Sale, &c., &c., continued on next page.

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ARMATURE WINDERS.—Electric Light Wiremen and others before applying for or accepting work communicate with the GENERAL SECRETARY, Electrical Trades Union, 19, Claude Road, Peckham.

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TWO 164 H.P. Nom. BABCOCK-WILLCOX BOILERS.
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Tubes for conveying Wire & Cables.

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NOTICE is Hereby Given that the FOUR PER CENT. MORTGAGE DEBENTURE STOCK REGISTER will be CLOSED from the 27th to the 31st instant, both days inclusive.

By order,
(Signed) F. E. HESSE, Secretary.
Winchester House, Old Broad Street, E.C.
25th January, 1893.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (Limited).

NOTICE is Hereby Given, that the COUPONS on this Company's FIVE per CENT. DEBENTURES, 1884 Issue, due 31st instant, will be PAID, on and after that date, at Parr's Banking Company and the Alliance Bank (Limited), Bartholomew-lane, London, E.C.
Coupons must be left at the above Bank three clear days for examination.

By order,
RICHARD COLLETT, Secretary.
Winchester House, Old Broad-street, London, E.C.
January 20th, 1893.

SUBMARINE CABLES TRUST.

NOTICE is Hereby Given that on and after the 7th February the sum of £1. 10s., BALANCE of the COUPON due 15th October, 1892, will be PAID by Messrs. GLYN, MILLS & CO., of 67, Lombard Street, between the hours of 10 a.m. and 2 p.m.
The Coupons should be left with the Bankers for examination four clear days before payment.

By order of the Trustees,
A. BRODRICK, Secretary.
Winchester House, 50, Old Broad Street, London.
26th January, 1893.

In the matter of a DEED OF ASSIGNMENT for the BENEFIT of CREDITORS executed on the 15th day of June, 1892, by Arthur Bernard Gill, residing at Grove Park, in the county of Kent, and carrying on business as an Electrical Engineer, at No. 36, Parliament Street, in the City of Westminster, under the name of Messrs. A. B. Gill & Co.

THE CREDITORS of the above-named Arthur Bernard Gill who have not already sent in their claims, are required, on or before the TWENTY-FOURTH day of FEBRUARY next, to send in their names and addresses, and the particulars of their debts or claims, to me, the undersigned, Arthur Thomas Clarke, of No. 6, Lombard Court, in the City of London, the Trustee under the said Deed, or in default thereof they will be excluded from the benefit of the Dividend proposed to be declared by me.
Dated this 24th day of January, 1893.

ARTHUR T. CLARKE,
Trustee.

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For the use of Electricians and Engineers.

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A Popular Dictionary of Words and Terms used in the Practice of Electrical Engineering.

Comprising upwards of 3,000 Definitions,

By T. O'CONOR SLOANE, Ph.D.
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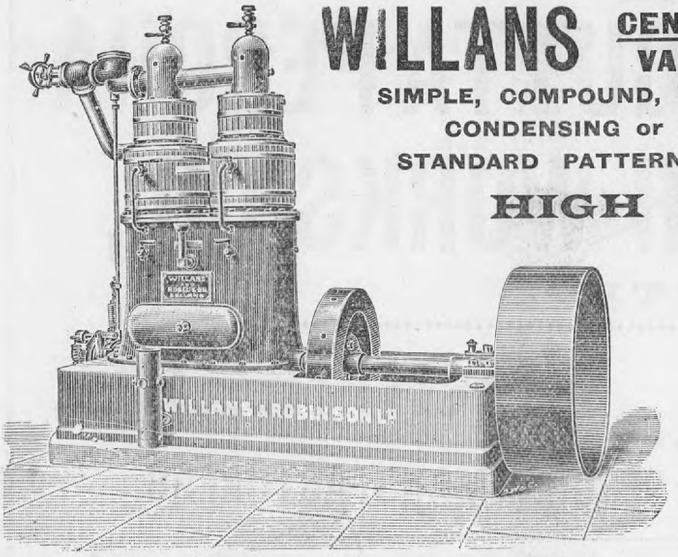

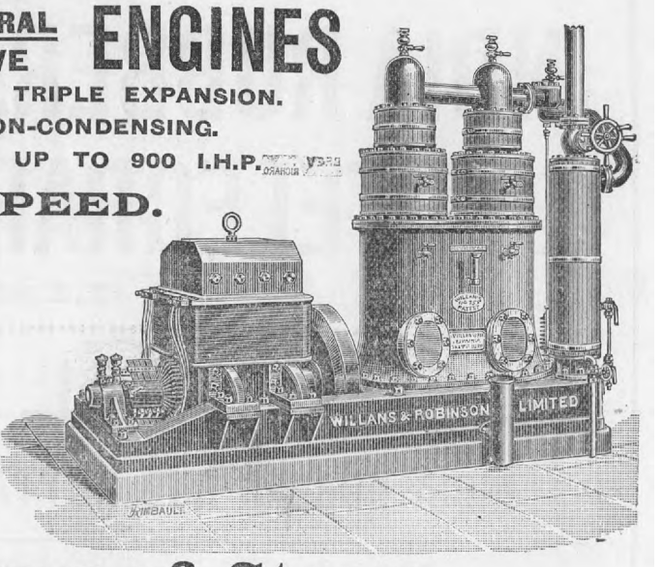

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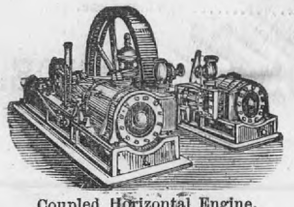
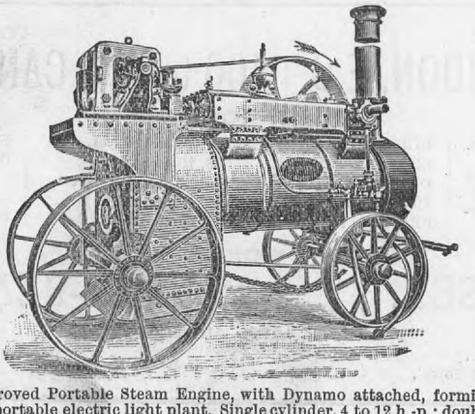


Coupled Horizontal Engine, 40 to 1,000 H.P.



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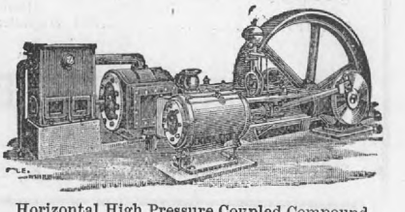

Horizontal High Pressure Coupled Compound Engine. 12 to 1,000 H.P.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 767.—Vol. XXX. FRIDAY, JANUARY 27, 1893. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6.

NOTES.

After an interval of seven months, Prof. Dewar has again exhibited the wonders of liquefied oxygen and air at the Royal Institution, and has given an account of the further researches which have been made possible by the low temperature at his command. There is little news of electrical interest, beyond the fact that, while nitrogen is not magnetic, a magnet does not suck the oxygen out of liquid air. The condensation of the mercury vapour in a Torricellian vacuum lowers the tension at −80°C. to about 0·000,000,003 of an atmosphere. The resistance of metals and of alloys was, of course, discussed; and, in referring to the fall of resistance of carbon, and the fact, which we pointed out in October, 1892, that at a temperature of about 3,200°C. the resistance would vanish, Prof. Dewar was obliging enough to withdraw his old determination of 6,000°C. as the temperature of the arc, which, as we have already suggested, upset the coincidence. As radiant energy is now included in electrical science, we may note the ingenious method of keeping liquid oxygen when once it has been obtained. Prof. Dewar surrounds the vessel with a vacuum jacket. Still air is an excellent lagging; but it is essential that it be kept still. The smallest convection currents do mischief, as is well understood in refrigerated meat stores; if air cannot be kept still it had better be excluded. This is clear enough; but the leading daily journal, in an otherwise excellent "special article," deduces the conclusion and promulgates the announcement that no radiation can take place across a vacuum!

The meeting of the shareholders of the St. James and Pall Mall Electric Light Company was in many respects a remarkable one. As a rule, when a concern is paying an honestly earned dividend at the rate of 7¼ per cent. per annum, and is setting aside substantial sums for depreciation and something for redemption of capital, everything passes off with surprising smoothness. On this occasion, however, there was a determined attempt to force the Board into comparatively reckless financial courses, the amounts set aside for depreciation and the capital redemption fund being deemed detrimental to the immediate interests of the holders of founders' shares. It is a matter for satisfaction that it was finally decided to leave this subject to the discretion of the Board. In common with other electricity supply companies, the St. James is suffering from the increased wariness of its customers. During 1892 the lampage has grown by 24·4 per cent., but not so the gross revenue, that has exhibited the comparatively modest expansion of 10·4 per cent. The coal consumption has been diminished by ¼lb. per unit sold, while that of water has been reduced from 13·6 to 11·75lb. per lb. of coal. Although the consumption of energy has increased by some 10 per cent., the cost of fuel has remained stationary, and that of oil, waste, &c., has gone down. We trust the St. James Company will continue to run in this groove of prosperity and sound finance.

The financial result of the working of the City and South London Railway for the half-year ended December 31st last, shows an improvement upon that arrived at in the correspond- period of 1891. During the last six months of 1892, the passenger receipts amounted in round figures to £22,000, as against £19,800 for the last six months of 1891. On the other hand, the corresponding total expenses were in round figures £15,390 and £15,516. The outcome being a dividend at the rate of ⅝ths per cent. per annum to the ordinary shareholders. Since the opening of the line some two years ago, more than 11½ million passengers have been carried; and the figure for the last half of 1892, exhibits a 17 per cent. increase upon that for the corresponding period, the increase in train mileage being nearly 14 per cent. The locomotive and generating expenses per train mile run are now down to 7·1d.

Many of the "notes" which we have extracted from the Paper read by Messrs. Brew and Ledger at the Old Students' Association refer rather to the management of isolated plant than to the practice of supply stations, and the interesting observations on the coupling of compound-wound dynamos do not apply to ordinary central stations. But with plain shunt-wound dynamos conditions may easily arise which will cause unstable equilibrium of load or hunting of the engines. This subject was fully discussed in a series of articles in *Industries* in 1890. Abstracts will be found in Vol. XXV. of *The Electrician* under the title of "Coupling and Control of Dynamos at Central Stations." Where batteries are used, the sole advantage of compound winding, namely, that it allows the machines to be over-compounded to suit the feeders, disappears. The control of the voltage of a station does not appear to present any serious difficulties in practice. But considering the low plant factor of some stations—that is to say, the ratio of the actual output to the full load output of the same number of dynamos for a given time—there is reason

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to suppose that the whole load is not so evenly distributed among the dynamos as is generally imagined. Some rather interesting experience on this point is recorded in another column under the title of "Non-Polarised Ammeters."

THE contribution to the obscure question of "stand-by" losses in boilers in Messrs. BREW and LEDGER'S Paper must be considered in connection with the fact that the steam-pressure was not maintained throughout the day, ready for running at short notice. No doubt some information from central station practice will be forthcoming before long, but these losses have their importance in isolated plant. It is difficult to see why they should be so much greater per hour in boilers which stand fourteen hours or so, than in ordinary factory boilers. These latter stand all night without attention, and without losing more than a pound or two of pressure. It is claimed for water-tube boilers that there is in them so little water to cool, that little coal is needed to bring them up to work again; but it is doubtful whether any other kind suffers so much by radiation. Lancashire boilers, of course, take up more room than can generally be spared, but a marine boiler could be lagged and French-polished all over if required. We should like to see some comparative figures of the "stand-by" losses of different types of boilers.

AN interesting discussion on three Papers on "Electric Traction" took place at a recent meeting of the American Institute of Electrical Engineers. The difficulty of dividing the current equally between two motors in parallel was alluded to, the problem being not unlike that of generating with two dynamos in parallel. Cases were mentioned in which not only did one motor do no work, but acted as a generator giving out 10 or 11 amperes. Mr. SPRAGUE believed that all fancy systems of traction, such as the series or double wire, were "practically dead, and we have come, on the 500 railroads in operation in the United States and elsewhere, to one single method of operation, a multiple arc system of distribution with a single wire overhead—and that is where we will stand." We are sorry to learn this, for it will render American experience in these matters of less use to us than ever, and, as in electric lighting, we shall have to design our stations and underground conductors as best we can. The opinion of the Mayor of Coventry may be taken as an indication of public opinion about trolley wires, at least in our towns, when he moved the adoption of the report recommending the Corporation "not to consent to such a system in Coventry under any circumstances whatever."

Mr. LEONARD'S ingenious suggestion of the use of a dynamotor in conjunction with a driving motor, described in *The Electrician*, Vol. XXIX., p. 200, did not meet with much approval during the discussion; nor did the great importance of a variable gear appear to be recognised. Dr. CHAS. EMERY described the use of a pump of variable capacity working a hydraulic motor, but it was not clear whether the pump was capable of a change of stroke, or whether a mere bye-pass was employed. Dr. EMERY, in describing the experiment, said that the fluid rapidly heated, although it circulated in 4in. pipes under a pressure of about 300lb. A large number of inventors appear to be at work on the problem in the United States. The Wenstrom hydraulic gear was alluded to in a note on page 1 of *The Electrician*, Vol. XXVI. We did not reproduce the description and illustration which appeared in American journals, since, after spending much pains, we could not make out the action of the parts from the drawing; but the principle was clear enough. There was a rotary oil pump and a bye-pass, and the effect was exactly that of a friction clutch. The whole of the work lost must be spent in heat. We do not think much of the bye-pass or friction clutch idea, but should be interested to see a variable gear constructed on the lines which we suggested in November, 1890.

THE substitution of a supply by meter at 6d. per Board of Trade unit, for a supply by contract at the rate of six shillings per ten-candle lamp per annum, has given rise at Bath to as near an approach to a riot as the inhabitants of that staid spa can be expected to venture on. Meters came generally into vogue on September 29th last, and the receipt of the bills for the Christmas quarter is alleged to have caused "a feeling of intense dissatisfaction" among certain consumers, chiefly tradesmen, and numbering only 7 per cent. of the total, the Company asserts. Had the City of Bath Electric Lighting and Engineering Company possessed a trained diplomat on its staff the blunder of switching over from a contract to a meter supply just as the dark days were beginning would not have been committed. The change should have been made during the dog days, and the consumers should have been brought gradually up to the fence. Lawsuits, public meetings, and boycottings are under weigh.

ON looking to see what type of meter was the source of this disturbance we rubbed our editorial eyes, for it is said to be one made by the Westinghouse Company, and is, therefore, presumably, the Shallenberger, the only meter for which the Board of Trade will go bail. The violence of the agitation would seem to render desirable the placing of certain eminent Board of Trade Electrical Standardising Laboratory officials under police protection. Seriously speaking, however, the Bath Company will do well to season the justice of its meters with a little mercy, for it was something in the nature of a sudden jump from a £5 to a £14 quarterly bill that made JOHN HAMPDEN take the field.

THE dangers of joking on serious matters are never more apparent than when we endeavour to liven up the tedious narratives of patent litigation by a little mild banter. During the LANE-FOX case we parodied a definition of an ampere-hour, but failed to explain with sufficient clearness that it was not solid fact. The definition, in consequence, was quoted by an American journal with some solemn remarks about newspaper science, and suggesting that the paragraph would have been "better suited for a humorous column in an electrical journal"! After giving the definition in full, our contemporary recommended the learned experts, who were supposed to be responsible, to "begin again by studying some ele-

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mentary work on electricity," and ended with the unkind suggestion — "Possibly these are the English 'electricians' to whom we Americans are indebted for the many unjust, undignified, and untrue remarks about progress in the electrical industry in this country." Nor was this all: the "ampere hour" *badinage* found its way into a French journal; not directly from our columns, it seems, but having twice crossed the Atlantic. Such poor humour as the parody possessed was not, we think, lost in the French translation; but it was followed by "*Oh ma pauvre tête, oh le pauvre tribunal!*"

In our leading article last week on the result of the Hopkinson three-wire case we ventured to quote from Goldsmith's "Elegy on the Death of a Mad Dog." It seemed to be rather more appropriate than Shakespeare's "engineer hoist with his own petard." But Mr. Andrews calls upon us to withdraw it, since he thinks that it may be interpreted to mean that *he* went into the witness-box "to gain *his* private ends." Mr. Andrews' attention was called to the words by a friend, who apparently did not recognise them as poetical, but seems to have thought they were an effusion of our own. This is very flattering, but we must confess that they were not meant to be taken in desperate realism, and we will do the thing handsomely while we are about it, and withdraw the whole quotation, including the obvious allegation that Mr. Andrews went mad and bit Dr. Hopkinson. We trust this incident may now be considered at an end.

The Belgian Telephone System.—The telephonic system of Belgium has been formally taken over by the Government.

The Crossley Telephone Transmitter Patent.—This patent, No. 412, of 1879, expires on Wednesday next, February 1st.

Experimental Researches on Alternate Current Transformers.—We hear that Dr. Fleming's reply will not merely be printed in the *Journal* as was announced at the close of the discussion on his Paper, but that Thursday evening, February 9th, will be allotted to him.

Cable Interruptions—

	Interrupted.
Cayenne-Vizeu	September 24, 1892.
Senegal-Pernambuco	December 26, 1892.
*Lourenco-Marques-Mozambique ..	January 25, 1893.

*Communication with South Africa is still maintained by the West Coast route

Bedford.—A special meeting of the Town Council was held on Thursday last week for the consideration of the electric lighting of the borough. The following motion by Captain Verey was carried:—"That the Urban Sanitary Authority do not themselves undertake the electric lighting of this borough, but at once take steps to make arrangements with a private company, under conditions to be hereafter arranged."

International Inter-Communication.—At a lecture on Tuesday to the Young Men's Association at Wanstead by Mr. W. P. Forbes, on "The Collection and Distribution of News," telegraphic instruments were shown in operation, and a wire having been connected to the Direct United States Cable Company's system, a congratulatory message was sent from the hall to Mr. Grover Cleveland in New Jersey, and in a few minutes an appreciative reply was received from the President-elect.

Croydon.—The limited area of Croydon which it was proposed to supply with the electric light is not to be so supplied, at the present moment at any rate. On Monday night last week, the Croydon County Council had before them the proposition of the General Purposes Committee to spend the sum of £22,500 in the supply of electricity to a central part of the borough. After a long discussion the proposal was negatived, although only by the casting vote of the Mayor.

British Museum Reading-Room.—More complaints are appearing in the daily papers about the unsteadiness and hissing of the arc lamps in the British Museum Reading-room. As the lamps take thirty amperes and are arranged two in series on 130 volts, the cause is not far to seek. The conditions are probably more difficult than any other arc lamps in London. Thirty ampere arcs are not easy to regulate, and running lamps two in series is about as trying an arrangement as any that could be suggested.

Telegraphic Communication with Egypt.—A fierce hurricane has been raging in Egypt during this week, and has broken the cables between Alexandria and Malta and Alexandria and Port Said. The wires between Alexandria and Cairo are nearly all destroyed, but one direct cable is still working with Malta.—The Eastern Telegraph Company, however, under date of 26th inst., notify that their lines in Egypt are completely restored, thus re-establishing telegraph communication with Egypt, India, and beyond.

Electric Meters.—In the Westminster County Court on Wednesday, the case of the Metropolitan Electric Light Company *v.* Nathan came before Judge Bayley. The plaintiffs claimed £3. 17s. 4d. for 128 units of electricity supplied. The defence was that the amount charged for was more than was consumed. The plaintiffs said that under their Act of Parliament the meter index was conclusive. Whatever the meter registered the consumer was liable for. Judgment was given for the plaintiffs for the amount claimed, with costs.

The Practical Measurement of Alternating Electric Currents.—On Monday evening next Dr. Fleming will commence a course of four Cantor lectures on this subject. The course will include graphic representations of periodic currents, their analysis and synthesis, alternate current measuring instruments, laws of current flow in inductive circuits, the construction of non-inductive resistances, capacity effects, the measurement of alternate current power, alternate current meters, methods of measuring total output of alternate current central stations.

Derry.—The Local Government Board have intimated that they are prepared to permit an electric lighting loan of £15,000 at 3½ per cent. interest, the principal to be repaid by equal instalments extending over a period of twenty-five years. The Lighting Committee have decided to further communicate with the Local Government Board with the view of having the repayment of the loan spread over an extended number of years, but in the event of the Board being unable to do this the loan will be taken out at twenty-five years and the work proceeded with.

The Chicago Exhibition.—Mr. H. D. Wilkinson, whose series of articles on "Submarine Cable Laying and Repairing" many of our readers have no doubt read with interest, has been appointed engineer to the British Section of the Chicago Exhibition, and will sail on or about the 20th prox. Mr. Wilkinson is "an old Exhibition hand." At the Paris Exhibition of 1889 he was in charge of Messrs. Davey Paxman's fine exhibit, in 1891 he was responsible for the electric lighting of the Naval Exhibition, and at the Crystal Palace Exhibition of last year Mr. Wilkinson also held an important post.

Coventry.—At the last meeting of the Town Council, the consideration of the General Works Committee's report on the question of electric traction for the Coventry and district tramways, which had been adjourned from the meeting a month ago, was resumed. The Mayor moved the adoption of the report, which recommended the Corporation "not to consent to such a system in Coventry under any circumstances whatever." This motion was not carried, and the matter was referred back to the committee. The method objected to by the Mayor is the Thomson-Houston overhead trolley, which has been proposed by Mr. W. S. Graff Baker.

The Pacific Cable.—It is understood that the Premier of Victoria, Mr. J. B. Patterson, will enunciate the policy of the new Government at the meeting of the Melbourne Chamber of Commerce on Tuesday next. Mr. Patterson is said to be strongly opposed to the French project for constructing a line of cable from Australia to New Caledonia, as the first section

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of the Pacific scheme. He urges that the several Chambers of Commerce throughout Australia should rather seek to co-operate with the projectors of the route *via* Canada in bringing pressure to bear upon the Imperial Government to facilitate the adoption of that line for the duplicate cable which is regarded as desirable.

Obituary.—The death is announced, at Melbourne, on the 11th ult., of Captain F. C. Rowan. Captain Rowan, who was only 47 years of age, was born in England and educated in Canada, where his father, who was an engineer, built the first railway in that dependency. He was educated for the army, and went to Victoria about 20 years ago, where he entered into business. Having always a keen interest in scientific matters, he became connected with the electric lighting movement, and became manager of the Australasian Electric Light, Power, and Storage Company. About three years ago the Company was bought by the Brush Company, and Captain Rowan continued his management under the new proprietary.

Windsor.—In reference to our note on p. 320 of our last issue respecting the Windsor electric lighting difficulty, it is necessary to explain that it is not the Corporation, but the Windsor and Eton Electric Light Company who are seeking to introduce the new illuminant to the Royal borough; and also that since the recent police-court proceedings the Company have not attempted any further opening up of the streets without permission. On the contrary, being asked by a leading tradesman to connect his premises with their mains on the opposite side of the street, the Company applied to the Corporation for leave for this purpose, and it was over this application that the wrangle in the Town Council arose, to which we referred last week. The Corporation have not yet accorded the permission asked for

The City Lighting.—In the course of his address to the Commissioners of Sewers, reviewing the past year's work, Mr. Alderman Treloar referred in the following terms to the City lighting :—

> Great progress has been made with electric lighting, and, indeed, the street lighting in all the main thoroughfares is virtually completed ; the side streets it is proposed eventually to light by means of glow lamps. I am sorry to say that, as regards the private lighting, we are much behind, and every effort should be made to press this on. The City of London Electric Lighting Company, in laying their tubes, took the opportunity, in a very enterprising manner, of placing other tubes sides by side with them, not only sub-terra but sub-rosa, with the view of ultimately using them for telephonic purposes. They cannot, however, so use these extra tubes without the consent of the Commission. Negotiations are now in progress to obtain from the company some practical advantage for the ratepayers before we give our consent.

The City and South London Railway.—The following letter, signed T. W. Ockenden, appeared in the *City Press* of Wednesday last :—

> Sir : The utility of this railway would be further increased if the Directors would have the seats in the carriages taken away altogether. At present there is sitting accommodation for 16 in each compartment. By mutual squeezing 20 find sitting space somehow. On the journey to town from 13 to 20 more passengers are packed in by the Company's ever-loyal turnkeys. The new arrivals stand, some of them on one leg, and balance themselves by clinging to a rail courteously placed for the purpose in the low roof overhead. It is manifest that the seats are simply an obstruction, and if removed more heads of human cattle could be conveyed, to the obvious advantage of the Company's exchequer. Now and then the lights go out, and some day, when the train comes to a standstill, if a panic should happen amongst the people thus wedged together and locked in, with all chance of escape cut off, perhaps some lives will be sacrificed, and then probably the Company will treat their patrons with more consideration

Nottingham.—On Thursday, the 12th, the new technical schools were opened with considerable ceremony, speeches being made by Lord Belper, Prof. Stuart, M.P., and the Postmaster-General. Subsequently the buildings were thrown open to the public, who manifested the greatest interest in the exhibits of local industrial products, and machinery of various kinds in motions, which had been got together by Prof. William Robinson. Amongst the electrical exhibits were some by the Brush Company, Crompton and Co., Nalder Bros. and Co., Mr. R. W. Paul, J. H. Holmes and Co. (Newcastle). The dynamo room contains a 30 H.P. compound vertical high-speed steam-engine, coupled direct to a dynamo generating current for lighting the entire building. The electric lighting plant was supplied by the Brush Company at cost price. The wiring was carried out by the senior students of the College, and a foreman from the Brush Company. In the dynamo room there is also a petroleum oil engine, supplied to the Committee at half-price, by Messrs. Priestman Brothers, Hull. This engine drives the various dynamos for testing purposes.

The Decimal System.—On Wednesday a deputation, representing the New Decimal Association, the chambers of commerce, and trades unions, as well as various scientific and educational institutions, waited upon the Chancellor of the Exchequer, at the Treasury Offices, for the purpose of urging upon the Government the adoption of the decimal and metrical system of weights, measures, and coinage, or to appoint a committee of inquiry into the subject. Amongst those present were Lord Kelvin, Sir Henry Roscoe, Sir A. K. Rollitt, Dr Gladstone, Sir Philip Magnus, Mr. J. Emerson Dowson, Mr. A. E. Siemens, and Major-General Webber. The Chancellor of the Exchequer said it was quite unnecessary to convince him that the decimal system was good. The point to be considered, however, was the practicability of its adoption at the present moment. So far as he knew, no great change in the currency which governed the wants and the habits of the mass of the people had ever taken place except in coincidence with some great revolution. A decimal system was introduced into Europe by the great French Revolution. The change in Germany took place, not in quiet times, but as a result of a great war and a great change which constituted the unification of Germany. He belived even in the United States the change was made consequent upon the establishment of the Federal system. There was no doubt of the theoretical merits of the system. Mr. Gladstone established the florin for the purpose of breaking ground and opening the way for a decimal system. Unfortunately, the florin had become the most unpopular coin in the country, and they were at present issuing half-crowns because they were preferred to the florin. He wished the deputation every success in the work in which it was engaged, but in his opinion the time had not yet come in which the Government could with any advantage undertake to operate upon a subject for which the great mass of the public was not prepared.

Electric Meters at Bath.—Some of the customers of the City of Bath Electric Lighting and Engineering Company are complaining of the action of the Directors in having departed from the contract system, and substituted meters. The receipt of the bills for the Christmas quarter, says the *Bath Argus*, greatly surprised several of the customers by reason of the unlooked-for excess of the charge by meter as compared with the sum hitherto paid under the contract system. One tradesman had contracted for a supply for £22 a year, and last quarter's bill, when the charges were made according to meter, amounted to only about £3 less than the sum for which a year's supply was originally contracted for. In the corresponding quarter of 1891 another firm was charged £5, and for the three months ending December, 1892, they had to pay £14. Another paid nearly £8, as against £2. 10s. by the contract system. In the case of one Milsom-street establishment the Christmas quarter account comes to £15. 10s., whereas the contract price per quarter is only £11 ; and in another city business, where the contract is for 36s., the last demand amounted to considerably over £4 for the quarter. It is said that many will refuse to continue the light unless some reduction in the price takes place, although private consumers in Bath pay less per Board of Trade unit (6d.) than those in other towns. Some of the consumers say that they would never have entertained the idea of having the light laid on had the probability been held out of such a change taking place, it being represented at the time that the uniform charge of 6s. per annum for a ten-candle power lamp would be cheaper than the price of gas, and that the Company would be able to pay a substantial dividend at this charge for consumption. Some of those who entered into contracts with Mr. Massingham had a proviso added to the agreement to the effect that no increase should be made in the charge for the first seven years, and in these cases the consumers are exempt from the meter arrangement. A public meeting will probably be held.

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ELECTROMAGNETIC THEORY.—XLIII.

BY OLIVER HEAVISIDE.

(*Continued from page 270.*)

§. 181. Still keeping to a simple dielectric, we may always, by consideration of the fact that the speed of propagation is v, find the form of the wave-front due to any collection of point-sources, and trace the changes of shape and position it undergoes as it progresses. For obviously, if a point P be at a distance vt from the nearest source, no disturbance can have reached P from it if it started into action *after* the moment $t=0$; and generally, the effect at P at a given moment arising from a particular source depends upon its state at the moment r/v earlier (if r be the distance from the source to P), and upon the previous state of the source, causing residual or cumulative action at P. We therefore know the limiting distance of action of the sources for every one of their momentary states. The wave-front belonging to a set of disconnected point-sources consists initially of disconnected spheres. But as they expand, they merge into one another to form a continuous extreme wave-front consisting of portions of spheres. When the point-sources are spread continuously over a surface to form a surface-source, we have a continuous wave-front from the first moment; or rather, two wave-fronts, one on each side of the surface. There is an exception, to be mentioned later, when the sources send waves one way only from the surface. This is not the already described case of the cancelling of two trains of waves at particular frequencies, but is a unilateral action obtained by a special arrangement of surface-sources. Passing over this, observe that when we have once got a wave-front we may ignore the sources which produced it, and make the wave-front itself tell us what its subsequent history will be. For, to trace the course of the wave-front from one moment to the next, we have merely to move any element of the surface in the direction of the normal to that element through a small distance a to obtain the new position at the moment a/v later. This being done for the whole surface, gives us the new position of the wave-front, and by continuing this process we may follow the wave-front in its progress as long as we please. Thus the wave-front coming from the surface of a sphere is a sphere; from a round cylinder, if infinitely long, also a round cylinder; but if of finite length, then a cylinder with rounded ends; from a cube, initially a cube with rounded corners, but becoming more and more spherical as it expands; and so on. It is easily seen that at a sufficiently great distance from a finite collection of sources of any kind, the wave-front tends to become spherical, or the complex source tends to become equivalent, at a great distance, to a point-source of some complex kind.

§ 182. Now consider the effect of an obstacle brought into our medium, say a non-conducting dielectric mass of different inductivity or permittivity. The manner of propagation in it is similar in kind to that in the external medium, but it varies in detail, and the speed will usually be different. Then, when we have a wave coming from (say) a point-source in the first medium, the presence of the obstacle at first makes no difference. It has no immediate action, and, until the wave reaches it, might as well not be there. But immediately the wave does reach it a change occurs. The interface of the two media becomes the seat of sources of fresh disturbances, or they may be considered fictitious sources, in contrast with the original, for they do not bring in any fresh energy. Thence arises a new effect, viz., reflection. Not the whole, but only a part of the wave disturbance enters the new medium. The rest is thrown back, and forms a reflected wave. In the same way as we may trace the course of primary waves from a source in a uniform medium may we trace the course of the secondary waves set up by the obstacle. The disturbance outside it is then due to the superposition of the primary and secondary waves, and, if there be just one obstacle, this state of things continues. Of course the secondary wave-front may itself be complex, because the disturbances going into the second medium and transmitted therein according to its nature, may reach the interface again at other parts, and there suffer reflection and transmission anew. This complication is done away with by making the obstacle infinitely big, with a plane boundary. Then we have just one wave in the obstacle and two in the medium containing the source, viz., the primary and the first (and only) reflected wave.

But if there be a second obstacle, not only will it, like the first, give rise to a secondary wave when the primary meets it, but each obstacle will act similarly towards the secondary wave from the other, whence arises a pair of tertiary waves, and so on. Thus, with only two obstacles, we shall have a succession of infinitely numerous waves crossing and recrossing one another, arising out of the action of a point-source, with great complications. But, however complex in detail, we have the important fact that the mere knowledge of the speed of propagation allows us to lay down the whole course of the waves generated, and the position of the wave-fronts belonging to a given epoch at the source. The mathematics of the full treatment may be altogether beyond human power in a reasonable time; nevertheless, we can always predict with confidence that the results must have such and such general properties relating to the course of the waves, besides the properties involved in the persistence of energy.

In the above we were concerned with discontinuous heterogeneity, or an abrupt change in the value of one or both of the constants c and μ at an interface. When the medium is continuously heterogeneous, or the "constants" change in value continuously from place to place, then the speed v is made a function of position. The process of partial reflection and partial transmission which occurred at the interface now takes place in general wherever the value of c or μ changes. These changes being continuous, so are the results, so that we do not have distinctly separable trains of waves, but rather a continuous distortion. We can, however, follow the course of a wave expanding from a point by communicating to the wave-front the speed proper to its position, such speed being, as above, definitively known. A spherical wave may remain spherical, only varying in its speed; or more likely, it may change its form as it expands. It may become ellipsoidal, for example, and of course must do so if the speed in different parts of the medium vary suitably.

It is possible for the inductivity and permittivity to change, either abruptly or continuously, without any reflection, or casting behind of the disturbance as a wave progresses, although its speed varies. In such a case it will be found that the ratio μ/c is constant. The change in μ, or the ratio of induction to magnetic force, then fully compensates the change in c, the ratio of displacement to electric force, either of which changes by itself would cause reflection.

In connection with a heterogeneous medium (including abrupt changes of nature), we may notice its behaviour as regards steady states, in contrast with that of a thoroughly homogeneous medium. In the latter case, as we have already described, the introduction of a steady point-source causes the steady state to begin immediately at and spread around it, after which no change occurs. That is, the medium being homogeneous, there is no reflex action. But when it is heterogeneous the case is quite different. The steady state of displacement due to impressed voltage depends upon the permittivity in all parts of the medium, and only comes about as the final result of the infinitely numerous reactions between different parts, due to the reflections that take place, which modify the final distribution of displacement as well as (usually) the total amount. There is a similar contrast in the mechanism of the mathematics involved in the calculation of the steady state. When the medium is homogeneous we may find it through the potential of fictitious matter at the source alone. When heterogeneous, we require to have fictitious matter all over the medium, or rather in all parts where it changes its nature, and, owing to the infinitely numerous reactions, we should, in a general or complete solution, require to perform not one space-integration, but an infinite series of successive space-integrations, before we could arrive at the true potential function, allowing for the variations of permittivity everywhere. Thus, by electromagnetic considerations we obtain some insight of the true nature of transcendental static problems, involving potential functions and assumed instantaneous action at a distance.

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§ 183. When the medium is not isotropic as regards either the displacement or the induction, or as regards both, we have very remarkable effects, known in the science of optics as double-refraction. There can be two distinct wave-speeds for a given position of the wave-front, and these speeds change when the direction of the normal to the wave-front changes. Hence double refraction, or the separation of a wave entering an eolotropic medium into two waves travelling independently of one another at different speeds. If the medium is only electrically eolotropic, although the displacement and induction are still in a wave-front (of either wave), and are perpendicular to one another, the electric force is inclined to the wave-front, so that the ray, which indicates the direction of the flux of energy, is inclined to the normal to the wave-front. Similarly, with magnetic eolotropy alone, it is the magnetic force that is inclined to the wave-front. When the medium is both electrically and magnetically eolotropic, both the electric and the magnetic force are inclined to the wave-front, whilst the displacement and induction, though still in the wave-front, are no longer perpendicular to one another.

By imagining plane electromagnetic sheets to traverse the medium in all possible directions about a point, and comparing their positions with respect to the point at equal times after crossing it, we arrive at the conception of the wave-surface. This is obviously a sphere in an isotropic medium. But when it is eolotropic, the two speeds, and their variation according to the direction of motion of the waves, make the wave-surface become a very singular double surface. With electric eolotropy alone, which is the practical case, it is Fresnel's wave-surface. It is also another Fresnel surface with magnetic eolotropy alone. But when the medium is eolotropic as regards both the induction and the displacement, the wave-surface is of a more general and symmetrical character, including the former two as extreme examples. It is still a double surface, however, except in one case. We have already mentioned that in an isotropic medium there is a peculiar behaviour when the ratio μ/c is constant, although μ and c vary. We might anticipate some peculiarity in the wave-surface when μ/c is constant. This constancy now means that the directional properties of μ are exactly paralleled by those of c. That is, the principal axes of μ and those of c are coincident, whilst the value of the ratio of the permittivity to the inductivity is the same for the three axes. The result is to reduce the double wave-surface to a single surface, which is an ellipsoid.

Assuming light to consist of vibrations of an "elastic solid" medium, single or ordinary refraction is explained by an alteration in the density or the rigidity of the ether. Not only is the theory quite hypothetical in considering the kinetic energy to be the energy of vibrational motions of displacement, but the alteration of density or rigidity assumed is a further hypothesis on the top of the main one, for there is no evidence that there is such a change. Moreover, the explanation will not work properly. On the other hand, the electromagnetic theory says that light consists of electromagnetic vibrations in the ether. This, too, is a hypothesis. But the auxiliary part, that refraction is caused by change of permittivity from one medium to another, is not a hypothesis, but a fact. Moreover, the theory works.

Similarly, double refraction in elastic solid theories of light is explained by eolotropy as regards elasticity, or by something similar relating to the density. This is also hypothetical, and not without its troubles. But, on the other hand, Maxwell declared that double refraction occurs because the doubly refracting medium is electrically eolotropic. Now this is a fact too, and the theory is a clear one.

These remarks will serve to illustrate what I mean by the far greater intrinsic probability of the electromagnetic theory, apart from the experimental work of late years. It is much less hypothetical than elastic solid theories. We know nothing about the density or the rigidity of the ether, or how they vary in different bodies, or if they vary. But we do know a good deal about electric permittivity and magnetic inductivity. Instead of dealing with possibilities, we are dealing with actual facts.

The old objection that a mechanical theory of light was surely to be preferred to an abstract electromagnetic theory was very misleading. The electromagnetic theory is mechanical, without, however, a precise specification of the mechanism. An elastic solid theory is merely a special mechanical theory. It cannot satisfy the electromagnetic requirements, but this failure, though immensely important in itself, is not the point here. Even if it did satisfy them, it would probably be less true than the electromagnetic theory, which, being abstract, does not assert so much. There may be many "mechanical" solutions of an abstract theory. Elastic solid theories are a great deal too precise in saying what light consists of, and mechanical speculations in general should be received with much caution, and regarded rather as illustrations or analogies than expressions of fact. We do not know enough yet about the ether for dogmatising.

One can imagine that a clear-headed man might be able to work his way through all the theories of light yet propounded, assimilate what was useful and true, eliminate what was useless or false, and finally construct a purified theory, not professing to explain what light is, but still connecting together in a perfectly unobjectionable manner, free from hypotheses, all the principal facts, and of so compliant a nature as to readily adapt itself to future discoveries, and finally settle down to a special form expressing *the* theory of light. It is hardly likely that the clear-headed man will be found for the purpose, and perhaps his theory would not be very popular. It would be so very abstract. What is far more likely is that the electromagnetic theory (itself abstract and possessing many of the desired qualifications), which has already begun to find its way into optical treatises at the end, will gradually work its way right through them to the beginning, and in doing so, oust out the most of the old-fashioned hypotheses. The result will be to have optical theory expressed throughout in electromagnetic language. To do it properly, it is hardly necessary to say that the preposterous 4π, which the B.A. Committee seem to want to perpetuate, should be ignored from the beginning.

§ 184. So far, in varying the nature of the medium, we have not introduced any property causing its local waste, such as the existence of conductivity (finite) necessitates. In all the varied journeys of electromagnetic waves in a (theoretical) non-conducting dielectric with non-conducting obstacles there is no waste of energy, and the work done by impressed forces is entirely accounted for by the electric and magnetic energy. Assuming a certain amount of work done up to a certain moment, and none later, that amount expresses the energy of the electromagnetic field, and, however it may vary in distribution, the total remains the same, just as if it were a quantity of matter moving about, having continuity of existence in time and space. The useless complication introduced by the circuital indeterminateness of the energy flux may be ignored. The only way, then, to get rid of the energy is to absorb it at the sources by working against impressed forces. Putting that on one side, there is the waste of energy by dissipation in space, which cannot be stopped. The energy is still in existence, and is still in the electric and magnetic forms, and must always be at a finite distance from its source and an infinite distance from infinity; but since it gets out of practical reach, and is constantly going out further, it is virtually wasted. Thus, ultimately, the energy of all disturbances generated in a boundless non-conducting dielectric goes out of range and is wasted.

To prevent this, we may interpose a reflecting barrier. Imagine a screen to be introduced, at any finite distance, enveloping the sources, of such a nature as to be incapable of either transmitting or absorbing the energy of waves impinging upon it. Then clearly the dissipation of the energy is stopped, and it all keeps within the bounded region. The waves from the source will be reflected from the boundary, and their subsequent history will be an endless series of crossings and recrossings. The only way to destroy the induction and displacement is to employ artful demons (or impressed forces), so situated and so timing themselves as to absorb the energy of waves passing them, instead of generating more disturbances. In the absence of this demoniacal possession of the region, the energy will remain within it in the electromagnetic form and be in constant motion.

But any opening in the screen, establishing a connection through ether between the inner and outer regions, will at

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once put a stop to this local persistence of energy. For energy will pass through the opening, and once through, cannot get back again (though a part may), but will escape to infinity. A mere pinhole will be sufficient, if time enough be given, to allow all the energy to pass through it into the external region, and there go out unimpeded to an infinite distance, in the absence of a fresh complete screen to keep it within bounds.

A screen to perform the above-described functions may be made of that very useful scientific substance, the perfect conductor, which is possibly existent in fact at the limiting zero of absolute temperature, the latest evidence being the recent experiments of Profs. Dewar and Fleming, measuring the resistances of metals at very low temperatures. If a perfect conductor, it is also a perfect obstructor, or is perfectly opaque to electromagnetic waves, without, however, absorbing their energy superficially.

(To be continued.)

THE LAUFFEN-HEILBRONN TRANSMISSION.

An interesting pamphlet has been forwarded to us containing a full description of the Lauffen-Heilbronn Transmission, the first, we believe, to utilise the three-phase system for the purpose.

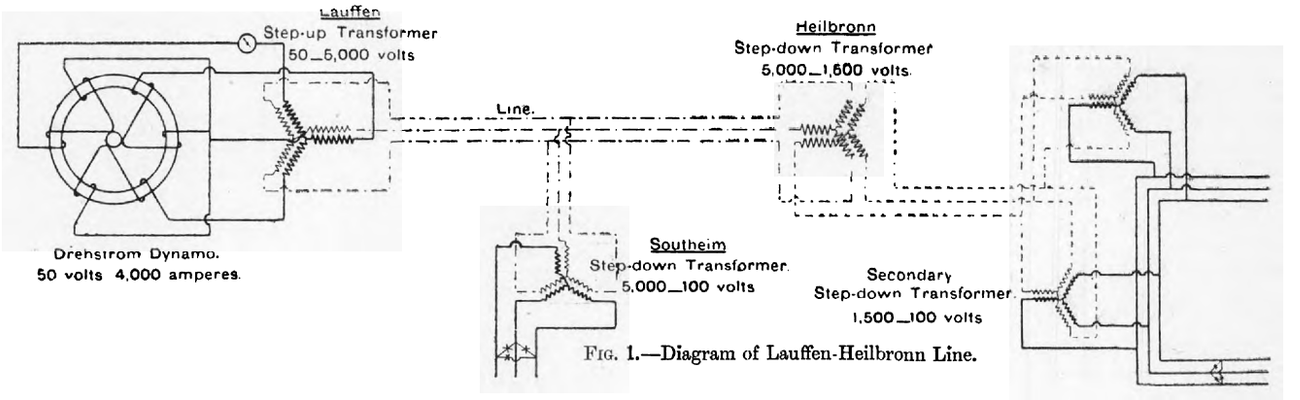

FIG. 1.—Diagram of Lauffen-Heilbronn Line.

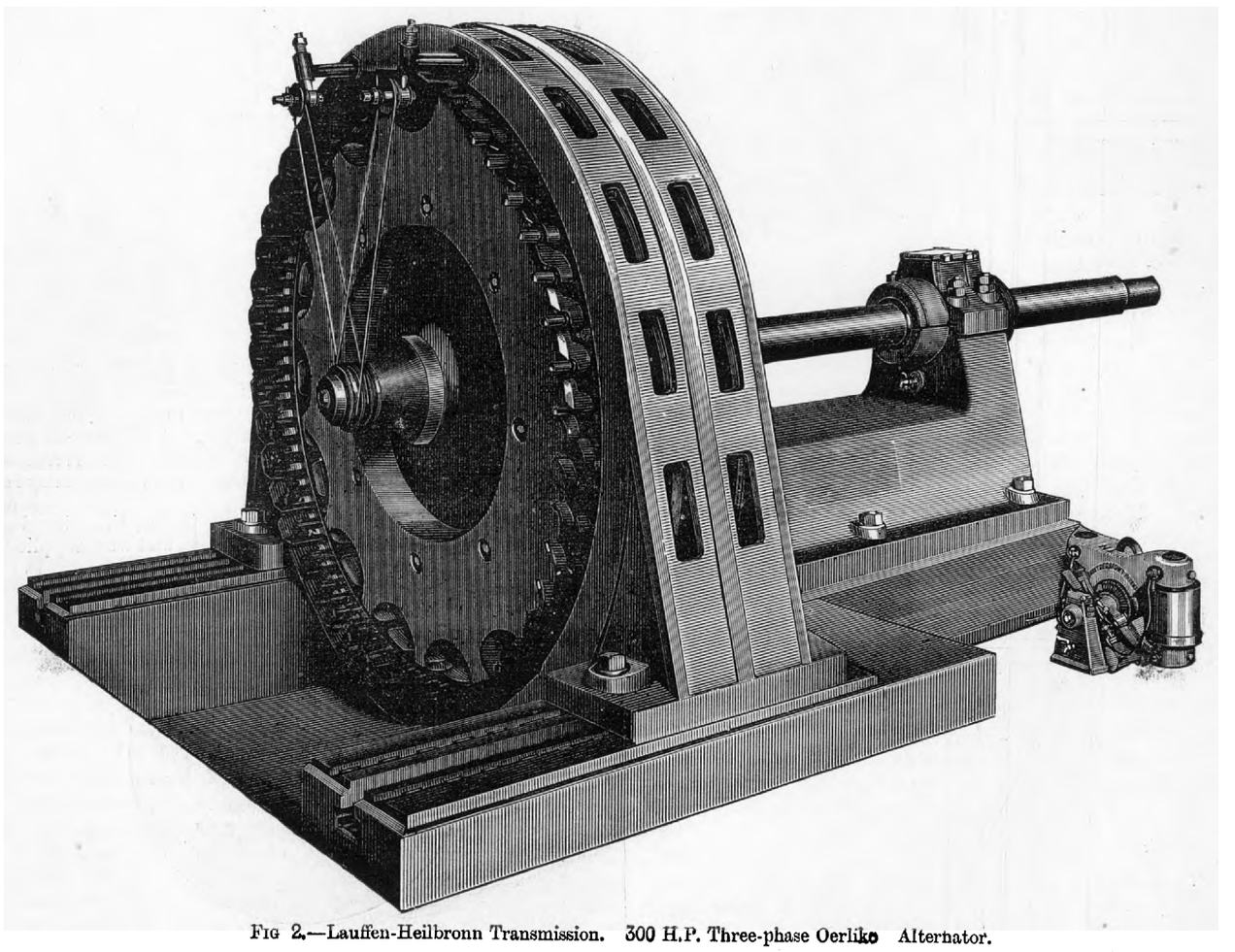

FIG 2.—Lauffen-Heilbronn Transmission. 300 H.P. Three-phase Oerlikon Alternator.

The Wurtemberg Portland Cement Works at Lauffen-on-the-Neckar determined towards the end of 1889 to utilise their superfluous water-power (about 900 H.P.) for lighting and supplying power to the town of Heilbronn, some six miles off, and selected the plans of Mr. Oskar von Miller, who proposed to use the three-phase system, which was then coming to the fore. The work was begun on September 15 1891, by the erection of the condu and laying of the cables, and on January 10, 1892, the current first sent out by the station. The power available is sufficient

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allow of about 18,000 16 c.p. lamps (or their equivalent) being in connection with the mains, or about 10,000 being run at one time. The losses in the mains from dynamo to consumer's premises are

Fig. 1 is a diagrammatic representation of the transmission. The primary dynamo in Lauffen has an output of 4,000 amperes at 50 volts. The pressure is transformed up to 5,000 volts for transmis-

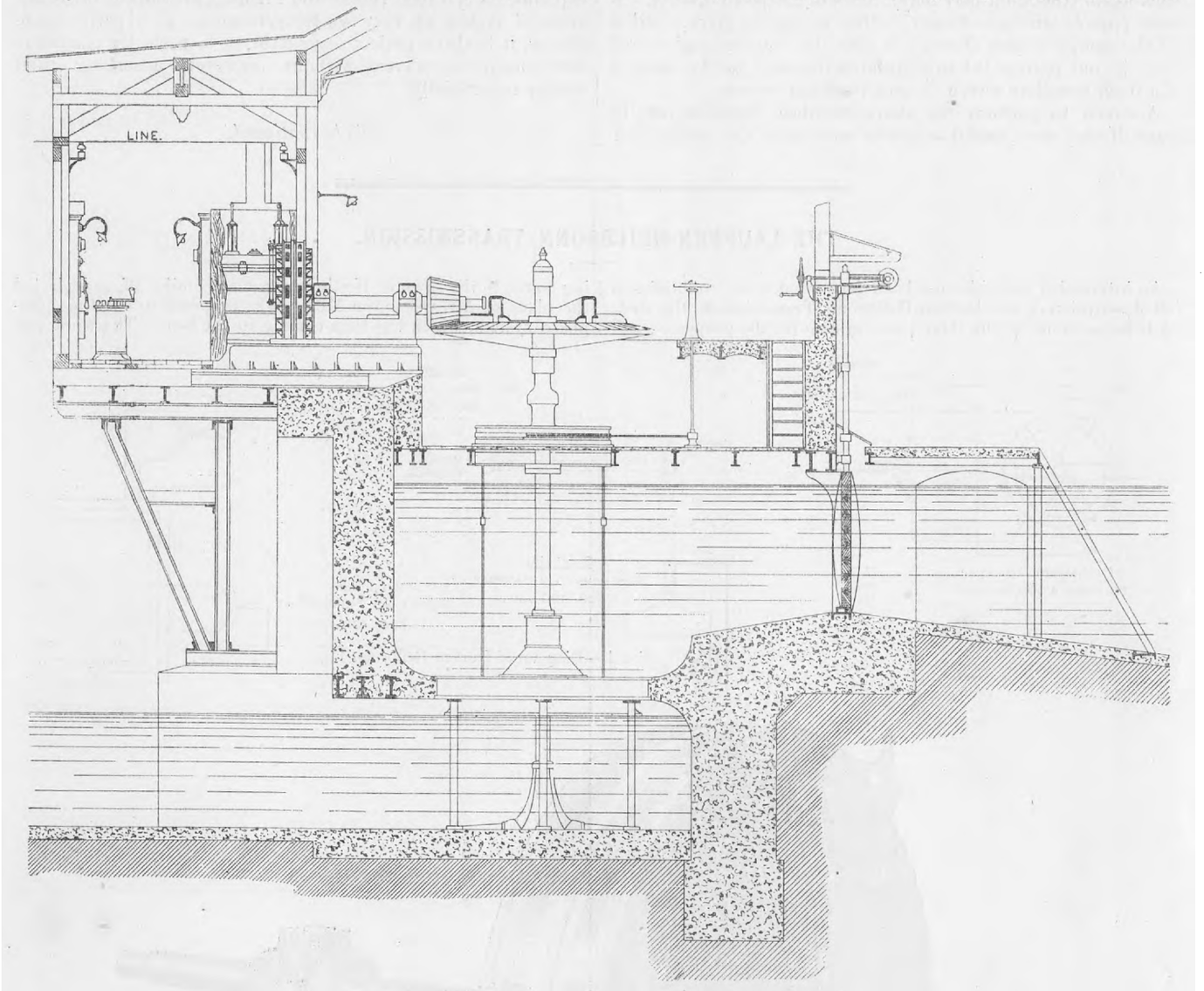

FIG. 3.—Sectional Elevation of the Lauffen Generating Station.

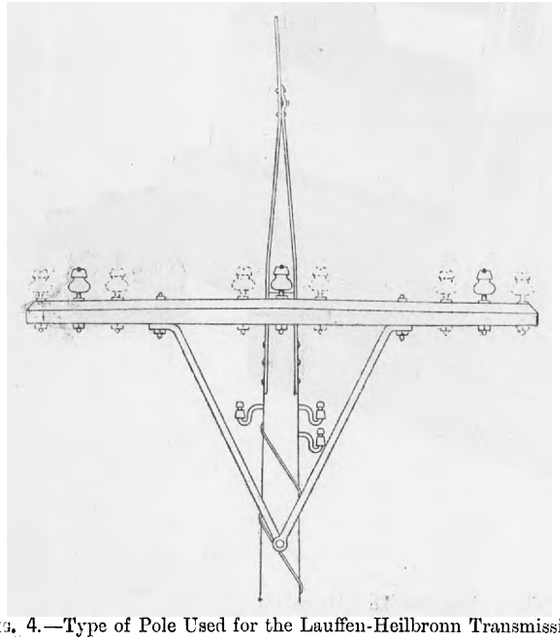

FIG. 4.—Type of Pole Used for the Lauffen-Heilbronn Transmission.

bout 15 per cent., of which 10 per cent. is in the transmitting wires, and 5 per cent. in the distributing network.

sion to Heilbronn, and reduced at the latter place to 1,500 volts, and led into the high-pressure network. From this primary network the pressure is reduced to 100 volts in a secondary set of mains, which supply the house illumination. About half-way from Lauffen to Heilbronn is the village of Sontheim, which is also supplied with current. The pressure is there reduced directly from 5,000 to 100 volts.

The turbines—only one of which is now in use, the other being being kept in reserve—are of the vertical type, and were supplied by

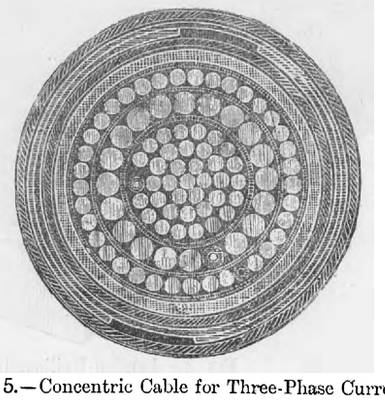

FIG 5.—Concentric Cable for Three-Phase Current.

the Maschinenfabrik Geislingen. As tested at the time of the Frankfort transmission, these turbines give 330 H.P., with 12ft. 6in.

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head. The speed is kept constant, by hand regulation, at 35 revolutions a minute. The dynamo is a three-phase machine by the Oerlikon Works, and is geared to the turbine by bevel gearing. This is the machine that was used for the Lauffen-Frankfort transmission, and was fully described in *The Electrician*, Vol. XXVII., p. 381, from which we reproduce Fig. 2. At the time of light load the superfluous energy is utilised for drying the clay used in the Portland Cement Works. It has been found cheaper to do this than to dry it by the old methods, and the result is a very evenly distributed load. In Fig. 3 is shown a vertical section of the Lauffen station, and Fig. 6 shows the small size transformers used in Heilbronn for stepping down from 1,500 to 100 volts. The transformers are arranged in cast-iron boxes, in which are also placed the cable joints, the current indicators, and the fuses. The covers are made to rotate, and the cases form easily accessible junction and service-boxes. In Sontheim the transformers are on the roof of a building. The transmission wires are three in number, of 6mm. diameter, bare, and run on oil insulators supported by wooden posts; these latter being about 50 yards apart and varying from 25ft. to 50ft. high. The arrangement is shown in Fig. 4. The

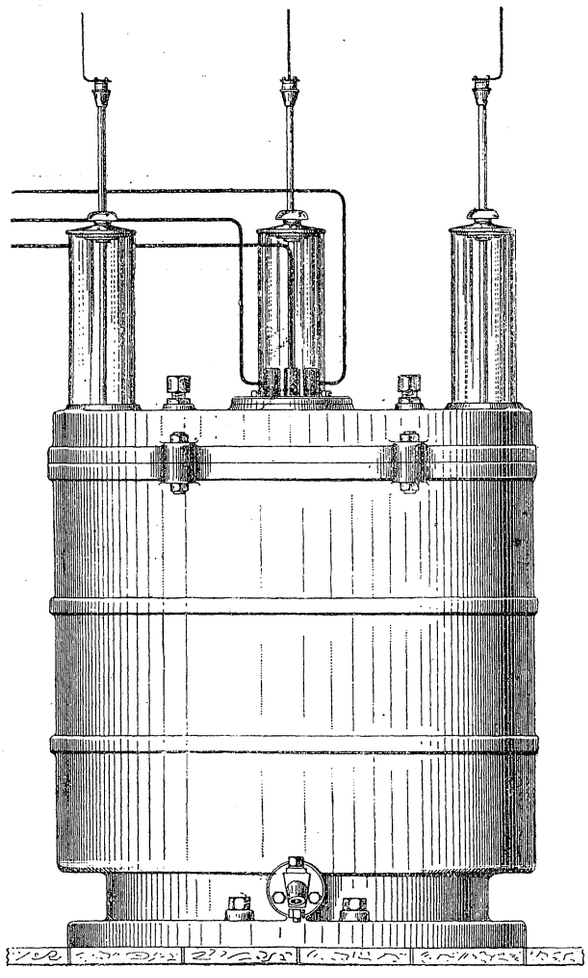

FIG. 6.—Heilbronn Step-Down Secondary Transformer. 1500—100 Volts.

wires are arranged on one horizontal line to keep them as high as possible above the trees; only three are at present in use. The posts are furnished with lightning conductors, connected to earth by barbed wire, which also serves to prevent climbing of the poles. About five miles of cables are laid, all of the triple-concentric type shown in Fig. 5. Every branch is furnished with fuses and safety apparatus. A feature of this transmission is the motors, which are extensively used. They are very simple, have no commutator, and are small for their output. To prevent the sudden variation of the light by switching in or out large motors, fluid resistances are so arranged that full contact can only be made after 15 or 20 seconds. Motors over 3 H.P. are coupled direct to the high-pressure network.

The price charged for lighting current is about 9d. per kilowatt hour, but if the current is used for motors or industrial purposes it is charged for at the rate of 4d. Reductions are made for long hours of working. The works cost up to March 1, 1892, about £13,000, and were then supplying 1,100 glow lamps of 16 c.p., 8 arc lamps (10 amperes), and 3 motors of 8 H.P. altogether. On November 1, 1892, the numbers had risen to 1,700 glow lamps, 20 arc lamps, and 11 motors of 32 H.P. altogether, and more were being daily coupled on. The public lighting of Sontheim takes 8 glow lamps of 20-c.p. Private consumers are also being coupled on in this village. The works have only necessitated adding three men to the number of the *employés* of the Portland Cement works.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 27th.

ROYAL UNITED SERVICE INSTITUTION.

3 p.m. Paper to be read: "Electric Balloon Signalling," by Eric S. Bruce.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "Japanese Magic Mirrors," by Prof. S. P. Thompson, F.R.S.; (2) "The Perception of Colour," by W. F. Stanley, F.G.S.; (3) "Recent Determinations of Molecular Refraction and Dispersion," by Dr. J. H. Gladstone, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "The Disposal of Town Refuse by Burning, and the Application of the Heat thereby Generated," by Arthur S. Butterworth, Stud.Inst.C.E.

SOCIETY OF ARTS.

8 p.m. Howard Lecture III. "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Just Perceptible Difference," by Francis Galton, F.R.S.

MONDAY, January 30th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II. (1) "The Practical Measurement of Alternating Electrical Currents," by Prof. J. A. Fleming, F.R.S.

TUESDAY, January 31st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be read with a view to discussion:—(1) "Smelting Processes for the Extraction of Silver and Gold from their Ores," by Henry F. Collins, Assoc.M.Inst.C.E. (2) "The Erection of Silver-Lead Smelting Works in Mexico," by James W. Malcolmson, Wh.Sc.

WEDNESDAY, February 1st.

INSTITUTION OF CIVIL ENGINEERS.

2 p.m. Students' Visit to the North London Railway Works, Bow Road, E.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Purification of the Air Supply to Public Buildings and Dwellings," by William Key.

THURSDAY, February 2nd.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual General Meeting at the Institution of Civil Engineers. Election of Officers. Paper to be read: "Description of the Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experiments Works, Haslar." by R. Edmund Froude.

FRIDAY, February 3rd.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. "Description of the Pumping Engines and Water-Softening Machinery at the Southampton Water Works," by William Matthews.

SOCIETY OF ARTS.

8 p.m. Howard Lecture IV. "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S.

ROYAL INSTITUTION.

9 p.m. Evening Discourse:—"Theory and Practice in Electrical Science" (with experimental illustrations), by Alexander Siemens, M.Inst.C.E.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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LONDON COUNTY COUNCIL PATRONAGE OF TECHNICAL EDUCATION.

At length the report has appeared of the Committee appointed by the County Council to consider how to dispose of the sum of £180,000 a year, made available by Mr. GOSCHEN, under the Act of 1890, and also the detailed report of the Secretary. The latter is a folio volume of 183 pages, bound in brilliant scarlet. It contains seven maps, which are very pretty examples of chromo-lithography, but which do not add much to the elucidation of the subject. There are also illustrations of various institutions. For want of an appended scale, these views are very misleading as to the size of the buildings, for the proposed Chelsea Institute appears larger than the People's Palace, and the Battersea Polytechnic is represented almost as imposing as the City Guilds Institute, at South Kensington. The volume contains only a meagre table of contents and no index.

The secretary's report explains what technical education is, and distinguishes it from liberal education on the one hand, and from handicraft drill on the other. It utters the usual stereotyped condemnation of the French *école d'apprentissage*, and the usual stereotyped regret at the decay of the apprenticeship system. But it makes no suggestions as to any remedy. All this we have heard before. The report then gives a mass of information which if it had been properly tabulated would have been very valuable, and, even as it is, is very interesting. Unfortunately, however, but few of the columns of figures are added up, so that when the committee's report informs us that only 1,400 students in the Board Schools, and 18,600 in all other places put together, attend evening classes in any branch of science, art, or technology (of an industrial character), although the smallness of the figures may surprise

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us, we have no means of verifying the assertion, nor of knowing what amount of study would be considered an "attendance."

The fact that 9,500 commercial students also attend lectures in the evening, does not seem to have been considered worth mentioning. From the figures in the table (which the reader must cast up for himself if he desires to know them), it appears that four Polytechnics have on the register about 8,000 evening students in scientific subjects, exclusive of commercial and other classes. This does not include the Borough-road Polytechnic, which, probably, has about 2,000 more. Of course, not all these attend regularly. So that it would seem as if of 20,000 evening students in science, art, and technology about one-third belong to the Polytechnics, 1,400 belong to the evening Board Schools, and the rest attend various classes either at voluntary institutions, or under the Science and Art Department. The number of people who are yearly under some form of evening instruction, whether industrial, or commercial, or literary, is probably about 40,000; but if it is recollected that about 100,000 children leave the Board Schools of London every year the small portion of those who continue their education becomes at once apparent. It is to be regretted that the report of the secretary gives us hardly any information as to the cost of the various classes which he mentions. Nor, again, does he give any comparison of the results—as, for instance, how many students from Polytechnic evening classes pass successful examinations, as compared with those from Board School evening classes. The subject is a delicate one, and comparisons are odious, so, possibly, it may have been thought wise to throw a decent veil over those interesting questions.

In their recommendations the Committee have had the wisdom to avoid one error. They do not intend to work any system themselves, nor to spend their money in bricks and mortar; they intend only to subsidise those institutions which already exist. For this purpose they propose that a Technical Education Board should be appointed, consisting of thirty-five members, of whom twenty are to be County Councillors, five from the London School Board, three from the City and Guilds Institute, and two from the City Parochial Charities. The Head Masters' Association and the National Union of Teachers are to have one representative each, and as it is of special importance that "the cordial co-operation of the Trades Unions should be secured" one place is given to a member from the London Trades Council. The co-operation, whether cordial or otherwise, of the employers of labour, or of the working men outside the favoured pale of the Trades Unions, does not seem to have been considered necessary. No special place is assigned to those who might be considered to be experts upon commercial education. Although in the secretary's report the efforts of the London Chamber of Commerce are rewarded with brief attention, it does not seem to have occurred to the committee that any benefit could result from the co-operation of that body. It is also curious that no provision should have been made for any representation of the Colleges of University rank upon the proposed Board. But there remain "other members not exceeding two," to be "selected by the Council from outside its own body.

The grants for the ensuing year, as recommended by the secretary and favourably received by the committee, are as follows:—To the Polytechnics, £16,000; to secondary day-schools (85 per cent. of the scholars of which are above the class of artisans), £22,000. It is proposed that this should be spent in a grant to secondary schools of £3 per head for all boys who have been in an elementary school, and in respect of whom the school-fee charged is not more than £3 a year. The fact of having been a public elementary school boy will soon become the only road to State pecuniary assistance; just as to attend church and take the Sacraments was once the only avenue to State employment. It would be advantageous if the grant was also given in respect of boys whose parents though once rich may have fallen into poverty on the same principles as the South Kensington grants extend to all boys whose parents have less than £200 a year. It is proposed that a grant of £3,800 should be given to University and King's and Bedford Colleges, to be increased to £10,000 a year as soon as the new university for London is formed and "adequate" representation is given to the London County Council, on its governing body. Of the remaining money, £8,000 a year is to be spent on scholarships, £10,000 is to be given to art teaching, £6,000 to science, £5,000 to technology, £3,200 to domestic economy, £2,000 to commercial subjects (which sum we hope will be increased in future), and £4,000 is to be spent in the formation of technical museums at Bethnal Green and in the Albert Palace, Battersea. The cost of administration is estimated at £5,000 a year, making a total of £85,000.

Taking the system as a whole, its principle seems to be to subsidise pretty fairly most existing institutions. The great danger will be lest the subsidies are not given as the result of patient and unostentatious work, but are left to the caprice of individual members of the Education Board, in which case electoral influences would be exercised and pretended privileges to the working classes paraded by various institutions in order to curry favour, as in the municipal schools in Paris. Far better will it be if some uniform conditions are imposed and the grants arranged upon some regular system, so that each institution will occupy itself seriously in doing good work, and not in cultivating "friends at court." Another danger would arise if the Trades Unions should attempt to capture the technical schools. Already in most of them certain trades classes are only open to them already in those trades. If this principle were too widely adopted the greatest injustice would be committed, as if, for instance, law were only to be taught to lawyers, or the teaching of medicine denied to all but doctors. In one case a whole class of plumber artisans refused to attend because a plumber's labourer was admitted. Even those most sympathetic with the objects of Trades Unions will hardly wish to deprive a labourer of his fair chance of becoming an artisan. To do this would be to convert a system of education into a system of the most odious class tyranny.

Upon the whole the County Council Committee is to be congratulated upon its recommendations. It has endeavoured pretty fairly to apportion the money at its disposal among the higher class education in which both rich and poor may participate, among the day schools chiefly used by the middle classes, and among those institutions more especially designed for workmen. This spirit of fairness augurs well for the future. Of course, no such system, however excellent, can cure all our ills. The true place to learn a trade is the workshop. Over-schooling has a tendency to produce priggishness in all classes. There are prigs in the Polytechnics as well as in the Universities. We are familiar with both specimens, but London is certainly deficient in secondary education at present, and if kept within reasonable limits and administered in a spirit of justice, the proposed subvention-system, with such modifications as further experience may suggest, will form an excellent basis for a scheme of municipal technical education, if, like everything else, technical education is to be municipalised.

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NON-SYNCHRONOUS MOTOR FOR ORDINARY ALTERNATE CURRENTS.

BY C. E. L. BROWN.

After numerous experiments with multiphase motors, I had become convinced, about a year and a-half ago, of the possibility of constructing motors for ordinary alternate currents possessing all the characteristics which, till now, have been attainable only by the use of multiphase currents. Among these characteristics of multiphase motors I would specially call attention to the following :—

First and most important, absence of collectors and brushes, and consequent simplification of design and reduction in the amount of attendance necessary ; secondly, the possibility of starting the motor against a load ; and, thirdly, non-synchronous running with the various advantages connected therewith.

The absence of collectors has, in very many cases, the result that the multiphase motor must be considered preferable to the direct-current motor ; so that, without exaggeration, we may say that the alternate current (though not, it is true, in its simplest form) is considerably in advance of the direct-current as a means of driving motors. When we also consider the ease with which the alternate current may be transformed, we can understand how in all the newer power-distribution schemes the alternate current (of two or more phases) has been employed. A disadvantage is nevertheless soon apparent, to which too little attention was at first given, viz., the complication of the mains arising from the fact that more than two wires are necessary. This disadvantage is chiefly apparent in cases of combined distribution of light and power, and creates a demand for a motor for ordinary alternate currents of equal simplicity with the multiphase motors and possessing their various advantages.

Attempts have not been wanting to produce such motors. This is best seen by the large number of patent specifications filed, in hopes of attaining this end. I do not here propose to consider in detail those attempts, merely remarking that they have been all more or less unsatisfactory, none of them having, to my knowledge, been adopted in practice. The reason of these unfavourable results seems to be the same as, until recently, prevented the construction of practical multiphase motors. I refer, primarily, to the want of attention to the magnetic resistance of the air-gap ; owing to the abnormal magnetising current required, the windings, even while the motor was running light, became so warm that continuous running was out of the question. The efficiency was also, consequently, very low. I have, as is well known, by placing the wires in holes through the iron (both of the fixed and rotating parts), entirely overcome this difficulty, and thus produced the first really practical multiphase motor. Another defect was in the form of the magnetic circuit, with prominent poles which produced injurious reactions in the induced part, rendering the starting of the motor very difficult.

I would also call attention to another point, which is specially noteworthy in American practice, viz., the high frequencies commonly employed. This causes difficulties from the great counter E.M.F. of self-induction, as well as from the inconveniently high number of poles required on small motors, in order to avoid excessively high speeds. There are several other reasons why these earlier experimenters have failed ; but I have, I believe, enumerated above the most important.

After these preliminary remarks I will now proceed to describe my new motor, first noting the remarkable phenomena upon which the principle of it is based. I have observed that a conductor, placed in an alternating field, if set rotating with a certain velocity, will itself run up to practically synchronous speed, and then has the tendency to keep to this speed against a load. Currents are induced in the conductor by the alternating field. So long, however, as it is at rest, these currents are neutral with regard to the inducing field. As soon as the conductor is set in motion this condition ceases, and a turning moment is produced, which increases as the speed rises, till synchronism is nearly attained. The following points should here be noted :—With a conductor in the form of a solid disc, for example, the speed will drop more or less below synchronism, according to the load. With a deeply serrated conductor, on the other hand, or one consisting of but few members, the tendency is to preserve almost exactly synchronous rotation, and if the speed once falls much below this the torque is considerably reduced.

It must also be noted that the direction of rotation is quite indeterminate. The conductor tends always to attain synchronous rotation in the direction in which it was first set in motion. In designing a motor based on these facts, the following points must be kept in view. The alternating field must be as strong as possible, and all magnetic resistances (as well in the inducing as in the induced parts) must be reduced to a minimum. Injurious eddy currents in both iron and copper must also be avoided as much as possible. These various requirements can be satisfied in the following manner :—The inducing winding (*i.e.*, that in connection with the mains) as well as the induced (receiving its current by induction from the former) are provided with iron cores consisting preferably of iron discs insulated from one another.

In order to reduce the magnetic resistance, the windings are embedded in iron, either in holes of suitable shape or between teeth which may be advantageously closed by a winding of iron wire. The teeth may also be widened so as to nearly close the opening. Either inducing or induced parts may, of course, be provided with either of these arrangements.

The inducing winding may be, of course, of any of the usual forms, with a suitable number of poles, the sections being connected in series, parallel or in a combination of both. The induced, which is usually also the rotating part, since sliding contacts are thereby avoided, carries a short circuited winding preferably insulated from the core, in order to avoid eddy

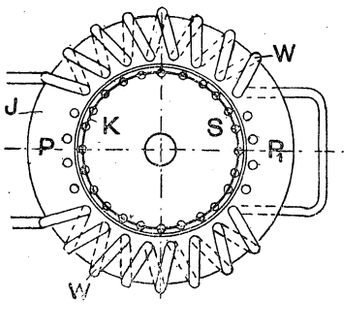

Fig. 1.

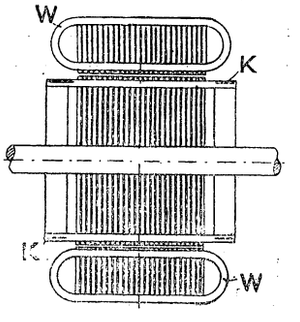

Fig. 2.

currents. This short circuiting may be carried out in various ways. All the ends at each side may be connected together by means of two copper rings, or the conductors may be connected in certain groups, which are separately short circuited. Or, again, wires similarly situated with regard to the external field may be separately short circuited with one another. Another method is to wind the induced part as ring, drum, &c., with a short circuiting connection. For regulating the speed a resistance, choking coil, or capacity may be inserted in the short circuit.

Figs. 1 and 2 serve to show the most important points about a motor designed on the above principles. The inductor J is shown fixed, and consists of a cylindrical core of laminated iron. The discs, of which it is built up, are perforated near their inner edges and carry the winding where shown as a ring (it could, of course, equally well be wound as a drum). The winding is not shown extending over the whole ring, but there is nothing to prevent its being so arranged. The connections are such, that poles are produced at P P.

The rotating part consists principally of a laminated iron cylinder carrying insulated copper wires S in holes close to its circumference. These wires are soldered at each end to stout copper rings K.

A somewhat different arrangement is shown in Figs. 3 and 4. This has the property, described at first, of almost synchronous running. Here, again, copper conductors S are bedded in a laminated iron core and soldered on both sides to stout copper rings K, the only difference being that the number of conductors is here very small.

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Figs. 5 and 6 show another type of rotating induced part, provided with a ring winding S. The opposite points are here connected to sliding contact rings, so that a resistance for regulating the speed may be readily inserted.

A motor constructed according to the above principles and suitably proportioned has a remarkably high weight efficiency. I have designed a non-synchronous motor, for example, weighing only 150 kg., which at about 2,000 revolutions could be loaded to 6 H.P. without excessive heating. Its efficiency is very good and the apparent watts are but very slightly more than the true watts. The outside dimensions of the motor without pulley are :—Length (along shaft), 430mm. ; greatest height, 350mm. ; greatest breadth, 340mm. These figures suffice, I think, to show that the output of this form of motor is scarcely behind that of one for direct or multiphase currents.

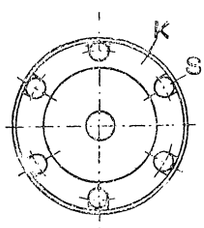

Fig. 3.

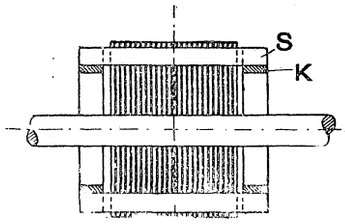

Fig. 4.

I may here briefly touch upon an important point, viz., the predetermination of the so-called "idle" or magnetising current, as it is, of course, necessary, in designing a motor, to be able to calculate this current. Experiments with a large number of motors of various outputs show that this may be done with sufficient accuracy for practical purposes, the observed currents differing in most cases by only a very small percentage from their calculated values. The same principles hold here as in the design of ordinary dynamo machines.

A convenient formula for determining the necessary values is that of Kapp (in his Paper on "Alternate-Current Machinery"). It is as follows :—

$$V = C \curvearrowright L W 10^{-8};$$

where

V = electromotive force.

C = a coefficient expressing the ratio between the E.M.F. of alternate and continuous-current machines. In the above-mentioned Paper will be found the values of C for various cases commonly occurring in practice. Herr Görges has extended this table giving values for other cases. (*Electrotechnische Zeitschrift*, 1892).

$\curvearrowright$ = total number of wires in the inducing part.

L = total number of lines per pole.

W = number of complete cycles per second.

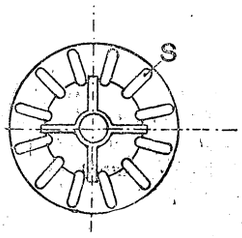

Fig. 5.

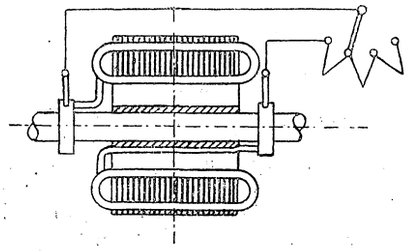

Fig. 6.

By substituting the values of V, C and W, we may find L the total induction and thence the density of the lines both in the fixed and rotating parts, as well as in the air-gap separating them. The mean length of the lines is taken at once from the drawing ; and from these data, by the well-known method of Hopkinson, the ampere turns necessary to produce this magnetisation can at once be found. The number of wires being given, we thus have the value of the idle or magnetising current.

Having found the current required to run the motor idle, we may easily determine with sufficient accuracy that required with a load. We may do this as with transformers having open magnetic circuits since in both cases the idle current lags 90deg. behind the working current. We have the following equation :—

Resultant current with any load = $\sqrt{I_i^2 + I_w^2}$.

There, I_i = idle current,

and I_w = working current.

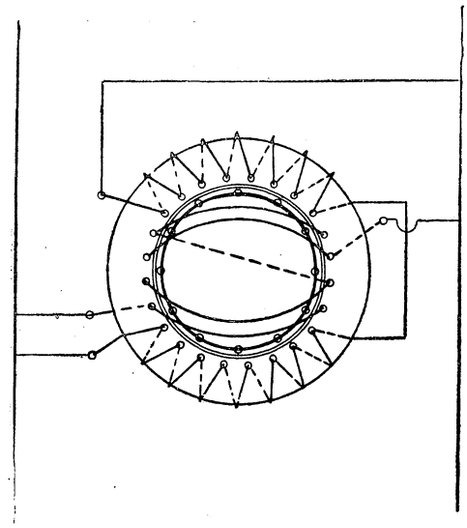

Fig. 7.

If for example, a motor takes 30 ampere idle current and 100 ampere current working, we have for the resultant current $I = \sqrt{30^2 + 100^2} = 105$ about—that is but a few per cent. more than the working current.

As regards induction in the iron, current density in the copper, &c., similar rules apply as for ordinary dynamo design.

As it would have occupied too much space to go at length into all the questions involved in the calculations for these motors, I have above merely sketched out the broad principles

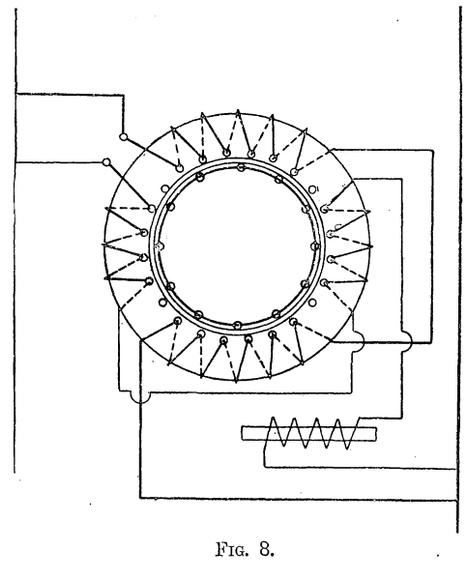

Fig. 8.

upon which they rest, wishing especially to point out that the calculations for such motors are similar to those which have long been in use for direct current machinery. I may add that what I have said above applies equally to multiphase motors, and, in fact, it should be clearly understood that with both broad types of motors the same principles apply throughout.

A motor designed in accordance with the principles described above has similar properties to a multiphase motor, *i.e.*, has no collector, runs non-synchronously, and, as far as efficiency and

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output are concerned, is also very similar. In one respect only does it differ considerably from a multiphase motor, viz., it will not start itself, and some method must therefore be found of neutralising this disadvantage. There are various ways of doing this, of which I will describe a few.

The motor may, for example, be provided with a second winding, wound in the spaces of the first, and which, being only a short time in action, may be of relatively small section.

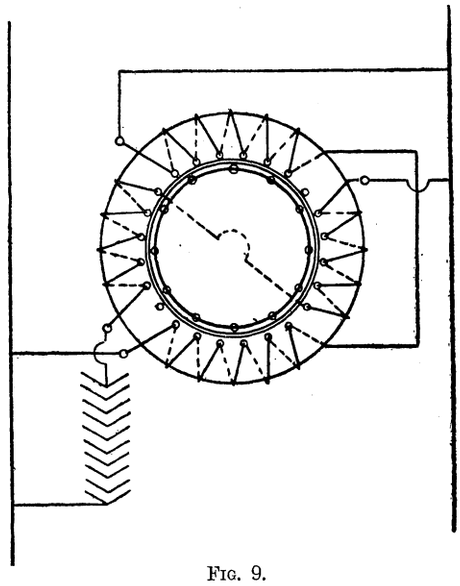

Fig. 9.

By giving this winding a different self-induction to the first, and connecting the two in parallel, the resulting phase-difference produces a rotating field, starting the motor and bringing it up towards synchronous running. This second winding can now be cut out, and the motor continues to run as single-phase motor as above described. The difference of phase in this second winding can be attained in various ways. One method is to wind one section as drum and the other as ring, as in Fig. 7, as it is well known that the latter has considerably greater self-induction than the former.

We may further attain the same end by connecting a self-induction (Fig. 8) or capacity (Fig. 9) or a resistance in

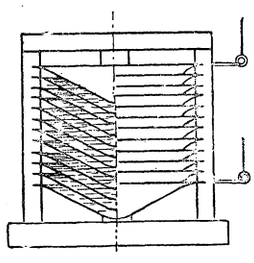

Fig. 10.

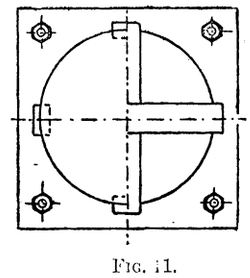

Fig. 11.

series with one section. This method may, of course, be used in conjunction with the above-described mixed winding. In order to obtain conveniently the necessary capacity, we may use a series of elements which Messrs. Stanley and Kelly have also lately employed in their experiments with alternate-current motors. A very convenient form of water capacity consists of a large number of iron discs dished out to a conical form, piled together with insulating distance pieces to allow room for the liquid. (*See* Figs. 10 and 11.) A solution of soda in water may be employed for filling. As a further method of obtaining the necessary difference of phase, suitably proportioned transformers may also be employed.

By means of this difference of phase, in a suitably-proportioned motor, a very considerable starting torque may be obtained. Thus I have succeeded in getting, with a 1–1½ H.P. motor, a torque corresponding to a load of 3 H.P. at full speed.

Another method of starting single-phase motors consists in providing the induced, usually the rotating, part with a winding connected with a collector (Figs. 12 and 13). By means of suitable brushes we may either supply this winding with current from outside, or the brushes may simply be short circuited. As soon as the latter are in their proper position with regard to the external field a powerful torque is produced, and the motor starts. As soon as sufficient speed is attained, the collector may be short-circuited by means of brushs pressing on contact rings connected with opposite points of the winding, or the winding may be short-circuited by means of a conducting ring brought into contact with the collector. The motor then works in the manner described above. In this case the inducting part is wound in the simple normal manner, *i.e.*, it requires no second winding, for the purpose of obtaining a difference of phase. On the other hand, the induced part has, instead of its simple short-circuited winding, a drum or ring winding, or it may be wound like the armatures of the Thomson-Houston or the Brush arc light machines.

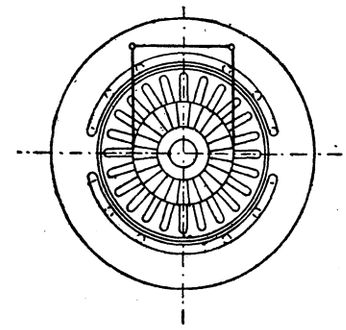

Fig. 12.

Having now described a few methods by means of which the motors may be started, I must not omit to say that those non-synchronous motors for ordinary alternate currents may be built of any size, from quite small types to machines of 100 H.P. and more. I believe that I shall not go too far when I say that in the above described simple motors we have a means of securing the speedy and certain extension of the use of ordinary alternate currents. These motors will be especially employed where light and power together must be supplied in the simplest manner possible.

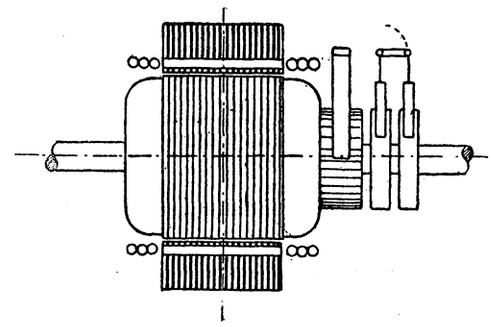

Fig. 13.

As regards amount of attendance necessary and safety in running, these motors are considerably in advance of those for direct currents, and as regards commercial efficiency for the same size, output, and speed are equally good. I am of the opinion that this new type of motor will displace multiphase motors in all those cases where, in addition to general lighting, power must be supplied, while for power distribution alone the multiphase motors will still find a use. In light and power distribution systems, having the so-called two-phase current, an advantageous combination of the two types of motor may be made. Thus small motors may be connected simply to one phase, like the lamps, while larger motors could be connected to both phases. I have now, I believe, described briefly the principal points of this type of motor; it is not yet possible to go further into details, especially as several questions with regard to patents are still to be settled. However, I hope that it will be possible before long to give a more particular description of some large installations employing this type of motor.

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THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

BY PROF. W. CAWTHORNE UNWIN, F.R.S.

In his last lecture he had explained that one essential condition to be met in arranging a central station was the fluctuation in the demand. He had shown at some length that this fluctuation involved, in steam-power generating stations which had no means of storage of energy, a great fuel consumption per horse-power hour supplied—a loss so great that in the very best-managed electric lighting stations the fuel consumption per horse-power hour was double the consumption required to do the same work at full load. Besides the cost of the fuel, there was a further item, namely, the interest and depreciation on plant, which was worked on the average for only one-third of the twenty-four hours. He had tried to show that that part of the fuel waste which was due to inefficiency of the engines at light loads could be accounted for, and to some extent that loss could be reduced by subdivision of the steam-engines into suitable units. The larger part of the waste, he was persuaded, in many electric lighting stations, must be attributed to the irregular working of the boilers. Storage would entirely overcome this difficulty. The secondary battery was so expensive that the solution of the problem was not to be found in that direction.

The Halpin Thermal Storage System.

The lecturer then went on to say that in his last lecture he had briefly explained a system which had been proposed by Mr. Druitt Halpin, a system in which for each pound of steam used 16lb. of water was heated to 406deg. at an absolute pressure of 265lb. per square inch, the water at the end of the operation being at a temperature of 367deg., ready to be heated to 406deg. again. Reference was then made to a diagram on the wall, which showed the general arrangement of a boiler and thermal storage tank on Mr. Halpin's plan. The boiler and the storage tank, which measures 30ft. by 8ft., were in free communication. There was an ordinary feed pump which supplied water direct to the boiler to make up for the waste in generating steam; but instead of keeping the water level in the boilers constant the water level in the storage tanks was kept constant, the boiler being filled with water. What happened then was this. The water was constantly being heated in the boiler and sent on into the storage tanks; in the storage tanks as steam was required it was given off, and the water there consequently fell in temperature; from the storage tanks the cooled water, together with feed, was constantly sent back to the boiler. The steam spaces of the storage tanks were all in communication, so that the pressure there was a uniform pressure in all the tanks. The steam required for working was taken off from the top of the storage tank through a reducing valve. If they had there a body of heated water, then any reduction of pressure at the reducing valve would cause the steam to go off at a rate depending on the difference of pressure. The storage tank was nowhere exposed like a boiler, and Mr. Halpin inferred that in that case it would not have any very rapid depreciation. What Mr. Halpin directly attacked by his device was the boiler waste and the difficulties of boiler management when the demand for steam varied from one-twentieth to four times the mean demand, a variation occurring every twenty-four hours. With thermal storage tanks the boilers could be worked continuously at a uniform rate throughout the twenty-four hours. The surplus heat in periods of small demand remained in the tanks, and the excess of steam demand over boiler production in hours of great demand was furnished by the storage tanks.

It was not possible to say without trial that no practical difficulties would arise in applying Mr. Halpin's plan, but he (the lecturer) had carefully examined the calculations, and had no doubt as to their accuracy with regard to the amount of heat stored and steam obtained, provided all things went on as Mr. Halpin supposed. He went one step further; so long as they had one boiler and one storage tank he thought everything would go on as Mr, Halpin supposed. When a new invention of apparent importance was presented the very worst attitude of mind with which to approach it was that in which you heaved a brick at it. He was not in the least likely to heave a brick at Mr. Halpin's system; at the same time, he would like thus far to qualify his statement. When instead of one boiler and one tank there were many boilers and many tanks, there did appear to him to arise some practical difficulties which did not appear yet to have been fully considered. There were difficulties of two kinds obvious on the surface, which he thought could probably be met. One was to obtain a sufficiently complete and rapid circulation, and the other was to ensure that when the pressure was reduced at the top of the storage tanks the steam was given off just where it was wanted, and not where it would embarrass.

* Abstract of Howard Lecture II., delivered before the Society of Arts, Friday, January 20th.

He thought the general method of working of Mr. Halpin's system was now clear, and he would, as it seemed to be really an important thing, now go a step further and examine what Mr. Halpin thought it would do in facilitating steam engine station working. Mr. Halpin had been good enough to put before him some figures which were based on a normal midwinter load-line of the Kensington electric lighting station. The total area of the load-line was 15,600 effective horse-power hours. The station could be worked, therefore, by engines and boilers which worked at 650 horse-power. Under present conditions, without storage, engines working to over 2,000 E.H.P. were required during the short period of maximum demand. Instead of boilers of 2,000 H.P. to meet the maximum demand, working on an average one-third of their time, and constantly shutting-off steam and then starting again, Mr. Halpin furnished boilers to supply a mean demand of 650 H.P., working them continuously during the twenty-four hours, and saving all the waste due to intermittent working. It was true that in place of the boilers dispensed with Mr. Halpin had to provide thermal storage tanks capable of supplying all the steam required when the demand exceeded the mean. An examination of the load curve showed that a store of steam amounting to 4,560 effective horse-power hours would meet the whole requirement. He found to store that amount of energy 900 tons of heated water were wanted, which might be contained in twenty-four storage tanks. Working the station *without* storage tanks, ten boilers were required, and the boiler plant would cost £10,300. Working the station *with* storage tanks three boilers were wanted, and 24 storage tanks. The storage tanks, on estimates which Mr. Halpin had shown him, and which appeared to be quite satisfactory, and the three boilers would come to £15,000. The cost of the plant with the storage tanks was, therefore, £5,000 more than the cost of the plant without storage tanks. But if they supposed that, in consequence of continuous working, only ½lb. of coal per horse-power per hour was saved, then the weight of coal saved would be 1,270 tons a year, and the value of that was a very good interest on the extra £5,000 spent on the plant. He did not doubt Mr. Halpin would put the saving at a great deal more than ½lb. per hour, and in stations they knew of it was inconceivable that there was not more than that which might be saved.

Cases which were still more advantageous, to the application of Mr. Halpin's system were those where there was now heat which was absolutely wasted. One such case was that of destructors for ashbin refuse. The destructor must be worked continuously day and night; it must also be worked at an almost regular rate, and the heat must be caught at the moment it was generated or lost altogether. It could hardly pay to attempt to use the heat from a destructor by any ordinary means, because the heat could not in most cases be utilised throughout the 24 hours. Another case which Mr. Halpin had thought of, and which was rather interesting, was this:—Scattered all over the country there were great manufactories of lighting gas; in those manufactories 312lb. of coke was burnt per ton of coal carbonised. For 312lb. of coke they would get 6,000lb. of furnace gas, which went off from the retort bank at a temperature of 1,200°F. Supposing the hot gases from the retort bank were taken through the flues of steam boilers of adequate heating surface, the furnace gases might be reduced in temperature to about 600deg. There was an available fall of temperature therefore of 600deg. in the furnace gases. That worked out to 759lb. of steam generated in the boilers by the waste heat of one ton of coal carbonised; that gave 25 E.H.P. hours per ton of coal carbonised. The gas industry was an enormous and wide-spread one. In the United Kingdom, there were 11,000,000 tons of coal carbonised annually for gas-making. The available part of the waste heat in the retort banks, at present all unutilised, amounted to 32,000 E.H.P. day and night throughout the year. That horse-power was equally available, of course, for electricity, compressed air, water, or any other form of power utilisation. Obviously Mr. Halpin's plan did very much facilitate any attempt to utilise waste heat of that kind.

Water-Power Generating Stations.

In the course of these lectures he had spoken of steam-generating central stations: he now came to the consideration of water-power generating stations. Where water-power could be utilised on a large scale, it was generally cheaper than steam-power. The water cost little or nothing, the cost of maintenance of machinery and superintendence was very small, the power was extremely regular, very controllable, and very convenient. The annual cost of water-power consisted chiefly of interest on capital expended in works and machinery. So well was this recognised that in industries like the aluminium industry, involving large quantities of energy, cheap water-power was considered the one essential of successful working. In this country water-power was unduly despised; in other countries water-power was hardly subsidiary to steam-power. The discovery of transmission of power to a distance made it possible to utilise water-power which was other-

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wise unavailable. It was because such a transmission of power by new means seemed available that a remarkable interest had lately been developed in the question of using water-power. In Switzerland, he believed, 80,000 H.P. was derived from water-falls, and used for manufacturing purposes. It was estimated that the total water-power available in Switzerland was 582,000 H.P. Putting the value of a horse-power year at £6, this represented an annual value of £6,500,000, or 1,250,000 tons of coal. At this moment there was hardly an important factory in Switzerland which was not using water, making preparations for using it, or surveys with the view of using it. He now came to consider another country. It was in the United States of America that water-power was most largely used, and where it was in most direct competition with steam-power. The money value of the water-power utilised in the United States was very considerable ; in 1880, taking the value at only £5 per annum per horse-power, it was £6,000,000 ; taking the whole of the States, 36 per cent. of the power used in manufacturing was water-power. Over a considerable portion of the United States, especially in those parts which were the most populous and the most devoted to manufacture, the water-power exceeded the steam-power. The method in which water-power was utilised in America and distributed to a number of consumers was almost peculiar to that country. He would take one particular case, the case of Holyoke, which he saw about six months ago.

The whole of the factories in Holyoke were worked by water-power, and the system was strictly a distribution of power from a central station to many consumers at a fixed rate on the amount of power used. The first weir or dam was built in 1847, but was carried away ; a second dam of crib work was built in 1849, and in 1868 they constructed an apron to that dam ; since then very difficult repairs had been carried out, and he believed it would in time be necessary to replace it with a solid structure. From above the dam an intake canal led to what they might call the first level ; from that level the water was supplied to a number of mills, driving turbines, and passing out in the tail races and into level No. 2. Having got to level No. 2 it worked another series of mills by turbines in the mills, and from their tail races was discharged to level No. 3 ; and there were still other mills taking their water from level No. 3, and discharging their tail races into the river. The power utilised was 15,000 H.P. during the day and 8,000 at night. When the ground on which the mill was built was leased the right to use the water was leased with it. When Mr. Herschell became engineer to the Water Company, at a time when the dam had become ruinous and things generally were going to the bad, the use of the water at the mills was exceedingly extravagant. By introducing a system of testing the turbines, the use of the water had been enormously economised. The balance of water saved was sold as surplus power, and therefore the rental of the water-power had very greatly increased. There was a staff of three men at Holyoke, whose sole business in life was to walk round and note the level of the water in the head and tail races and the position of the sluices, two by day and one by night. A return was made to the office daily of the level of the water in every mill, and from that a curve was drawn of the consumption of water for every mill every day throughout the year, and on the area of that curve a charge was made to the mill for the water power it used. Mr. Herschell established a turbine testing station, the first in the world, to which turbines of any size might be sent. He saw tested in that house the first of the 1,500 horse-power turbines which were to be erected at Niagara. The cost of water power varied largely in different localities ; at St. Lawrence and Manchester the total annual cost of an effective horse-power was about £4. 7s. per annum. At Holyoke it was less. At Geneva it was under £3 per annum. He would like to say very generally that the cost of the effective horse-power derived from water in the manufacturing towns of the United States was certainly not over £3 per annum ; but there were cities where it was three or four or five times that. In New Jersey especially they were using a very large amount of water-power, which cost them three or four times that. Steam-power was not specially dear there, and the fact that in New Jersey they were using water-power where it apparently cost more than steam-power was pretty good proof that there were conveniences and advantages in many cases in the use of water-power which counterbalanced even an excessive cost.

Hydraulic Motors.

He would now say something about water-motors, water-wheels having been practically superseded. They might allow the water to descend in a closed chamber, and at the lowest point, to act upon the pressure engine, which had a piston just like a steam engine. There was another way of using water, which was to allow it to issue from a pipe under pressure, and to acquire velocity due to the head, and by then directing the water on to a turbine they would get a force which would drive the turbine. Pressure engines driven by water were generally cumbrous and expensive machines, but there were two applications where they were employed with advantage. For cranes or lifts, where slow motion was wanted, the direct action of water-pressure on pistons had been found to be extremely convenient. Small rotary motors, driven by water pressure, like rotary steam-engines, in a system of hydraulic power distribution where only an intermittent or small supply of power was required and a very great pressure was available, were also now very often used. The volume of water used by a pressure engine was constant whether much or little work was to be done. Pressure engines, therefore, although having an efficiency of 80 per cent. at full load, were very uneconomical for light loads. In Switzerland on systems of hydraulic distribution small pressure engines with two oscillating cylinders, the movement of which opened and closed the admission and exhaust ports, were very largely used. In Geneva they put a counter on small pressure engines, and the consumer was charged according to the number of revolutions the motors made. There was a pressure engine invented by Mr. Rigg, and possibly known to many present, with a variable stroke, in which the difficulty of varying the quantity of water used so that it was in proportion to the load was got over. Mr. Rigg's engine might have a uniform efficiency at all loads, and from its perfect balance it could run at very high speeds, but as the friction increased as the square of the velocity, its efficiency must fall with any great increase of speed. An engine of this type, with four cylinders, running at 90 revolutions at full load, at 110 at half-load, and at 130 when drawing empty waggons, was used in Wales.

For large powers the turbine was almost the only type of hydraulic motor used. The water was supplied from a supply-pipe and guided by fixed guide vanes, so that it entered the revolving wheel in a definite direction and at a definite speed. There were inward flow, axial flow and radial flow turbines. The whole principle was this : the water came from the fixed wheel and obtained a definite velocity and direction, and was then deviated by the curve of the floats of the revolving wheel. In consequence of this deviation it exerted a reaction on the wheel which drove the turbine. There was no essential difference between inward flow, outward flow, and axial flow turbines, choice depending upon considerations of secondary importance. A fundamental difference arose in turbines according to whether or not there was any pressure in the clearance spaces between the guide vanes and the wheel. In the older turbines the water left the guide vanes with only part of its pressure head converted into velocity head. There was then a pressure, greater or less, sometimes a pressure equal to half the head due to the fall at the point where the water entered the moving wheel. Turbines which had pressure in the clearance spaces were called pressure turbines. It was a condition of their use that the wheel passages should be completely filled with water. The velocity of the water in the wheel was determined by the section of the passages, and consequently the relative velocity of the water in the wheel increased during flow through the wheel. The other fundamental type of turbine, the impulse turbine, was one in which the water issued with the full velocity due to the head from the fixed guide vanes. There was no necessity in that case that the passages between the consecutive vanes of the moving wheel should be filled with water. As a matter of fact, not only was it generally not so, but ventilating holes were made which prevented any choking of the water in the passages of the moving wheel. The impulse turbine was so much more easily regulable that it was steadily gaining ground and displacing the pressure turbine.

The regulation of turbines presented a great deal of difficulty. Taking pressure turbines first, there were three modes of regulation. First, by an equilibrium sluice of some kind, placed in the supply pipe ; the head might be varied to suit the work to be done. As this mode acted by destroying part of the head or work of the water, it was very uneconomical ; and if the speed was to be kept constant it was worse still, because to each head there was a speed at which the turbine was most efficient, and if it had to be run at a constant speed it could not be suited to the different heads at which it had to act when a throttling regulation was used. That sort of regulation was very mechanical, very simple, very cheap, and very bad. A second way was one in which part of the passages in the fixed guide blades might be closed. In some turbines they shut up part of the wheel passages and left others open ; that was a very bad way of regulation. There was a great deal of eddying. There was a third mode. All the guide passages of a wheel might be simultaneously varied in area by some mechanical arrangement. If they supposed the whole of those fixed directing vanes moved so that the area might be simultaneously varied in all of them, then they would have a perfect mode of regulation for a pressure turbine. That had been done in some turbines, best of all in the turbine invented by Prof. James Thomson, and more or less in some American turbines.

He now came to consider the regulation of impulse turbines. In impulse turbines the water in the wheel passages flowed in a free stream. The closing of some of the guide-blade passages in the case of impulse turbines produced no appreciable effect on the efficiency.

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The regulation of those turbines by partial admission was, therefore, easy and efficient. As every particle went into the wheel free to act for itself, it did not at all matter whether they closed some of the passages in the guide wheel or not. For high speeds a pressure turbine had an inconveniently high-speed of rotation; and the velocity of the wheel was a fixed function of the head, and the diameter of the wheel could not be much altered without seriously increasing the frictional or kinetic losses. Hence the number of rotations for a supply of water at a given head was fixed within very narrow limits in the case of pressure turbines. With a partial-admission turbine the diameter was arbitrary, and might be as great as they pleased. Hence the turbine could be designed to give any required number of rotations without its efficiency being in any way affected. To show how convenient impulse turbines were, he had placed on the wall drawings of some very large turbines at Greenock. Those turbines were of 580 H.P., driving rope pulleys and with regulation like those Geneva turbines. He also had drawings of a 800 H.P. turbine of exactly the same type used in the Terni Steel Works, where they drove all their machinery by water-power. One of the largest steam hammers in the world was there, worked by air compressed by water-power. A very curious type of the same kind had come into enormous vogue in the Western States of America. There was invented by a carpenter what was really a simple impulse turbine, which was known as the hurdy-gurdy or Pelton wheel. It consisted simply of buckets on a wheel; there was a jet of water coming through a nozzle and playing on those buckets, which were curved so that the deviation of the water was not very sensibly different from the other cases of impulse turbines. Really the Pelton wheel was a rather crude impulse turbine. He did not think it was quite as good as the Geneva turbines, but it had a very good efficiency; one at Holyoke, showing an efficiency of 80 per cent. under pretty high head. It was not at all suitable for a low fall. He mentioned it some time ago at the Civil Engineers, and since then Mr. Ellington had obtained two of those turbines and had placed them upon the London Hydraulic Company's supply system, and they were now working under a head equivalent to 1,600ft. head. Mr. Ellington assured him that they were both doing well, and had an efficiency of at least 75 per cent. In Washington Territory, quite on the Western coast, a very large electric lighting station was worked entirely by those Pelton wheels. He showed on the wall one mode of regulating the Pelton wheel; it was a very simple mode. There was an ordinary governor, and the governor tilted the nozzle. It was a very wasteful method; but where there was plenty of water that was not very important.

For a long time turbines were only used in cases where hand regulation was sufficient, and it was only since they had come to be used a good deal in connection with dynamos that the question of governing had assumed a very great importance. The regulation of water supply to a turbine was a very different thing from the control of the supply of steam to a steam engine. Turbine sluices were large and heavy in some cases, and required considerable power to move them. It was also necessary that all regulation should be gradual, because you had behind the turbine sluice a long column of very heavy water with a very large momentum, and if you tried to alter its velocity too suddenly destructive forces were called into action. It was not possible for an ordinary governor like a steam engine governor to act properly on a sluice except in small turbines. They must use a relay governor. There was a very curious action with a direct-acting governor. Suppose part of the load of the turbine to be thrown off, and the turbine to begin to gain in speed, the governor balls would rise, and as they rose they closed the sluice. That went on till the turbine ceased to gain in speed and began to fall in speed. As it fell in speed the balls fell again to their normal position, and as they fell reopened again the sluice a little way. With the clutch governor he had on the wall this action did not occur. Part of the load was thrown off, the balls rose, they put bevelled wheels into gear, so that the sluice began closing. The sluice began closing very gradually, and for some time the turbine went on gaining in speed, and got a great deal above its proper speed; but all that time the sluice was gradually closing. At last it closed enough to stop the gain of speed. Then the balls fell and threw the clutch out of action, and left the sluice too low down. The speed began to fall and the clutch was thrown out when the sluice was too low down. The reverse series of operations then began; the governor balls fell, the cluch, acting too gradually, opened too slowly, the turbine got much below its proper speed, the clutch re-opened and left the sluice too high up. With governors of that type they got a fluctuation of speed of this kind. There had been various attempts to get over that. Messrs. Rieter even used a friction break which was put into action by the governor and destroyed an excess of work at the time the sluice was getting into operation, and prevented the speed fluctuating as it did with an ordinary clutch governor. But the most beautiful turbine governors which he had seen were those which had been introduced chiefly in connection with the turbines round Geneva by Messrs. Faesch and Piccard. He had a diagram of one of their governors on the wall; they had several types more or less different, but this was a very simple one which was used on the 300 H.P. turbines which drove the dynamos for lighting Geneva. There were hydraulic cylinders with pistons of different areas. The under side of one piston was always under a constant water pressure due to the pressure in the water mains. The top side was usually in connection with the air, and had no pressure on it. By admitting water from the lower side of the lower piston, by admitting water through one passage and then through another passage to the top side of the larger piston, the ram moved downward. That was controlled by having a frictionless piston valve in the middle of the ram. This was put under the control of the governor, and as it rose the water was admitted to the top of the piston, and so caused the ram to move downwards and act on the sluice to close it. In the converse case, when the speed was falling, it placed the top of the ram in communication with the air, and so allowed the ram to rise and to open the sluice. If they studied that governor they would find two things: first that the action of the governor was almost absolutely unimpeded. There was almost absolutely nothing for that governor to do but think out whether the speed was right or wrong. The next thing was that there was only one possible position of the ram in which it was not moving, and that was just exactly where the speed was normal. It followed the action of the piston valve accurately.

CENTRAL STATION NOTES.*

BY W. BREW AND P. G. LEDGER.

The object of the authors of this Paper was to avoid as far as possible a mere record of tests and figures, and to select a few salient points from central station routine for discussion. They divided the subject into:—1, Boilers; 2, engines; 3, dynamos; 4, switchboards, instruments, &c.

The figures obtained by an expert's test as showing what can be done by care and attention to details are no doubt very valuable, and especially so to the man who wants to sell the engines, but the figures which chiefly interest the shareholders and managers of electric lighting stations are those giving the ordinary every day coal and water consumption and load efficiency under the working conditions of the central station. Tests during which more than the normal amount of care and attention was paid to firing and other details by the usual boiler and engine attendants are omitted, and the results of a few experiments made with plant in various places working under its normal conditions are recorded. At almost any central station in this country for a period of about two or three hours out of the twenty-four the load is twice or even three times the amount it is at any other part of the day. A good idea of about how much this affects the coal consumption may be obtained from the following experiment with four Lancashire boilers (18ft. in length by 6ft. 6in. in diameter, diameter of flues 2ft. 6in.), feeding the omnibus pipes at 80lb. steam pressure, from which three horizontal engines were supplied. The average consumption of coal per indicated horse-power hour was first noted starting and finishing with steam up and fires in normal condition, and was found to be about 4·31b., under the same conditions of load as would be applied when the effect of cooling down the boilers was taken into account. In making the second part of the test the *modus operandi* shown in the table below was followed. In the table one of the reference letters A B C D being omitted in the last column but one indicates that the corresponding boiler was allowed to cool down for that evening; to use the boilers equally a complete cycle of change would occupy four weeks.

Day of the week.	I.H.P.				Total coal burnt.			Lbs. of coal burnt per I.H.P. hour.	Boilers in use.
	Engine No.			Total I.H.P. hours.	Tons	Cwt.	qrs.		
	1	2	3						
Wednesday	78·0	82·4	13·0	390·1	1	10	0	8·81	A B C
Thursday...	40·4	50·4	174·5	596·9	2	2	0	7·87	A B C D
Friday.....	78·0	82·4	13·0	390·1	1	10	0	8·81	A B D
Saturday...	40·4	50·4	174·5	596·9	1	18	2	7·06	A B C D
Sunday ...	All four boilers allowed to cool down.								
Monday ...	78·0	82·4	13·0	390·1	1	13	0	9·47	A C D
Tuesday ..	40·4	50·4	174·5	596·9	2	2	0	7·87	A B C D

Remarks.—Feed water supplied cold. Temperature about 55° F.

The above table shows that when specially steaming boilers for short periods of usage in an ordinary station routine, about double

* Abstract of a Paper read on January 20th before the Old Students' Association.

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the price must be paid for an indicated horse-power hour compared with similar boilers continually employed for long intervals. This state of affairs could be improved by having previously at hand a fair supply of heated feed water; but in ordinary cases the supply is not sufficient to cope with the demand for extra boilers during the short interval of heavy load.

It is a well known fact that an over-compounded dynamo will not run satisfactorily as a generator supplying a shunt motor, if motor and generator be nearly the same size; a practical case of this was described by Mr. Kapp in *The Electrician* of April, 18, 1885, p. 472. Other facts equally certain, but perhaps not so well recognised, are that two over-compounded machines will not run satisfactorily in parallel, neither will two so-called compound dynamos, whose characteristics (terminal potential difference and current) deviate much from a straight line. These phenomena may be classed under two heads. 1st. Those due to the form of the characteristic of the machines concerned. 2nd. Those due to the effect of considerable self-induction coming into play with a rapid variation of the load as one or more of the machines are thrown in, with a consequent lag of magnetisation and potential difference at the terminals.

Fig. 1 represents the connections diagrammatically; s s^1 are the additional series turns, w a wire (usually called the balancing wire) joining the inside brushes *b b*, and A and B represent the omnibus bars. If we suppose the bars A B to have little or no resistance, or better, suppose the external circuit connected midway between the two machines, and add the resistance of one bar to each of the series turns of the dynamos, we find that the above connections reduce themselves to the well known lozenge-shaped diagram of the Wheatstone's bridge, the balancing wire replacing the galvanometer, as in Fig. 2. Let x y and z denote the currents in the various sections in the usual manner; then employing determinant analysis it may be shown that the current through the

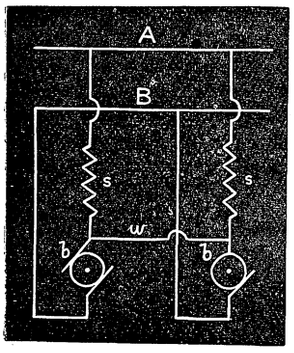

FIG. 1.

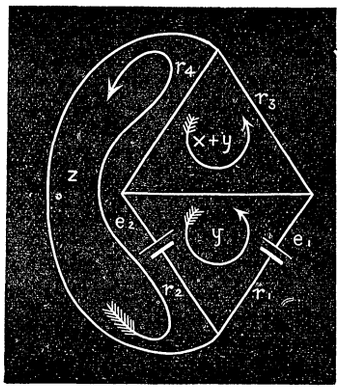

FIG. 2.

balancing wire will be proportional to the difference in the electromotive force of the two machines. Consider now the currents flowing in the series turns of the machines, *i.e.*, $(x+y)$ in the branch r_3 and $z-(x+y)$ in the branch r_4; denoting these by A and B respectively, and in the expressions putting $r_5=0$ we have :—

$$A=\frac{e_2\,(r_4\,r_1)+e_1\,(r_2\,r_4)}{\Delta},$$

$$\text{and } B=\frac{e_2\,(r_3\,r_1)+e_1\,(r_2\,r_3)}{\Delta},$$

from which it will be obvious that if in addition to r_5 being zero we have the condition $r_3=r_4$ then the currents through the series-turns will be equal; in other words, if the two machines running in parallel have equal resistance in their series-turns and the resistance of the balancing wire is small, then, whatever the difference between e_1 and e_2, or r_1 and r_2 may be, the currents through the series-turns of the machines will be nearly equal. The above simple investigation, therefore, shows us two things. First, that in order to run two compound machines in parallel efficiently they should be of the same size, or, at any rate, have equal resistance in their series-turns. Secondly, the balancing wire should be of low resistance and not a fine wire as is sometimes stated in text books.

Fig. 3 represents the characteristics of two compound dynamos which could not be got to run in parallel until the compounding had been altered; the speed of the machines had been altered to accommodate a greater drop of potential difference along the mains than was at first estimated for, owing to the replacing of several arc lamps by incandescent lamps on the mains. A glance at the upper part of the curves will show that the machines were over compounded at this speed, and it will be evident that two such dynamos working in parallel will be in a constant state of unstable equilibrium; for assuming the machines to have a load equally divided between them at the start, and anything to occur to alter this condition, such as the joint of a belt running over a pulley, or a slight variation in the speed of one of the engines if the dynamos are direct-driven, then that machine which has come off best with regard to the load has the potential difference at its terminals increased, while the reverse is the case with its neighbour, which rapidly relinquishes the remainder of its load to its stronger brother, and is promptly reversed, a proceeding which is generally accompanied by a pyrotechnic display at the commutators of both machines. Again, take the case of a somewhat common characteristic of a large compound machine in which the terminal potential difference rises until about half the load is on, then gradually falls until at full load it has exactly the same potential difference as on open circuit, it is obvious that two such machines running in parallel will also be in a state of unstable equilibrium for certain light loads. The practicability of running compound machines satisfactorily in parallel depends to a considerable extent upon the form of the characteristic of the machines concerned.

In December, 1890, in a letter to *The Electrician*, Vol. XXVI., p. 280, one of us gave some curves illustrating the lag of induction through the armature of a dynamo behind the magnetising current producing it, and as the curves refer to a machine similar in every respect to the two whose characteristics we have given in the last figure, it will, perhaps, make matters more complete if we give these curves again; we therefore reproduce them in Figs. 4, 5 and 6. Curves are first obtained showing the rise of potential difference at the machine terminals and the rise of current in the shunt respectively, with time after the closing of the shunt switch across the omnibus bars :—A com-

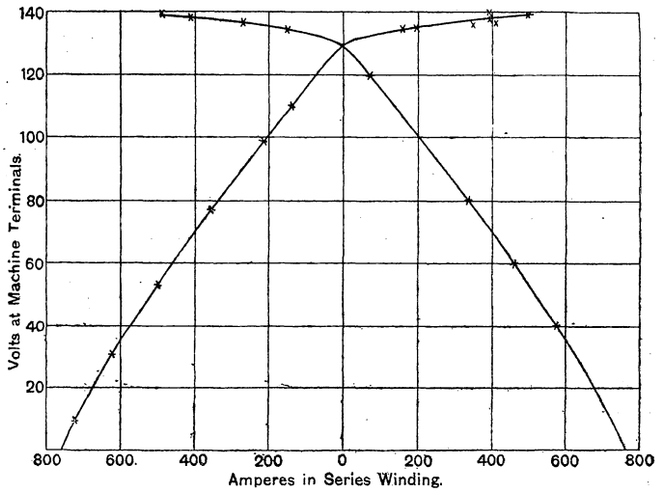

FIG. 3.—600 Revolutions per Minute. Total Ampere Turns 400 per Unit Division.

parison of the ordinates of these two curves at the same instant gives us a third curve which will represent to a certain scale the variation of the induction through the armature, with the exciting current producing it.

In Fig. 6 this curve, with varying current, is compared with a similar one taken with a steady magnetising current, a considerable interval being given between each reading to allow the magnetism to settle.

It will be obvious that, although the self-induction of the series turns may not be so great as that of the shunt winding, an effect of this nature will be of considerable importance in switching large compound machines rapidly into parallel. Suppose, for example, we have two machines, A and B, and we require to put A in parallel with B, which is loaded; and suppose we note the potential difference at the terminals of B, and make the electromotive force of A slightly greater (by altering the speed of the engine, or otherwise), so that A will take up some of B's load as soon as we close the switch, we see that B will behave as an over-compounded machine, and A the reverse for a short interval.

We have seen that we may express the final steady value of a current which will flow through a machine (when put in parallel and shortly after the switch is closed) in terms of its electro-motive force, and a certain effective resistance involving the resistances of the other machines already in parallel between the omnibus bars and the resistance of the external circuit.

In the ordinary state of affairs the shunt-circuit will be closed, of course, and a steady current will be flowing through it from the omnibus bars, and the only effect of importance upon this steady current when the main switch is closed will be that due to mutual induction between the shunt and the main circuit through the armature and series turns.

The usual way of regulating large shunt machines working in parallel, and coupled direct to the engine, is by varying the speed of the engine by means of an adjustable governor, increasing or

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diminishing the tension of the spring according to the potential difference required at the machine terminals. An adjustable resistance in the shunt of the machine is sometimes used, but with a fair-sized dynamo this system of regulation is quite inadequate to cope with rapid variations in the load. In the case of a sudden load being thrown upon a machine direct driven, the speed of the engine may

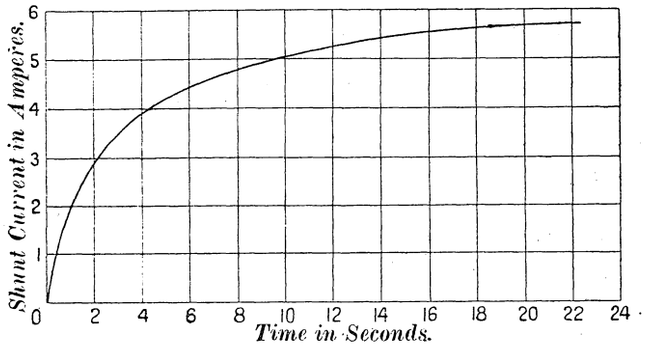

FIG. 4.

be raised quickly, and then lowered a little as the current rises in the shunt. In most cases, however, the loads thrown suddenly on the machine are not sufficient to cause any serious fall of potential difference, and the regulation may be, therefore, effected gradually. What occurs in an ordinary central station when

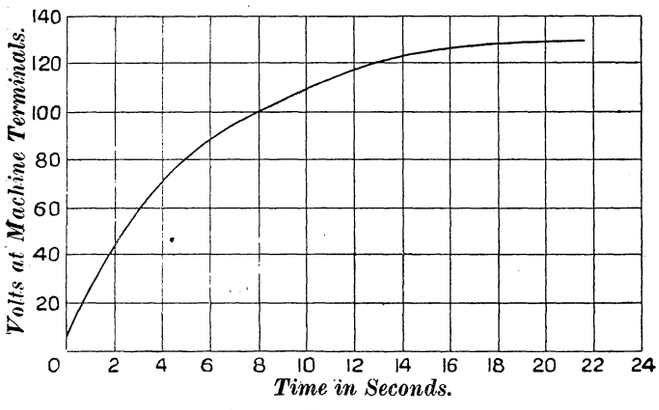

FIG. 5.

a sudden fog comes on is probably well known; a good deal more than the average amount of coal is burnt in the time, and a higher rate of activity generally is required of the staff. In the case of a station running with shunt machines direct coupled to their engines the number of dynamos connected to the omnibus

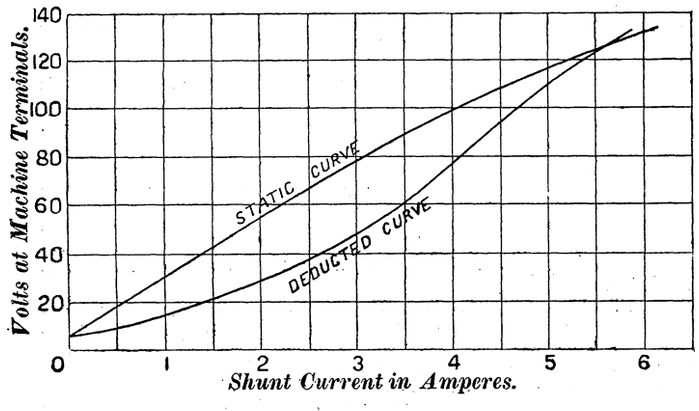

FIG. 6.

bars depends upon the demand of the customers at any time. In most stations of this type each dynamo is provided with an automatic cut-out placed between one or both of the machine terminals and the omnibus bars, whose duty it is to cut off automatically the machine in the event of a reduction in its electromotive force due to a hot bearing or other cause, thus saving the armature, whose electromotive force has been reduced, from destruction by the other machines coupled in parallel with it. Now, although an automatic "cut-out" may work with theoretical preciseness with an ordinary varying current, it is rash to rely upon it under the conditions of a sudden increment or decrement in the current passing through it, for, owing to the inertia of the moving parts (which must be made somewhat large to carry the current), many of those at present on the market will vary considerably in their point of cut off. Thus it happens that upon visiting some central stations, and examining closely some elaborate piece of mechanism of this nature, we discover a substantial wooden wedge, or piece of stout whipcord to be necessary to the satisfaction of the engineer in charge, rendering the ingenious and admired apparatus quite passive as regards either service or mischief. When full-sized motors are coupled to the mains they do not tend to improve the steadiness of the light, for their load is constantly varying with uncertainty, and although helping to keep up the all-day efficiency of the plant, matters would be improved if they could be run off mains distinct from the lighting mains. Some kinds of electric lighting also, such as that of theatres, often require for stage effects, &c., rapid and considerable variations of current, but the redeeming feature of theatre lighting from a supply station is that the station people know within a minute or so when the load will vary, and the amount of its variation, and are therefore on the look out for it. The late Royal English Opera House, although coupled to the mains of the Metropolitan Electric Supply, was ordinarily worked from its own installation under the management of Mr. J. Peschek. The conditions of the working were somewhat trying; for instance, the great necessity of crispness in response to signals, and the manipulation of large and varying loads thrown suddenly upon, and again taken as rapidly off, the keeping of boilers under steam for several hours for the special requirements of, perhaps, an hour or so, &c., &c. The installation comprises three locomotive boilers (by Marshalls), supplying with steam three Willans compound engines coupled direct to Siemens shunt dynamos, having an output of 650 amperes each at 100 volts. A set of 108 E.P.S. 31 L accumulators are also used for supplying light during the day throughout the house; these are charged in three sets parallel and discharged in two sets parallel. The current leaving the engine-room during an opera usually varied from 600 to 1,200 amperes, and the total consumption from 300—550 B.T.U. per diem. The following items compose the cost of running the installation per diem with seven performances per week, two performances usually being given on Saturday, and about three full rehearsals in a month, the results being the average of some months' running:—

Engine-room wages	£1	19	0
Depreciation of plant at 10 per cent.	5	0	0
Water for boilers	0	2	0
Fuel " "	2	2	0
Repairs, oil, and waste	0	11	0
Total	£7	14	0

Taking the case of the operas *Ivanhoe* and the *Basoche*, with an average consumption of 459·37 B.T.U. and 524·25 B.T.U. respectively, we find the cost of production per B.T.U. during *Ivanhoe* was 4·02d., and during the *Basoche* 3·52d., which, when we consider the size of the plant and the trying load curve, is not at all bad.

NON-POLARISED AMMETERS.

I desire to call attention, says Mr. Clarence E. Gifford in the *Electrical World*, to the danger accompanying the use of non-polarised ammeters in power stations. The danger lies in the fact that instruments of the non-polarised type give always deflections in the same direction, regardless of the direction of the current. Take the case of two or more shunt or compound wound machines working in multiple. Suppose that the voltage of any machine of a group falls, from any cause, to such a point that the output from that machine is nil, the index of the ammeter falls back to zero. If this escapes the notice of the attendant the pressure from this machine may in another moment have fallen to such a point that the machine is receiving current and running as a motor. Even the provision of equalising wires, where these compound dynamos are worked in multiple, does not, unless the equalising wires are of exceedingly low resistance, entirely obviate the evil effects of the series winding on a compound dynamo that once decides to start in business as a motor. In other words, so long as a dynamo is producing ever so small an output (whatever the output of its companions), just so long the series windings, working in connection with the equalising wires, will operate in their legitimate manner, and tend toward effecting a uniform voltage in the various machines of the group. But when the output of one of our machines gives

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place to an income of current, the income of the owners of the plant is sometimes affected in an inverse ratio.

Returning after this digression to the point where one of our dynamos became a motor. Its ammeter leaves the zero point and indicates an amount of current which the attendant innocently supposes to be output. This may soon give a reading exceeding the output of any single one of its companions. The attendant "regulates" the machine by throwing the resistance into the shunt field; the ammeter, somewhat to his surprise, goes farther ahead of its fellows; he regulates some more, and the ammeter takes another jump; he gets excited, and there follows a race between him and the wheel of the rheostat on the one hand and the ammeter on the other; and, before the range of the rheostat is reached, the engine joins in the chase, because its dynamo is now operating with such power as a motor that the engine will be pulled through at a high speed, her governor being simply capable of limiting the steam supply within certain limits, but beyond such limits being of no avail in counterbalancing the power of the motor. Meanwhile, suppose, in addition to your "self-imposed" burden, that a heavy line load has come on—Results: blown fuses, overloaded dynamos, lines shut down, new fuses, and new and probably fruitless attempts to regulate—Bedlam in the station, and the "devil to pay" generally. Query: Why didn't you apply your voltmeter to the troublesome machine? Well, personally, I never had the above sad experience, but any one who knows the ordinary ways of a power station will be able to answer the question, and will also be readily able to see how a combination of high ammeter, low voltmeter, and run away engine might be a somewhat difficult problem for a man of even good ability.

Remedy: If you use non-polarised ammeters for your machines, put a brass strip across the front of the case, near the top, and from the centre of this strip pivot a vertical polarised steel bar or needle, the pivot being slightly above the centre of gravity of the needle. The needle should be of good magnet steel, well charged, and so pivoted as to move very easily. Then, if the current passes in the same direction through all your ammeters when the machines are in proper operation, the polarised needles will, of course, all be deflected in the same direction, one with another; and any deflection to the opposite side of the vertical line will indicate that the dynamo to which it belongs is being run as a motor.

THE ELECTRICITY SUPPLY BUSINESS IN PARIS.

The following table deduced from one published by *l'Industrie Electrique*, may prove of interest when compared with similar ones relating to the metropolis. The total lampage of these four companies amounts, it will be seen, to 170,000, yielding a total income of £240,000, or an average of £1. 8s. per lamp:—

Company.	Capital £	1892. Receipts £	10 c.p. lamps connected.	Capital £ expended per lamp connect'd	Receipts £ per lamp connected.	Length of mains (miles).	Lamps per mile of main.
Edison ...	200,000	80,000	45,000	4·44	1·7	20	2,250
Clichy ...	200,000	40,000	30,000	6·67	1·3	22	1,370
Popp	440,000	40,000	50,000	8·80	0·8	51	980
Parisienne.	400,000	80,000	45,000	8·88	1·7	20	2,250

PHYSICAL SOCIETY.

At an ordinary meeting of this Society, held January 13, 1893, Prof. G. F. Fitzgerald, M.A., F.R.S., President, in the chair, a Paper was read by Mr. F. W. SANDERSON on

"Science Teaching."

In this communication the author considers the methods of teaching physical science, and remarks that other sciences may best be treated in some different manner. The method recommended is one found suitable in public schools where boys may remain till about the age of nineteen In elementary and secondary schools modification would be necessary with a view to making it more immediately useful, whilst in university and technical colleges other methods might be preferable. The object of his public school method was to make physical science a definite means of education, rather than to produce skilled physicists. Certain mathematical subjects, such as arithmetic, geometry, and algebra, should be taught before physics is begun, and taught in such a way as to aid subsequent physical work. In teaching arithmetic it is deemed desirable to distinguish between the science and the art of it, and to have separate hours for instruction in each. The subjects included in each part are described in some detail in the Paper. No existing arithmetic satisfies the author's requirements. Geometry is considered of the first importance; practical geometry and the use of instruments forming the best introduction to the subject. It is recommended that the elementary part be taught by the mathematical master with a view to formal geometry, *e.g.*, Euclid. As most practical geometries consist of isolated constructions they are useless for teaching the subject in a scientific manner. Number of problems suitable for a graduated introductory course are given. After elementary geometry mensuration may be taken up with advantage, the facts being verified by drawing to a scale, measuring, or by weighing, but no rules being given. Trigonometry of one angle may then be commenced. Here also free use should be made of the drawing board, each pupil finding the sines, cosines, and tangents of angles by drawing and measurement, and making tables. Quite independent of the mathematical class, the author has been in the habit of carrying boys on the engineering side through a course of graphical analytical geometry, in which they draw straight lines and the quadratic curves, &c., from their equations, solve simultaneous linear equations, quadratics, cubics, &c. Other geometrical constructions follow. The subject as to what branches of science should be taught in the different departments of a school is then considered, and schemes are given for the Classical, Modern and Commercial, Science, and Engineering sides. Some general principles which have been kept in view in arranging the physical teaching are next described. In the first place the fundamental experiments and observations on which each scientific law is based are explained to the pupils, and when possible the experiments are performed by the boys in the laboratory. Secondly, from the experiments the laws are stated as precisely as possible, the form of statement depending on the knowledge possessed by the class. The problem of expressing a law mathematically from its most fundamental statement is then fully considered. Thirdly, mathematical deductions from the laws are followed out, and the pupils perform experiments to verify the results, and thus confirm the laws. Fourthly, a course of exact physical measurements is given, which includes mensuration, hydrostatics, mechanics, sound, heat, electricity and light. A first and second year course is arranged in each subject, and in both years all the boys work the same experiment at the same time. This necessitates multiplication of apparatus, but being of a simple character in the lower forms, where the pupils are numerous, it is not prohibitive. It is also stated that boys get better results with comparatively rough apparatus, if large, than with delicate and expensive instruments. About half the time devoted to physics is spent in the laboratory. Mathematics is introduced as far as can be done without straining the pupils too much, and with young classes appeal is made to experiment where the strictly logical argument would be difficult to follow. Instead of teaching the applications of science, as done in some technical schools, the author's method is to teach pure science, and let the applications come in as illustrations.

At the end of the Paper detailed lists of experiments for practical courses in electricity and optics are given. Samples of the apparatus used were exhibited at the meeting, those for optics being particularly simple and ingenious.

DISCUSSION.

Prof. A. M. WORTHINGTON said his experience led him to a very hearty agreement with Mr. Sanderson on all essential points, and he thought there was now a close agreement amongst teachers as to the best methods. He therefore wished to ask: Had not the time now come at which the Physical Society might usefully endeavour to exert direct influence on science teaching? As the scientific instruction of a person who intends following a scientific calling is generally divided into stages, and conducted in different places under different teachers, he thought it was desirable that those in charge of his training at each stage should say up to what point his instruction should be carried before he reaches them. Other matters in which the society might do useful work were, 1st, reporting on text books and condemning the bad ones, and 2nd, furthering the adoption of the decimal system. At present, he said, an enormous extension in the teaching of physical science is taking place, and it seemed within the power of the Physical Society to place itself at the head of the movement. Another point which required to be settled was the relative importance of physics and chemistry at different stages of a student's education.

Mr. L. CUMMING agreed with the general principles laid down by Mr. Sanderson. In attempting to carry out such schemes numerous difficulties presented themselves, especially where the science master had not control over the subdivision of the boys' time. He had tried teaching the science of arithmetic to boys in the lower forms, but the results were not encouraging, for he found very few who could do much in it. They seemed to devote themselves much more readily to concrete problems and the art of manipulation of rules. Graphical statics was very valuable. As regards experimental lectures, he believed them to be very important, especially in junior classes. For scholarship boys, a different method had been tried with success. Instead of performing lengthy experiments completely before the class, the essential parts were gone over, and for the minor points the results obtained in experiments made before or after the lecture were given, so that all the data for reducing the results were to hand. This saved considerable time. He had hoped Mr. Sanderson would

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say something about the slide rules, and wished to learn his opinions on its use.

Dr. STONEY said he was very much struck with the methods of teaching brought forward by Mr. Sanderson, and remarked that his own work would have been considerably lightened if such a scheme had been developed many years ago. Experimental methods were very valuable, provided the inaccuracies of measurement be kept in view. Plotting curves was also very instructive, and might be made a means of furnishing the fundamental notions in the differential and integral calculus. As to the introduction of chemistry, his experience went to show that this should be done at an early age. Dynamics should also be begun early.

Mr. W. B. CROFT thought that if the Society did make rules to regulate the teaching of physical science, these rules should not be too strict, for the ages and aims of boys might differ widely. At Winchester the science teaching was carried out on the lines recommended by a committee of the Royal Society appointed to consider the subject. The object of the scheme was not merely to make science a means of education, but an integral part of the education of the pupils. He also made a point of keeping the lecture experiments up to date.

Mr. RENTOUL said dynamics should not be taught as a mathematical subject, but experimentally. He thought it of the first importance that boys should learn how to find out facts for themselves, and for this practical work was essential.

Prof. AYRTON remarked that the conditions under which science was taught differed in different places. He himself taught with the object of enabling the persons under instruction to improve the industry. For this purpose he believed the analytical method more suitable than the synthetical one advocated by Mr. Sanderson. It also had the advantage of being more scientific, for it was more natural, being in fact that used by children from birth, for they had no other means of learning the nature and properties of their surroundings. In his first year's technical course the work was synthetical, whilst in the third year the students, having analysed existing apparatus, were taught to devise new or improved forms, and hence the work became more synthetical.

Mr. F. J. SMITH said it was important that students be taught to measure by the balance, micrometer, spherometer, &c., as soon as possible. He also inquired how far Mr. Sanderson's pupils could help themselves in making the apparatus required for the simple experiments.

Dr. GLADSTONE agreed with many points in the Paper. Lately he had had to do with schemes for improving the teaching in elementary schools. Children were naturally philosophers, but at present their curiosity was considered objectionable and sternly repressed. Efforts were now being made to alter this state of things. Kindergarten classes in infant schools were a step in the right direction. It was very difficult to introduce analogous methods in the higher standards, but natural science had now obtained a footing. Although the methods of teaching adopted might be those suitable for pure science, care should be taken to put in practical illustrations, for when suitably chosen, they are sources of great interest to children.

Mr. SANDERSON, in reply, said the slide rule was used throughout the course. Mechanics was taught by actual machines, such as pulley-blocks, screw jacks, &c. The boys made some apparatus, but to make all would require too much time.

The PRESIDENT, when proposing a vote of thanks to the author of the Paper, said that in Ireland the opinion that boys and girls cannot be taught science greatly predominated. They found considerable difficulty in getting any continuation of kindergarten teaching sanctioned. Possibly drawing might be allowed, but this seemed all they could hope for at present. He wished to emphasise the fact that in such schools the object was education, and practical applications of science were not important, except in so far as they created an interest in the subjects. At present scientific teaching was in an experimental stage, and, as in other things, progress is made by trial and error. Many different methods were being tried, and it was important to know which were successful and which failures. He thought the Physical Society might be useful in collecting information on the subject by issuing a circular of questions to science teachers, and subsequently drawing up a report on the subject.

LEGAL INTELLIGENCE.

The National Telephone Company (Limited) and Another v. Graff Baker.

TUESDAY, JANUARY 17TH.

At the opening of the 6th and last day of this case Mr. BOUSFIELD stated that the Solicitor-General was unable to resume his argument, and proceeded himself to take up the citation of American cases.

Mr. BOUSFIELD said he would only trouble his Lordship with one case, an important one, in which the British authorities were cited, and which plainly went on the same law as was administered in his Lordship's Court. It was *The Cumberland Telephone and Telegraph Company* v. *The United Electric Railway* (42 Federal Reporter, p. 273). The concluding passage of the judgment in this action ran as follows:—"The substance of all cases we have met with in our examination of this question—and we have cited but a small fraction of them—is that, where a person is making lawful use of his own property, or of a public franchise, in such a manner as to occasion injury to another, the question of his liability will depend upon the fact whether he has made use of the means which, in the progress of science and improvement, have been shown by experience to be the best; but he is not bound to experiment with recent inventions not generally known, or to adopt expensive devices when it lies in the power of the person injured to make use himself of an effective and inexpensive method of prevention. If in the case under consideration it were shown that the double trolley would obviate the injury to complainant without exposing defendants or the public to any great inconvenience or a large expense, we think it would be their duty to make use of it, and should have no doubt of our power to aid the complainant by an injunction; but, as the proofs show that a more effectual and less objectionable and expensive remedy is open to the complainant, we think the obligation is upon the Telephone Company to adopt it, and that defendants are not bound to indemnify it; in other words, that the damage incidentally done to the complainant is not such as is justly chargeable to the defendants. Unless we are to hold that the Telephone Company has a monopoly of the use of the earth, and of all the earth within the city of Nashville, for its feeble current, not only as against the defendants, but as against all forms of electrical energy which, in the progress of science and invention, may hereafter require its use, we do not see how this Bill can be maintained. We place our denial of an injunction on the grounds: Firstly, that the defendants are making lawful use of the franchise conferred upon them by the State, in a manner contemplated by the statute, and that such act cannot be considered as a nuisance in itself. Secondly, that in the exercise of such franchise, no negligence has been shown, and no wanton or unnecessary disregard of the rights of the complainant. Thirdly, that the damages occasioned to the complainant are not the direct consequence of the construction of the defendant's roads, but are incidental damages resulting from their operation, and are not recoverable. The cases involving this principle are almost innumerable, and in our examination of them we are satisfied the great weight of authority bears in the direction we have indicated. As a result the motion for an injunction must be denied." The learned counsel then commented on the cases quoted by Sir Richard Webster in his opening speech. The defendant rested his case on the well-known case referred to of *Vaughan* v. *the Taff Vale Railway Company*. He submitted that the present case was almost identical with *Vaughan* v. *the Taff Vale Railway Company*. That was a case of what might be called dangerous employment of a dangerous article, a locomotive, and it was upon the ground that the statute had expressly authorised the use of a dangerous article, and that the dangers of the article were contemplated in authorising its use, that it was held that the result, namely, the sparks setting fire to some of the property, was one contemplated, and one against which the defendant was protected. Assuming, of course, that the danger here from an electric railway in reference to the present case was a danger simply of disturbing somebody else's wires, that was the danger which the use of electricity involved. He submitted that as the net result of the evidence the plaintiffs had failed to discharge the burden which was upon them, of showing that his client had been guilty of any negligence in the adoption of the system actually adopted. If disturbance of the kind complained of was a nuisance, then a disturbance by a telegraph wire, either so long or so near as to affect, or even a telephone wire which was so close as to affect, would also be of the same character. Therefore the plaintiffs' argument necessarily led to the result that any electrical disturbance which was so great as to make noises upon their telephone wires was a disturbance which was *per se* a nuisance, and which was actionable. On the other hand, what the defendant submitted was that these were disturbances which were necessarily incidental to every great city, to every place such as Leeds or London, and that having regard to the quantity of telegraph, electric light, electric power, electric tramway wires, and so on, that were gradually being used for different purposes, electrical disturbances were things which were incidents in the present state of civilisation, even though they were not incidents ten years ago, when the telephone was established, and that they were disturbances which the telephone companies themselves could, and ought, and must, from the very nature of their business, protect themselves against. Supposing the plaintiffs were freeholders, and that he was a freeholder, and that between the lands there was a long boundary. On the boundary of his land he put up a telegraph wire of sufficient length; on the boundary of their land they put up a telephone wire coming within the range of disturbance. Then they would be entitled, if Sir Richard Webster's law was good law, to complain of the use of the telegraph wire as a nuisance if there were electrical disturbances. His case was that these were disturbances which, in a crowded place and in cities, people who had a business depending on very delicate currents must necessarily contemplate, and that they could and ought to protect themselves against these disturbances from the very nature of their business, and from the nature of the requirements of mankind at large in regard to other electrical devices which were now coming into common use. If they looked at the New Telephone Company and the Post Office they would see they acknowledged that it was an incident of their business that they must protect themselves against the ordinary incidents of that business. All over the world, practically, other people were doing the same thing. In New York they were transforming the exchanges, and abandoning earth returns. In Stockholm, even, where there were 10,000 telephones, which was a great number for a place of that size, they were already transforming their exchanges. In other places, for instance, in Paris, they had already transformed the exchange. The plaintiffs apparently still stuck, whether from motives of economy or in order that that list of dividends which his Lordship had before him should be kept up to its high water mark, to the old "cheap and nasty" system of the earth return.

Sir RICHARD WEBSTER, in his reply, said he hoped that he could render his Lordship some assistance in deciding a very interesting case, involving novel considerations. With regard to the Solicitor-General's ingenious water well analogy, he had at once to point out that the facts proved in evidence showed that no such analogy existed at all. What was the defendant doing? Was he drawing from the reservoir of the earth, putting down a pipe, and getting up natural water? No, he worked steam engines, he worked dynamos, and generated vast currents of electricity, not existing in the natural and uninterrupted condition of the earth. The defendant established a non-natural condition of things. A person who unlawfully for his own purpose created a non-natural state of things, who brought on his property a wild beast, did it at his peril.

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His clients stood in the position that what they were lawfully doing was hurting nobody else; what the defendant was lawfully doing was injuring individuals who were carrying on a lawful trade. Since Mr. Macrory's report there was no dispute as to a damaging escape of electricity. According to Prof. Silvanus Thompson's evidence prior to 1880, the maximum electrical energy employed was about one-sixth of a watt. The defendant's dynamos developed 60,000 watts; 360,000 times as much energy. Was not that the keeping of a wild beast, the escape of which must be guarded against and prevented by those who, for their own purposes, had thought fit to utilise that extreme power. A somewhat curious and far-fetched argument was used that morning. It was said that there must have been contemplated electricity which would do harm to neighbours because there was a clause which especially protected the telegraphs. A person must have had very little experience of the passing of private Bills through Committee to use any such argument in a Court of Justice. One had only to read the language of the section relating to the telegraph wires in order to come to the conclusion that it was an incorporation of a special code for the special protection of Government property, no private individual being in the same position. Private individuals were left to assert their rights in the Courts in the way they were doing that day. Coming to the American cases, he would cite the judgment of the Supreme Court of New York in the case of the *Hudson River Telephone Company* v. *The Watervliet, Turnpike, and Railroad Company*. The importance of that case was that it was a judgment of the Supreme Court of New York, and, so far from it being a judgment supporting the principle which his learned friends contended for, it was actually a case in which they ordered a new trial because the judge had not directed the jury that the Telephone Company could recover in the event of the currents coming off from the tramway undertaking, and thereby causing the injury to the property. The date of the judgment was Sept. 9, 1891.

Mr. DUNHAM: I think that has been reversed.

Sir R. WEBSTER: It is very unlikely, because a new trial was directed. The Supreme Court of New York can scarcely have been reversed.

Mr. JUSTICE KEKEWICH: It is the Supreme Court of New York. Not the Supreme Court of the United States.

Mr. DUNHAM: I am told that that is a judgment on an interlocutory point, but that the main question in the action was subsequently decided contrary to that.*

Sir R. WEBSTER, after quoting English authorities, said that his learned friend, Mr. Bousfield, spoke as though the single-wire system was only the system of one company. The evidence before the Court was that more than nine-tenths of the telephone business was done on the one-wire system, and the only suggestion was that, in places where there was very acute disturbance from other causes, as in London, it might be desirable to have another system. He had only to say in conclusion that he asked the Court to lay down no harder rule than that the defendant was not to conduct his business so that he interfered with the business of the Telephone Company lawfully carried on, and entitled to the protection of the law.

The SOLICITOR-GENERAL, at his Lordship's request, then referred to further cases bearing on the action occupying the attention of the Court, and was again followed by Sir Richard Webster.

Mr. JUSTICE KEKEWICH: I must consider this case, and I will do so as soon as other duties permit. I only wish to say at the present moment, having you all here, that this case strikes me as a very cogent example of the necessity which has been enforced by many Judges, including myself, and lately by different reports of the necessity for the power of bringing an action before a competent tribunal after issue joined in order that the method of procedure may be determined. I cannot help thinking that if this had been brought before a Judge in Chambers to settle what should be argued, we should have saved several days' evidence, and should have come to a satisfactory conclusion in not only a much quicker way, but, what is the result of quickness, much less costly. I cannot blame anybody; I do not blame anybody; but it is a reform that has been near my heart for a long time, and I cannot help enforcing it.

Macintosh v. Siemens.

This was an action brought under the provisions of the Employers Liability Act, in which the plaintiff sought to recover damages for personal injuries sustained owing to the alleged defective condition of the defendant's plant at their electric light works at Greenwich. The plaintiff's case was that on July 22nd last he was ordered to go to work on a lift which was being constructed for the purpose of testing the utility of electricity as a motive power. In the course of his work he was ordered to go across a plank, and in carrying out that order he slipped and fell to the ground, with the result that both his legs were fractured, and he had aver since been incapacitated from work.

For the defence, it was alleged that the work which the plaintiff had to do was perfectly safe if he had chosen to use proper and ordinary care. It was absolutely denied that the beam from which he fell was in a "wobbling" condition, or that it was by any means unsafe. The defendants' foreman and several other witnesses were called to prove that the beam in question was part of the permanent structure, and was in the same position at the present moment as it was on the day of the accident.

After hearing the case at great length his Honour told the jury the questions which they had to consider were as to whether the defendants' plant was defective, and if it was, whether the carpenter was guilty of negligence in ordering the plaintiff to do work of an unduly dangerous nature.

The Jury, after a short consultation, found that there was no defect in the defendants' plant, and no negligence on the part of their foreman or any other servant.

His Honour entered judgment for the defendants, and made a formal order for costs.

* See *The Electrician*, Vol XXIX., November 18, 1892, p. 58.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan.* 14, 1893.

Gilbertiana.—The discussion stirred up on your side of the Atlantic by the note which appeared in the American letter of a few weeks ago has reached this side of the water, and is being taken up by the American journals. Last week the *Iron Age* devoted a page or more of space to this subject, giving a reprint of Prof. Thompson's first letter to *The Electrician*, with Mr. Dredge's reply, and supplemented by another reply to Prof. Thompson's letter written by Messrs. John Wiley and Sons, the publishers, to the editor of the *Iron Age*. A number of electrical journals have also taken up the subject, and given more or less space to the matter. The general opinion seems to be that Prof. Thompson has unnecessarily stirred up a discussion on this subject, and it is quite generally agreed that Mr. Mottelay, or anyone else, has a perfect right to translate and publish Gilbert's work in the English language, irrespective of whatever the Gilbert Club might be intending to do. The journals, however, have not yet commented on Prof. Thompson's latest reply, which appeared in *The Electrician* which came to hand this week, and it may be that this letter will change the opinion of some American journalists in regard to Mr. Mottelay's action prior to his announcement that he was bringing out a translation. It is generally understood in this country that Mottelay's translation will be issued from the press in three or four weeks at the latest, and that the only reason it is not now on the market is because of the desire on the part of the publishers to protect the English copyright on the work. Some interest is manifested in the anticipated reply of Mr. Dredge to Prof. Thompson's latest letter.

Storage Battery Traction.—This form of traction seems to be a favourite system for "experiments" in New York. For a number of years system after system has been tried on different lines of street railway, only to disappear in a month or two and to give place a little later to another system operated by another company in a different part of the city. A trial was made this week on one of the lines of a storage battery system, which had been announced as the coming thing in the storage battery line. Speed tests had previously been made by the General Electric Company's engineers, it is said, which showed that on a 6 per cent. grade the car ascended at the rate of 6·7 miles per hour. The trial trip made this week showed a speed on the same grade of something like two or three miles per hour, although it should he said in fairness that the track was in rather poor condition. Less and less confidence is coming to be placed in the storage battery for electric traction purposes. That the storage battery and the storage battery car will work there seems to be no question, but that it will work economically has yet to be shown, and until this can be shown Yankee investors are likely to prefer the overhead trolley, which has already shown that it can be ecomically operated under nearly all conditions of street railway traffic in other than the very smallest cities.

CORRESPONDENCE.

VOLTAMETER EXPERIMENTS WITH AN INDUCTION COIL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The Paper of Dr. Magnus Maclean, of which you print an abstract in *The Electrician* of January 20th, is of interest as an attempt to show the magnitude of the current at break in the secondary circuit of an induction coil, by arranging a vacuum tube and an electrolytic cell in series in the circuit, and weighing the electrodes after the coil had been in action for a certain period of time. In this way Dr. Maclean arrives at figures giving about one-sixth of a milliampere as the average current in the secondary circuit during a period of 4,200 seconds in a particular experiment. But

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when an induction coil is acting, a very large proportion of the whole time is made up of the intervals between the successive contacts of the vibrator. Dr. Fleming has quoted* some experiments of Blaserna in which the duration of the impulses in a secondary coil were measured, the times arrived at for a particular coil were 0·000485 sec. for the current at make, and 0·000275 sec. for the current at break. If we suppose that the currents at make were all stopped off by the vacuum tube, and if we take the fairly rapid frequency of 400 a minute for the rate of vibration of the contact breaker; then the total duration of the break currents in the secondary per minute amounts to 0·000275 sec. × 400, which gives 0·11 sec. Thus, out of each minute there is wasted time to the extent of 59·89 sec., or, in other words, the break currents pass through the electrolytic cell for 0·183 per cent. of the total time. Consequently, in one of the experiments reported, where the current calculated from the gain of weight in the copper electrode is 0·1669 milliamperes in a period of 4,200 sec., a correction should be made for the actual time of the passage of the current; and if Blaserna's figures are used, the real time during which the copper was deposited comes out as 42 sec. × 0·183, or 7·686 sec., and the average current during this period becomes 91 milliamperes instead of one-sixth of a milliampere. Even if the times given by Blaserna are not quite applicable to the particular coil used by Dr. Maclean; and even if the contact breaker may have acted with double the frequency which has been assumed, it still remains quite evident that large corrections must be made for the time during which the secondary coil is carrying no current.

In the same Paper Dr. Maclean gives figures to determine a ratio between the current in the primary circuit and the current in the secondary; but here, also, corrections are necessary, for the total current in the primary must depend largely upon the time during which the parts of the vibrator are in contact, and the current in the primary would be greatest when they were in contact all the time, in which extreme case the current in the secondary would be at a minimum.—Yours, &c.,

H. L. Jones.

HYDRAULIC MAINS AS A SOURCE OF POWER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your review of Mr. Segundo's book on "Domestic Electric Lighting" you mention his suggestion of the hydraulic power mains as a source of power in a rather disparaging manner; yet, if fitted in a proper manner, I think it affords a very convenient, if not a very economical, power for small houses, as all that has to be done is to turn on the water and the machine starts.

As to cost at 10s. per 1,000 gallons, 1 B.H.P. on the spindle of a Pelton water-wheel would cost 1s. 6d. per hour, taking the head at the nozzle as 1,650ft. = 710lb. per square inch, or 1s. 9½d. at 600lb. only.

The diameter of a Pelton water-wheel to run at 3,000 revolutions per minute under 700lb. pressure would be 12in., and diameter of jet to give 1 H.P. would be about 0·08in., taking coefficient for the jet at 0·68.

With the extension of electric light mains all over London, the need for such a plant as I have here roughly sketched out is probably gone past, but in certain cases it might prove useful.

A gas engine would be cheaper in working, but would cost more to erect and keep in repair, besides being much more bulky, as the hydraulic machine being well balanced might run at a much higher speed.—Yours, &c.,

George T. Pardoe.

3, Selborne-place, Littlehampton.

[Taking our correspondent's figures, and a dynamo of 80 per cent. efficiency, and allowing nothing for friction, the cost appears to come to 2s. 6d. per supply unit. But we understand that the London Hydraulic Power Company make a minimum charge of 25s. per quarter, for which sum they supply 3,000 gallons (*The Engineer*, January 20, 1893, p. 46). This comes to 8s. 4d. per thousand, and reduces the 2s. 6d. to 2s. 1d. It would be very difficult to apply a governor to a supply of water at this pressure, and, therefore to work below full load without increasing this already serious cost. We understand that the Exchange Telegraph Company use a dynamo driven from the Hydraulic Power Company's service by a Pelton wheel.—Ed. *E.*]

* "The Alternate Current Transformer," Vol. I.

TRADE NOTES AND NOTICES.

Our readers are reminded that the 1893 Edition of "The Electrician" Electrical Trades' Directory and Handbook is now in the press, and will be ready in a few days. Firms and others who have not returned the slips asking for information are requested to do so *immediately*. The price of the Directory and Handbook will be as before: *Subscription*, 5s.; after publication, 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

Tenders Invited.—The Corporation of Nottingham invite tenders for the supply and erection of boilers at their electric lighting station in Wollaton-street, Nottingham. Some further particulars are given in our advertisement columns, and specifications and all other information can be obtained on application to the electrical engineer, Guildhall, Nottingham. Tenders have to be sent in to Mr. S. G. Johnson, town clerk, not later than Thursday, 16th February.

Tenders Accepted.—The Town Council of Bournemouth have accepted the tender of Messrs. Goddard, Massey, and Warner, for the electric lighting of the pier. Six tenders were received.

——— The tender of Mr. W. Winn, 106, Union-street, Borough, S.E., has been accepted for the gas fittings and electric installation at the Old Crown and Cushion public-house, Westminster Bridge-road, S.E., at £295.

——— The tender of Messrs. James Maxwell and Sons, of Dundee, has been accepted for the wiring, &c., of the Town House for the electric light. The amount of the tender is £140, the highest tender being £260.

Improvers Wanted.—The Hull Corporation are prepared to take two improvers into their electric light works. Particulars appear in our advertisement columns, and applications must be delivered to Mr. F. Harman Lewis, borough electrical engineer, by Feb. 9th.

Plant for Sale.—Messrs. Wheatley Kirk, Price and Goulty advertise for sale a number of engines and boilers by the best makers.

Australasian Electric Light, Power, and Storage Company (Limited).—Mr. J. H. Duncan and Mr. B. H. Van Tromp, of 39, Coleman-street, E.C., have been appointed liquidators in this winding up. All claims must be sent in by Saturday, March 4th.

In the Matter of A. B. Gill.—The creditors of Arthur Bernard Gill, who have not already sent in their claims, are required to do so before February 24th to Mr. A. T. Clarke, of 6, Lombard-court, E.C., the trustee. Further particulars will be found in our advertisement columns.

City of London Lighting.—The City of London Company give notice that, unless prevented by unforseen circumstances, electric energy will be laid on within the next few months in the five areas in the City of London known as (1) Nicholas Cole Abbey sub-area, (2) Finsbury-circus sub-area, (3) Salisbury-square sub-area, (4) Billiter-square sub-area, and (5) Farringdon-street sub-area. The Company anticipate that very shortly a further list of these sub-areas will be issued. Further particulars will be found in our advertisement columns.

The Johnston System of Conduits.—The City of London Electric Lighting Company have decided to put down the Johnston system of conduits in John Carpenter-street, close to the Blackfriars District Station. This is the first opportunity the International Electric Subway Company, Limited (who own the system), have had of showing the subway in actual work in London, although many hundreds of miles have been laid in America.

Shippey Bros. (Limited).—We are informed by Mr. A. Shippey that this Company have been appointed European agents for the fuse wires manufactured by the Sperry Electric Mining Machine Company of Chicago.

Messrs. Rashleigh Phipps and Co.—This firm have secured the contract from Messrs. Duveen Bros. for completely installing their extensive premises in Old Bond-street with the electric light.

Oxford University.—Mr. Morgan Williams (Messrs. Morgan Williams and King) has been instructed by the Bodleian Curators to report on the proposed electric lighting of the buildings under their control.

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SOCIETE GENERALE DES TELEPHONES.—This Company, whose offices are at 41, Rue Caumartin, Paris, and for whom Mr. G. A. Nussbaum, 29, Ludgate-hill, E.C., is general agent in England, have just issued a new catalogue of nearly 200 pages, dealing fully with the various specialities manufactured by the Company. More than 250 illustrations are included in the catalogue, showing the large variety of instruments the patents of which are owned by the Société, which comprise all kinds of telegraphic and telephonic apparatus, registering instruments, batteries, &c.

MESSRS. O. BEREND AND CO.—This firm issue a handy pocket catalogue, giving illustrations of a large number of specialties which the firm supply.

NON-SPLITTING FILE HANDLES.—Messrs. F. Kühn and Co. have lately introduced a soft non-splitting file handle made of specially prepared pulp, which is warranted not to split. The ferrules do not fall off, and a large file can be driven into a small handle without cracking it.

CALENDAR FOR 1893.—The New York Equipment Company are to be congratulated upon the issue of a neat pocket memorandum tablet and calendar, which is made of imitation ivory and is very neatly designed.

ABERYSTWYTH.—The question of the electric light for this town is again creating attention, and the Public Lights Committee recommend the Council to enter into a provisional agreement for a grant in perpetuity of a water-course for the purposes of the electric lighting scheme.

BRYNMENIN.—Messrs. Jones Brothers, brewers, have, in addition to lighting their own extensive premises at Brynmenin, entered into an arrangement with the Ogmore and Garw Local Board, by which they are to light the village of Brynmenin by electricity.

CARDIFF.—At the last meeting of the Corporation Mr. Alderman Jacobs said that the Committee desired it to be made known that the Corporation would be in a position to supply the electric light in the autumn of this year. A deputation waited upon the Committee to complain of the insufficient gas lighting of some of the main streets of the borough.

COWPEN.—Friction still exists between the Electric Lighting Company and the Local Board, the subject which now causes dissension being as to whether certain fines imposed upon the Company by the Board are instituted by circumstances over which the Company has no control.

DUNDEE.—At the last meeting of the Works Committee of the Gas Commission it was statad that the new central station was practically complete, and that the light would be introduced in about a fortnight. The electrical engineer was instructed to appoint an efficient staff for the station. Subsequently it was decided that the question of lighting the Old Steeple and the Police Office by electricity should be submitted to a sub-committee to discuss and to obtain tenders.

EDINBURGH.—The report of the deputation recently appointed to visit the principal southern central stations has been issued. The deputation state that they early ascertained that a large number of local authorities throughout the Kingdom had preceded them in their visits to the various stations, showing the interest taken in the subject throughout the country. Every opportunity was offered the deputation at the stations visited to make themselves thoroughly conversant with the subject. A considerable portion of the report is taken up with details of plant and working at the various stations visited, which include Newcastle (2), St. Pancras, House-to-House, West Brompton, Westminster Electric Supply Company, City of London Electric Lighting Company, St. James's and Pall Mall Electric Light Company, Cambridge, Bradford, and Oxford. The report was subsequently submitted to the Lord Provost Committee, and after some discussion it was referred back to the Electric Lighting Sub-Committee to frame a report to submit with their suggestions to the Council. The discussion which ensued arose chiefly upon the point whether it would be preferable for the Corporation to deal with the subject of electric lighting, or whether it would be better to hand the matter over to a local company to work.

FOOTBALL.—The electrical staffs of Messrs. Siemens Brothers and Co. (Limited), and Messrs. Johnson and Phillips will play a match under Rugby rules at Charlton Park (Weeke's-lane entrance) to-morrow (Saturday), commencing at 2:45 p.m. sharp.

HOVE.—Mr. Frank King (Messrs. Morgan Williams and King) has been appointed by the Town Commissioners of Hove to report to them regarding the tenders for the electric lighting of the Town Hall.

HAMMERSMITH.—All the necessary documents in reference to the draft of the Provisional Electric Lighting Order have been lodged with the Board of Trade. We understand that no notice of objection has been received by the vestry.

HUDDERSFIELD.—The Finance Committee have appropriated £2,000 from the Mayor's fund in connection with the installation of the electric light in the Town Hall.

IPSWICH.—The subject of the electric lighting of Ipswich again came before the Local Board at their last meeting, and hopes were expressed by several members that steps would be taken to reintroduce the light.

JOHANNESBURG (S.A.R.).—The Johannesburg Electric Light Company are making considerable additions to their electrical plant in order to keep pace with the growing demand for the light. It is expected that in the beginning of February they will be able to supply the electric light to shop-keepers only requiring occasional displays. This class of customers has not previously been catered for by the Company.

MELBOURNE.—The Electric Club of Victoria held its annual dinner on the 14th ult. The club numbers 45 members, and is likely to be a similar success to the one started in New South Wales eighteen months ago. It is proposed to devote the summer months to excursions to installations of interest, and the winter months to the discussion of papers to be read before the club. The members include all the electrical men in the colony, and a number of other persons interested in electrical matters.

NATIONAL CYCLE SHOW.—On a visit to the Crystal Palace we searched diligently for incandescence "head lamps"—but in vain, and curiously enough the small dynamo to be driven by the "waste power" of a rider, though often talked about, was nowhere to be seen.

NEW TELEPHONE COMPANY (LIMITED).—The second annual *conversazione* of this Company's *employés* in the Manchester district was held at the offices in Portland-street, Manchester, on Friday evening last.

PRIVATE BILLS IN PARLIAMENT.—Amongst the cases in which the required proofs have been given before the examiners (Mr. Campion and Mr. Thoms), in compliance with the Standing Orders regarding Bills deposited for the ensuing Session, was included the Edinburgh Corporation Tramways Bill allowing the Corporation the use of cable or electrical power on the lines belonging to or to be acquired by the Corporation, and also a measure to authorise the Glasgow Corporation to construct additional tramways.

READING.—At the last meeting of the Town Council the draft Provisional Order was presented, and a resolution to the effect that the Council consent to the granting of a Provisional Order to the Reading Electric Light Supply Company (Limited) was carried.

SANDGATE.—A special meeting of the Local Board is to be held for the purpose of considering the expediency of acceeding to an application made by Mr. S. Sellon, of Parliament-street, Westminster, for permission to adopt electric traction to the Sandgate tramways. The scheme is for an overhead side-suspension system, with poles 20ft. apart. Mr. Sellon, if his proposal is accepted, will include arrangements for lighting by electricity the whole extent of the sea wall.

SOUTHAMPTON.—A proposal to light the Audit House and Public Offices by the electric light, at a cost not to exceed £180, came up for discussion at the last meeting of the Town Council, but in view of the opinion expressed that new municipal offices would soon be necessary, the consideration of the matter was deferred.

THE TELEPHONE.—Speaking at a meeting, last Monday, of the London Chamber of Commerce, Sir Albert Rollit, M.P., observed that, with respect to the question of the telephone, he had said in Parliament—and he thought so still—that the Government could do more than private enterprise, and he thought that there were illustrations of this in some foreign countries. He thought, however, that there was some misapprehension in supposing that London and the country generally would not derive considerable benefit from the new system. The Government had taken up the trunk wires, and town and town would very soon be able to communicate with each other. Within a few yards from where they were then assembled (Eastcheap, London, E.C.) they could communicate with Hull, and the public would have similar opportunities elsewhere soon. It was easy to speak with Marseilles; and he believed that at no distant date they would be able to speak across the Atlantic, and have visual representation of the person with whom they might be conversing. He believed this to be not a mere guess, but a fair inference from what science had already accomplished. What had been done on a very large scale in America was now being done in this country. He had seen what an admirable system of development of the telephone had taken place in Denmark, and he believed at no distant time that London would have the benefit of the most efficient system—a complete metallic circuit, and in all respects the most efficient instruments that could be provided; that, through negotiations now pending with the Commissioners of Sewers and the Electric Lighting Companies, underground would largely replace overhead wires, and, in fact, that London would have what it ought to have, the best and most modern system of telephonic communication that could be devised.

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TORPOINT (DEVON).—For some months past there has been considerable friction between the Gas Company at this place and a large section of the ratepayers, the latter complaining of the cost of the gas lighting, and that the proposed imposition of a sixpenny rate is an attempt to make up the Company's dividend at the ratepayers' expense.

TORQUAY.—At the last meeting of the Town Council the Electric Lighting Committee suggested that, having regard to the financial position of the Borough, offers be invited from those willing to take over the powers possessed by the Council under the Provisional Order for 1891. An amendment was carried that the matter be referred back to the Committee and that a specialist be called in to advise.

YORK.—Seventeen tenders have been received for the electric lighting of this city, and it has been resolved to appoint Prof. Kennedy to advise the Electric Lighting Sub-Committee on the subject.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

December 31, 1892.

24,159. Sir C. S. FORBES, Bart. London. Improved apparatus for forming the conductors of incandescent electric lamps.

January 2, 1893.

36. F. V. STEAD. London. Improvements in electrical indicators.

January 3, 1893.

*78. R. VARLEY, jun., and F. C. JONES. Manchester. Electro-magnets.

122. SIEMENS BROS. AND CO., LIMITED, and G. W. PERRY. London. Improvements in fastenings for securing metal arms or brackets to telegraph poles,

133. H. N. LAWRENCE. London. Means for obtaining electricall resistances.

*140. G. W. HARRIS. London. Improvements relating to storage batteries and electrodes therefor.

January 4, 1893.

172. R. KENNEDY. Glasgow. Improvements in and relating to arc lamps.

206. Sir D. I. SALOMONS, Bart., and L. PYKE. London. Improvements relating to apparatus for producing light by means of alternating electric currents.

212. W. LANGDON-DAVIES, F. H. NALDER, HERBERT NALDER, C. W. SCOTT CRAWLEY and A. SOAMES. London. Improvements in diplex and multiplex telegraphy.

222. N. MITCHELL. London. Improvements connected with electric electric belts and bands for curative purposes.

January 5, 1893.

229. F. G. READ. Manchester. Improvements applicable to dynamos.

236. A. SMETHURST. Manchester. An electric railway signal for use in fogs or any other time.

258. R. E. B. CROMPTON and H. J. DOWSING. London. Improvements in means or apparatus for use in the application of electricity for heating liquids and in means or apparatus for manufacturing the same.

259. R. E. B. CROMPTON and H. J. DOWSING. London. Improvements in the heating of surfaces for the drying, heating or other treatment of paints, oxides, or other matters by the aid of electricity, and in the means or apparatus employed therein.

January 6, 1893.

*336. A. J. BOULT. London. Improvements in or relating to lightning conductors. (Gustav Walch, Germany).

January 7, 1893.

344. B. P. SCATTERGOOD. Leeds. An apparatus for heating water or other liquid by means of electricity.

358. I. RIPPINGHAM. Dublin. A combined knocker and electric bell whereby an alarm is given should an attempt be made to remove the knocker.

*387. K. D. BOWENS. London. A combined electric launch and sailing vessel.

391. E. HANCOCK and A. I. MARQUAND. London. Improvements in the manufacture of elements for electric or secondary batteries.

January 9, 1893.

402. A. P. DENNISON and M. H. BARBER. Manchester. An improved automatic cut-out for series incandescent electric lighting.

442. T. CARLO. Genoa. New electric lighting of gas engines.

449. I. E. STOREY. London. Improvements in or relating to electric motors. [Date applied for under Patents Act, 1883, Sec. 103, June 9, 1892 being date of application in United States].

457. S. O. COWPER-COLES and THE METALLURGICAL COMPANY, LIMITED. London. Improvements relating to the coating of wire and other rolled or drawn metallic sections by electro-deposition and apparatus therefor.

January 10, 1893.

471. C. A. ALLISON. London. Improvements in variable speed electric motors. (Carl Hering, United States).

510. E. DE PASS. London. Improvements in electric transmission of power. (Edwin Wilbur Rice, jun., United States).

516. H. H. LAKE. London. Improvements in measuring and recording instruments for electric currents. (Edward Weston, United States).*

517. H. H. LAKE. London. Improvements in instruments for measuring electric currents. (Edward Weston, United States).*

518. H. H. LAKE. London. Improvements in apparatus for measuring electric currents. (Edward Weston, United States).*

519. H. H. LAKE. London. Improvements in electric resistance boxes or coils. (Edward Weston, United States).*

520. H. H. LAKE. London. Improvements in and relating to apparatus for measuring and indicating electric currents. (Edward Weston, United States).*

COMPANIES' MEETINGS & REPORTS.

The Eastern Telegraph Company (Limited).

The forty-first half-yearly ordinary general meeting of this Company was held yesterday at Winchester House, Old Broad-street, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. George Draper) read the notice calling the meeting, and the minutes of the past meeting, which were approved by the present meeting and signed by the Chairman as correct. The report of the Directors was taken as read.

The CHAIRMAN, in moving its adoption, stated that the gross revenue for the half-year ended September 30th had been £352,391, or a decrease of £2,548, compared with that of the corresponding period of 1891. In analysing the message receipts they found decreases in the traffic with certain places, which were almost recouped by the increases in other places. There was no considerable fluctuation in any way, and the amount received from their investments in other companies was practically the same as in the corresponding period of the previous year. The total working expenses for the half-year had been £98,797, being an increase of £1,666; but expenses attending repairs and renewals of cables, &c., had amounted to £37,636, being a decrease of £9,411, compared with those of the corresponding period of 1891. In addition to keeping their own cables in a state of efficiency they had been doing work for the South African, West African, and the Brazilian Submarine Telegraph Companies; and the amount received from these companies, together with their having had to expend less cable on their own repairs, had had the effect of reducing the expenses under this head, which had enabled them, notwithstanding the reduction of £2,548 in their receipts, to carry forward to next half-year £62,847, or £5,338 more than at the corresponding period of the previous year. He might mention that they had received during the half-year from other companies £15,610 for the hire of this Company's ships. As they would have noticed from paragraph 6 of the report, the Directors offered to the holders of the Five per Cent. Debentures, redeemable at par in 1899, the option of exchanging their security for the Four per Cent. Mortgage Debenture Stock of the Company. This offer was responded to by holders of nearly one-half of the debentures. The debentures being to bearer they had to reach the holders through the medium of bankers, brokers, &c., who had presented the last coupons for payment, and in cases where the Directors' circulars had not reached the holders, they would be glad to consider the application of any one who was still desirous of affectng the exchange. All particulars as to terms could be obtained at the Company' office. The holder of the mortgage debenture stock was placed in a better position than he stood in by the old bond, which was quoted that day at something like 7 premium, whereas the new mortgage debenture stock stood at something like 10 premium. For those who wanted a permanent investment the Four per Cent. Perpetual Security which the Debenture Stock afforded was beyond all question a very sound and safe one. A storm had interrupted their land lines at Cairo, and the sea had not been altogether free from disturbance. The result was that during the past month they had had many repairs to make; but he was glad to say that every year taught them more how to deal with these repairs, and more and more established their cable system as a property. Last month they had about ten broken cables, and took out 30 faults. All this proved that they had their property very much in hand, and that their ships were very generally employed. The system they had adopted of duplicating the cables also made the continuity of their system so reliable that the public rarely knew when any interruption occurred. He desired very briefly to refer to Egypt, which was one of the Company's great stations, and they had a very important traffic with that country. He frequently went to Egypt and saw the working of the English system in force, and all he could say was that he believed there was not a better governed country in the world than Egyp was at the present time under English administration. The men of experience who had charge of affairs were working with an unselfish motive, their only selfish desire being that they might command the respect and grati

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tude of the people of Egypt by their just and wise government. They had heard a few days ago of the little trouble that had arisen, but it was insignificant for the men who were there representing this country's interests and those of Egypt to deal with; and he had no fear that any trouble would arise out of it. They had no politics in their company, and the better Egypt was governed the better would be the traffic on their telegraph system in connection with that country. They were also on very friendly terms with Turkey. Rather a remarkable speech was made recently by a gentleman who had a European reputation, he referred to Mr. Rhodes, and it was men like Mr. Rhodes who were required in developing a new country where great ability and great energy were required. Mr. Rhodes was endeavouring to open up Africa, and he proposed eventually to carry through Africa on to Cairo a telegraph system which he thought some day would enable him to carry telegrams from the Cape to Europe for something like 2s. against this Company's charge of 9s.

Sir JAMES ANDERSON (the Managing Director): 4s.

The CHAIRMAN, continuing, said that he did not know whether Mr. Rhodes said 2s. or 4s. The projected line, however, had to pass through countries other than those which were under the control either of England or Mr. Rhodes. The Mahdi controlled a portion of the country through which it was proposed to carry the line. He thought that by the time Mr. Rhodes got his telegraph to Wady Halfa this Company would have paid off their debentures, and would probably then have a capital of not more than that which Mr. Rhodes proposed for carrying his telegraph system through Africa. Meantime, every territory that was passed through depended upon Mr. Rhodes finding gold, and if he did find gold his line must of necessity become a feeder to the Eastern Company for a great many years to come. He mentioned these facts in order to relieve the minds of any of their shareholders on the point, and to show them that, instead of the projected line being a competitor, for twenty years to come it was much more likely—if it went on—to be a feeder to this company. When Mr. Rhodes' line reached Cairo, and he hoped the country would be so developed as to enable him to get there, their Company would be very ready and willing to meet him upon his own ground; and he thought the chances were, looking to the greater security which he might say existed in a submarine system as against a land line, that the Company would not only be able to do the work more accurately and more quickly, but also probably cheaper than the projected land line. At the same time he wished Mr. Rhodes every success in opening up this dark country. It was a long way from Cape Town to Wady Halfa, and when he got to Wady Halfa he would be in the hands of the Egyptian Telegraph Executive. They had just settled, through the Eastern Extension Company, with which their Company was very closely connected, the question of a slight advance in the rates to Australia. The reduction which took place in the rates was from about 10s. to 4s., the Governments guaranteeing the return which the Company was receiving at the time the reduction was made. It was found, however, by the Governments that the loss of revenue by the reduction in the rate was not recouped so rapidly as had been expected, and when they asked for the rates to be advanced by 9d. the Board did not think they ought to stand in the way of meeting the wishes of their co-partners. The change had been most successfully carried out, and as far as they could see at the present time they would, he believed, be able to get back a little more of the former revenue and reduce the loss which had been sustained owing to the very large reduction originally made. Since their last meeting they had made a contract with Her Majesty's Government, in which India was interested, to lay a cable from Zanzibar to Seychelles and to Mauritius. For this the Company would get a guarantee for twenty years of £28,000 a year. Altogether, their Company was probably in as strong a position as it was ever in, and their property was increasing in value and likely to become still more valuable.

Sir JAMES ANDERSON afterwards explained on the map the country through which the projected line of Mr. Rhodes was intended to travel, pointing out the difficulties which would be encountered in the course of the work.

The CHAIRMAN afterwards stated that they had just received an announcement that their land lines were in order to Cairo. As there had been a little difference between Sir James Anderson and himself respecting Mr. Rhodes's proposed tariff, he would read what that gentleman had said on the subject:—"This line to Egypt, provided the Mahdi is "squared," will cost £300,000 to £400,000, and we have lying to the east and west of the coast (that is our system) cables which cost over £3,000,000. We are now charged 9s. 6d. a word for our communications, but when we can get to Egypt by the telegraph I am referring to, we shall be able to do it for 1s. 7d. from Egypt to England, or in all about 2s. 6d., against 9s. 6d. a word." He afterwards proposed a resolution for the adoption of the report.

The VICE-CHAIRMAN (the Marquis of Tweeddale) seconded the motion, which was unanimously adopted, and resolutions were afterwards passed, re-electing the retiring Directors and auditors.

On the motion of Mr. BURGESS, a vote of thanks to the Chairman and Directors was passed, and the proceedings then terminated.

(*We shall publish a full report of this meeting in our next issue.*)

St. James' and Pall Mall Electric Light Company (Limited).

The ordinary meeting for 1893 of the shareholders of this Company was held at the Company's central station, Carnaby-street, Golden-square, W., on Tuesday last, Mr. Eustace J. A. Balfour presiding.

The GENERAL MANAGER and SECRETARY (Mr. F. J. Walker) read the notice calling the meeting, the report of the Directors and statement of accounts being taken as read,

The CHAIRMAN: The next business is the moving of this resolution:—

"*That the report and accounts for the year ended 31st December submitted by the Directors be received and adopted, and that the dividends recommended be declared and paid on the 1st of February.*"

Mr. LATIMER CLARK: I second that.

The CHAIRMAN: Gentlemen, in moving the adoption of the report and accounts, I think that it will be of interest to the shareholders if I briefly enter into a few matters in connection with the year's working, and with the present condition of the affairs of the Company. We may look back upon the past year with satisfaction. There is, it is true, nothing showy or brilliant in our report, and the dividend which we recommend, although not so large as some may have ventured to anticipate, yet shows that the business possesses a most satisfactory earning power. For it must be borne in mind that in the future we have every reason to suppose that our earnings will increase, without any considerable additional capital expenditure. One of the most curious features in the year is the economy which consumers now exercise as compared with former years. This may best be shown by noting the relative increase in the gross income from supply of light and of the number of lamps wired. The latter is 24·4 per cent., while the former is only 10·4 per cent. Had our gross income increased in proportion to the number of lamps wired our net earnings would have enabled us to pay a much larger dividend. Looking, however, at this matter broadly, I think that it is probably a good feature in the business. Because I think that many would-be customers have hitherto held aloof, owing to a general belief that electric lighting was excessively costly. A very satisfactory feature in the year's working is the saving which has been effected in the cost of production. Thus the consumption of coal has been diminished by ¼lb. per unit sold, while that of water has been reduced from 13·6 to 11·75lb. per lb. of coal. Dealing with these figures the editor of *Lightning* says:—"From these figures it will be seen that Mr. Crompton's 'sheer costs' estimate is more than realised. *Total costs* show altogether a reduction of ¼d. per unit, which cannot be regarded as otherwise than very satisfactory, and reflecting the highest credit on Mr. Dobson, the Company's able engineer," a remark with which the Directors cordially agree. It is our intention to maintain, and if possible to increase this economy. While on this subject I think that you should realise that our economical management does not apply to cost of production alone, but also to capital expenditure. In this we compare very favourably with other metropolitan companies. I evidently cannot particularise, but our capital expenditure per unit of capacity is satisfactorily low. Indeed, there is one company which has spent about double what we have done, while the most favourable is considerably ahead of us. These results have only been obtained by the most rigid and continuous supervision. You will notice that there has been a considerable reduction in the amounts set aside for depreciation of plant and machinery. After careful consideration the Directors came to the conclusion that the very large expenditure on repairs, maintenance and renewals justified this reduction. But the putting of depreciation at a just valuation is a matter which will have to be considered in each year on its own merits, as the conditions are constantly varying. For instance, a few days ago serious damage was done to one of our engines in Mason's-yard by the breaking of the crank shaft. We cannot be free from such accidents, which indeed must be regarded as inseparable from the wear and tear of our delicate machinery. We regret extremely the result of the action brought against the Company by Dr. Hopkinson in respect to the three-wire patent, and are carefully considering what further action to take in the matter. An idea seems to have got abroad that our supply can thereby be stopped. This is not the case, as arrangements have been made by which, if necessary, the supply can be continued without further infringement of the patent. We cannot at this time go into further detail. On June 7th last four members, representing some of the founders' shareholders, Mr. Charles Fry, Mr. W. Sturdy, Mr. Geo. Kitchin, and Col. Francis, issued a circular, calling a meeting of founders' shareholders to consider certain matters in connection with the management of the Company, which they regarded as detrimental to their interests. The Directors, while of course they are bound to consider the interests of the whole body of shareholders only, were anxious to discuss these matters in a friendly way with the representatives of the founders' shareholders, and a meeting was consequently arranged between delegates from the two. The first point complained of is "that the Directors did not bring forward for division as profit the £15,000 received by them as premium on 10,000 shares issued on December, 1891, but intimated that they had carried it over to a capital reserve fund." Now, in reference to this complaint, I have to note that the Directors in the prospectus as to the issue of those shares stated that the amount derived from this premium would be put to a capital reserve account. It was under this condition, therefore, that the shares were subscribed for. Thus, the Directors could not alter the arrangement if they would. Further, those owners of founders' shares who applied for shares, acquiesced in this arrangement, and had notice. But if these shares had been issued at par instead of at a premium, the founders' would not have benefited. We should, in this case, have issued Five per Cent. Preference Shares instead of Seven per Cent. But as a sum equal to 7 per cent. on the *whole* capital of the Company has to be paid before the founders' are entitled to receive any dividends, they would have been as far as this is concerned in exactly the same position as now, and they would not have the contingent benefit of a quarter of this £15,000 in case of a winding-up of the Company. All classes of the shareholders benefit alike by the strengthening of the Company owing to the existence of this capital reserve fund. The next point raised by the representatives was that an excessive amount had been written off for depreciation. I have already dealt with this subject, and can only repeat that in each year the Directors will do their best to arrive at a just valuation of the amount that should be written off. They are quite at a loss to discover

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on what grounds the statement in the circular is based. The next objection raised is to the formation of the special redemption fund. The Directors have carefully considered the representations made to them on this subject, and they feel very strongly that the course they have adopted is not only right in itself but will meet with the approval of the shareholders generally. It would no doubt be very pleasant to divide the £2,000, which this fund now amounts to, as profits, but it would not be sound finance. Under the Electric Lighting Acts our property may be, and probably is, a vanishing security. In many ways it resembles an investment in leasehold property. We therefore feel bound o create this fund. In all these matters the Directors have considered he well-being of the Company as a whole, and not the special interests of any one class of shareholders. But even thus it is worth noting that in the direction of big profits the interests of the founders' and ordinary share holders are identical, since for every pound given to a founders' shareholder a corresponding pound is divided amongst the ordinary shareholders. I fear I have already kept you too long, and I fear that our accommodation here is not luxurious. In conclusion, I shall be glad to do my best to satisfy any gentleman present who may seek information.

Mr. FRY wished the Chairman to complete the whole story by placing before the shareholders the letter of the 21st December from the representatives of the committee of the founders' shareholders and the reply thereto. He wished further to know whether any steps had been taken by the Board to see that a full report of the meeting should be sent to every shareholder. This was a question raised at the last meeting. It was a practice followed by other Companies, and he thought that every shareholder should have a verbatim report of the proceedings. Turning to the report, he thought that the shareholders must feel a certain amount of disappointment that they had not been able to get on faster with the central station, where they were now assembled. Of course, circumstances might have arisen—such as the difficulties connected with ancient lights, and other matters—to impede their progress; but it would have been much more satisfactory if the station had been opened for the last few months, because it would have been earning a dividend, instead of which they had been paying interest on capital which had been entirely unproductive. He would now pass to No. 6 paragraph, which dealt with the question of the redemption fund. They must be aware that there were such things as the rights of the founders' shareholders. Those rights were clearly pointed out in the first form of the Memorandum of Asssociation, and they were repeated in the Articles of Association subsequently passed. There was another point which he would like to mention—that the founders' shareholders maintained that they had a right to the division of this redemption fund among the shareholders. He was strongly of opinion that they had. This was not their own opinion only, for they had taken the advice of counsel on the subject, and they meant to contest their rights. Another point which he desired to state, was, that the ordinary shareholders had rights as well. If they took into consideration the various provisions in connection with the Electric Lighting Acts, he thought that they were not likely to be ultimately bought up as appeared to be the prevailing opinion. With regard to paragraph 7, as to which he would have to ask some questions presently, and which dealt with the action brought against the Company by Dr. John Hopkinson, he did not think that the Directors had shown that their judgment had been very sound. Possibly they would find that on this subject, and especially on the question of the redemption fund, the vendor and shareholders were right, and that the directors were wrong. He would ask whether it was not possible for the latter to alter their opinion at the last moment? It was said in paragraph 6 that "this question was before the meeting of the members of the Company last year, when the creation of the fund was approved *nem. con.*" He would not dispute that, but if they would look at the reports of that meeting, it would be seen that there was great opposition to it. He saw that Mr. Muirhead raised the question, and particularly pointed out the items of depreciation, which he considered ridiculous. The fact was that the recommendation of the Directors was not carried *nem. con.*; because there was opposition to it in the room. He would like to ask whether the opinion of eminent counsel had been taken on the point. As to the alleged infringement of the three-wire patent of Dr. John Hopkinson, he wished to ask by whose advice it was that they adopted that system, because he presumed that it was possible to find out what were patents and what were not patents. Their adopting it had ended, it appeared to him, very disastrously to the Company. He would reserve his right to move an amendment later.

Col. FRANCIS detailed the circumstances under which last year the depreciation account was considered to be excessive by some of the shareholders. The most material point on which the committee of the vendors, shareholders, and the Board were at variance was as to the scale which should be fixed for depreciation. He quite agreed that there should be a scale, but not a fluctuating one. Depreciation at a certain rate was established in respect to the meters of the Company; but in the case of those meters which had been in existence one or two months depreciation for the whole year was charged. He had appealed to the best authority he could find as to what should be a proper amount for the depreciation of meters, which the Directors had placed at 12 per cent., while the authority referred to had answered him 5 per cent. But the main fact that depreciation for the entire year was charged on instruments which had been in use, say, only three months, was the chief ground of complaint. Then, again, in the report of last year, it was stated that they purchased machinery two years old at the Naval Exhibition, and they said that they had made an excellent bargain in buying that machinery, which had been tried, and yet depreciation was charged on it for the whole year. In fact, depreciation for the whole year was charged on many things at work for only three months.

Mr. SAMS wished to point out that in the memorandum of association it was declared that after the various dividends had been paid, any balance of profits should be divided among the shareholders. He had bought one vendor's share, which he thought would bring him in 5 or 6 per cent.; but he found that he got nothing like that for it. He had bought solely on the statement of the memorandum of association, and what the Directors had done seemed to him to be quite a mistake.

A SHAREHOLDER suggested whether it would not be to the advantage of the Company to buy out the vendors' shareholders.

The CHAIRMAN, in reply to Mr. Fry's first request, read the following correspondence:—

[COPY.]

"5 and 6, Great Winchester-street, London, E.C.
"December 21st, 1892.

"ST. JAMES' ELECTRIC LIGHT COMPANY.

"DEAR SIR: We have been in communication with our clients, consequent on the interview we had with the Directors and yourself on Monday last, and we are now instructed to ask whether, assuming our clients can see their way to narrowing the questions between them and the Company to the one item 'Special redemption fund,' your clients would agree with ours to have that point determined by arbitration, rather than by the far more expensive and protracted means of proceedings at law. Whilst asking you to treat this letter as written without prejudice, we hope it may be taken as an assurance on the part of our clients that they are desirous of terminating as speedily as possible the questions depending between them and the Company.—Yours truly,

"(Signed) LYNE AND HOLMAN.

"S. Morse, Esq., 4, Fenchurch-avenue, E.C."

[COPY.[

"4, Fenchurch-avenue, London, E.C.,
"January 16, 1893.

"FOUNDERS' SHARES.

"St. James' and Pall Mall Electric Light Company (Limited).

"DEAR SIR: Your letter of the 21st came before the Board of the St. James' and Pall Mall Electric Light Company (Limited) at their meeting on Friday.

"The Directors have fully considered the whole position, and are most anxious to deal with and terminate as speedily as possible any question raised by any section of the shareholders of the Company.

"But, as I have already pointed out to you, their position is that they submitted the proposed special redemption fund—to the creation of which your clients are objecting—to their shareholders in general meeting, when the course proposed by them was approved by the shareholders *nem. con.*

"The Board were, and are, of opinion that the creation of such fund was, and is, a prudent and legal course for them to adopt.

"Under these circumstances the Directors do not see how they can, as a Board, agree to submit a question affecting the accounts so approved by the shareholders in general meeting to the arbitration of an outside person.

"Yours, faithfully,

"Messrs. Lyne and Holman." "SYDNEY MORSE.

The CHAIRMAN, continuing, said that the Directors were always anxious to meet the shareholders in every way, and if the meeting finally decided by resolution properly carried that the matter in question should go to arbitration the Board would be bound by such decision. As to the question of sending a report of the proceedings to each shareholder, the Directors did not see that there was any special reason why that should be done; but if there was a strong feeling in favour of the proposal the Directors would fall in with it. He was very glad to think that Mr. Fry considered this to be one of the best companies in London, in spite of the two drawbacks referred to.

Mr. FRY said that there could be no two opinions about the fact that they had the finest staff that an electric light company could possibly have.

The CHAIRMAN said as to the non-completion of the central station that the matter was fully referred to in the report. He thought that if Mr. Fry were only aware of the minute details which the Directors had had to consider, and the care which they had had to exercise to avoid possible litigation, that that gentleman would be rather astonished that the works were so far forward as they were. As to the question of the purchase of the site there for 42 years, it was a very complicated one, and had been constantly discussed by them and their legal advisers. They took the view that it was more than likely that if the local authorities bought up the Company's property at the end of the Provisional Order, which they had a perfect right to do, nothing would be paid to them for goodwill, and all they would get, as Mr. Fry had said, would be the price of old iron. Of course there was a doubt whether the local authority would buy them up or not. He mentioned these things to show that there were really two sides to all these questions, and he hoped it would be considered that the Directors had given them the most careful consideration. It was not a sign of weakness, but rather one of strength to give their attention to such matters. Mr. Fry asked them to remember their decision as to the redemption fund. They were always ready to take into consideration any question brought before them by the shareholders, and he could only say that if it were their wish that the Board should do as Mr. Fry suggested, then they would do so. They were asked further by Mr. Fry under whose advice they adopted the three-wire system. Their view at the time was that it was not a patent, and it was the view of almost every scientific man. Col. Francis was Chairman at the time of it, it was thoroughly gone into before adopting it. A great many scientific men still held that the decision of the judge was wrong.

Colonel FRANCIS said that the scientific adviser to the Company, Mr. Latimer Clark, had assured him over and over again that his firm depended on the three-wire system, and how was it possible to suppose, with their adviser and their designer at their side, that the patent could be contested?

The CHAIRMAN said that, as Chairman of the Company, he was perfectly prepared to accept his share of any responsibility with respect to

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the action in connection with the three-wire patent, but he did protest most strongly against a former Chairman of the Company coming forward and shirking a responsibility which he with others took on his own shoulders.

Colonel FRANCIS said that he was shirking nothing, and that Mr. Clark and his partners in the firm had said to him over and over again that they possessed the rights; and more than that, by referring to *The Electrician*, it will be seen that those gentlemen were advertising that they were the designers of the system.

Mr. CLARK said that Colonel Francis waa wrong in referring to his firm, which had been a limited company for many years, of which he was chairman. At the time the St. James' Company was formed he became a director of it, but not as a scientific expert, although he had always tried to give the best advice he could. What Colonel Francis thought was the three-wire patent had reference to the ordinary culvert system, and all the arrangements and details of actually carrying out the three-wire system. The patent being fought out was an electrical patent, and had no reference to the shape or form of the culverts, and, therefore, any rights this Company had were the rights to form the culvert, not the patent.

Colonel FRANCIS still maintained that Mr. Clark had led him to understand that he had rights to the patent.

Mr. CLARK: It was perfectly impossible.

The CHAIRMAN, in reply to Mr. Cottrel, said that as to what were the specific arrangements contemplated for carrying out the lighting without infringing any other patents, he did not think that it would be advisable or desirable in the present condition of their machinery that such technicalities and particulars should be discussed. Mr. Kirby just reminded him that although this Company were the actual defendants in the action alluded to, all the electric light companies who used the low-tension system were fighting with them, and would bear their proportion of the cost.

The resolution was then put to the meeting and declared carried by 31 to 7 votes.

Mr. LATIMER CLARK moved and a shareholder seconded the re-election of Sir John H. Morris to his seat on the Board.

Mr. FRY asked whether Sir John was the nominee of other trust companies with which the St. James' Company was connected.

The CHAIRMAN: No.

The motion was then agreed to *nem. con.*

Mr. Gerald W. Balfour, M.P., was on the motion of Mr. CLARK, seconded by a SHAREHOLDER, also unanimously re-elected to his seat.

After some further discussion, and at the invitation of the Chairman Colonel FRANCIS moved the following resolution:—

"*That the question between the vendors and the directors with regard to the redemption fund should be submitted to arbitrators.*"

Mr. FOSTER seconded the motion.

Dr. WEBB moved by way of amendment:—

"*That this subject be left to those who are the trusted guardians of our interests.*"

From what he had heard that day he had greater confidence than ever in the policy of the Board and in the soundness of the Company.

Mr. BOURNE seconded the amendment.

The CHAIRMAN, having put it to the meeting, declared the amendment carried.

Dr. WEBB proposed, and a SHAREHOLDER seconded, the reappointment of the auditors, Messrs. Deloitte, Dever, Griffiths and Co., which was agreed to; and a vote of thanks having been accorded to the Chairman, the proceedings terminated.

Newcastle-upon-Tyne Electric Supply Company (Limited).

A meeting of the shareholders in this company was held last week, at which the Directors' report and balance sheet were adopted, and a dividend of 4 per cent. was declared. The Directors' report (which is accompanied by an auditors' certificate, setting out that the buildings, plant, meters, &c., stand on the balance-sheet at the cost to date, is attached) is as follows:—

The amount of share capital subscribed amounts to £29,920, on which £25,699 has been paid. Besides this, £15,000 has been raised on debentures. The profit and loss account shows a gross profit of £2,300. 5s. 1d., which is reduced to £1,311. 19s. by payment of £988. 6s. 1d. for interest on debentures and on calls in advance. This, added to the amount brought forward, viz., £364. 13s. 3d., makes a total of £1,676. 12s. 3d. to be disposed of. Out of this sum the Directors propose the payment of a dividend at the rate of 4 per cent. per annum, less income-tax, payable on February 1st, which, on the capital as paid during 1892, will absorb £895. 13s. 5d., leaving a balance to be carried forward of £780. 18s. 10d. Out of this amount the Directors recommend that a sum of £600 be carried to a reserve fund, to meet any depreciation that may arise on the Company's assets.

City and South London Railway Company.

The following report of the Directors of this Company for the half-year ended December 31st last, will be submitted to the seventeenth ordinary general meeting, to be held at Winchester House, E.C., on Wednesday next, at three o'clock:—

The receipts from all sources for the past half-year have amounted to £22,652. 13s. 11d., and the cost of working has been £15,389. 17s. 2d, leaving a profit of £7,262. 16s. 9d. Inclusive of the balance brought forward from June 30th last, the net revenue account shows an aggregate total of £8,304. 12s. 2d. After making provision for the debenture and debenture stock interest, amounting to £4,258. 19s. 2d., a balance remains available for dividend of £4,045. 13s. 0d. Out of this sum your Directors recommend the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of ⅝ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £822 to be carried forward to the next account.

The number of passengers conveyed during the six months ended December 31st, 1892, exclusive of season ticket holders, was 3,217,602, showing an increase over the corresponding period of the previous year of 468,547.

Your Directors have satisfaction in reporting that the service of trains has been carried on during the whole of the half-year with great regularity, and with an almost entire absence of any interruptions whatever, whilst the receipts from traffic have increased considerably.

The following table shows the number of passengers, exclusive of season ticket holders, carried since the opening of the railway in each half-year:—

Half-year	Number of passengers.	Receipts (including season tickets).
Ended December 31, 1890 (11 days) about ...	165,000	£1,568 3 9
„ June 31, 1891 ...	2,412,343	19,403 6 9
„ December, 31, 1891 ...	2,749,055	19,798 16 6
„ June 30, 1892 ...	2,813,162	20,931 4 2
„ December 31, 1892 ...	3,217,602	22,002 17 5
Total since the opening of the line ...	11,357,162	83 704 8

By the appended certificate of the engineer, it will be seen that the locomotives, rolling stock and generating plant have been efficiently maintained and are in good working order. Difficulties with the local authorities have delayed the commencement of the much-needed siding accommodation at Stockwell station, forming part of the Clapham extension line, but it is hoped that these works will very shortly be started. The conversion of the terminal debentures into either Four per Cent. Perpetual Debenture Stock, or Five per Cent. Perpetual Preference shares is progressing satisfactorily, and will result in a considerable saving of interest to the Company.

A resolution for the conversion into consolidated ordinary stock of the remaining 3,000 ordinary shares already issued, will be submitted to the special meeting, to be held at the conclusion of the half-yearly meeting.

It is anticipated that the Bill promoted in the last Parliament by this Company for the extension to Islington and other purposes, will be proceeded with immediately after Parliament assembles. A Bill to extend the time for the purchase of lands under the Act of 1890 (Clapham Extension) and for other purposes, has been deposited in Parliament for this Session.

The Directors retiring by rotation are Messrs. Charles Seymour Grenfell and Edwin Tate, who are eligible for re-election. The auditors retiring are Messrs. Turquand, Youngs, Weise, Bishop, and Clarke, and they offer themselves for re-election.

Anglo-American Telegraph Company (Limited).

The following report of the Directors of this Company will be presented to the ordinary general half-yearly meeting of the proprietors, to be held at Winchester House, E.C., to-morrow (Friday), at 2 o'clock:—

The total receipts from July 1st to December 31st, 1892, including the balance of £954. 17s. 11d. brought forward from the last account, and a sum of £1,619. 16s. 9d. transferred from the Interest of Renewal Fund Securities, amounted to £164,365. 11s. 3d. This sum, however, is subject to revision, as the law suit between this Company and the Paris and New York Telegraph Company is still pending before the Court of Appeal. The traffic receipts show a decrease of £4,670 as compared with the corresponding period of last year, but the total for the year 1892, as compared with 1891, shows an increase of £5,365.

The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £58,628. 7s. 6d.

Interim dividends of 12s. 6d. per cent. on the Ordinary Stock and £1. 5s. per cent. on the Preferred Stock, were paid on November 1st last, absorbing £43,750, leaving a balance of £61,987. 3s. 9d., out of which the Directors recommend the proprietors to declare final dividends of 17s. 6d. per cent. on the Ordinary Stock, and £1. 15s. per cent. ou the Preferred Stock, amounting to £61,250, making a total distribution for the year ended December 31, 1892, of £2. 15s. per cent. on the Ordinary Stock, and £5. 10s. per cent. on the Preferred Stock, leaving £737. 3s. 9d. to be carried forward to the next account.

The Company s repairing S.S. "Minia" has been engaged during the past half-year in the repair of the North and South Placentia Cables, and the Duxbury Cable. She has also been employed by the Direct United States Cable Company, and the Western Union Telegraph Company for the repair of cables belonging to those Companies, the payments for which appear in the revenue account. The Brest-St. Pierre Cable was broken on July 14th, and repaired on August 5th by the Telegraph Construction and Maintenance Company's S.S. "Britannia," the S.S. "Minia" not being at the time available to undertake the work as an entire renewal of her decks had become necessary.

The Company's cables and land lines are in good working order and condition.

The appeal in the proceedings between the Anglo Company and the Par and New York Telegraph Company, in the Appeal Court of Paris, has no yet been heard

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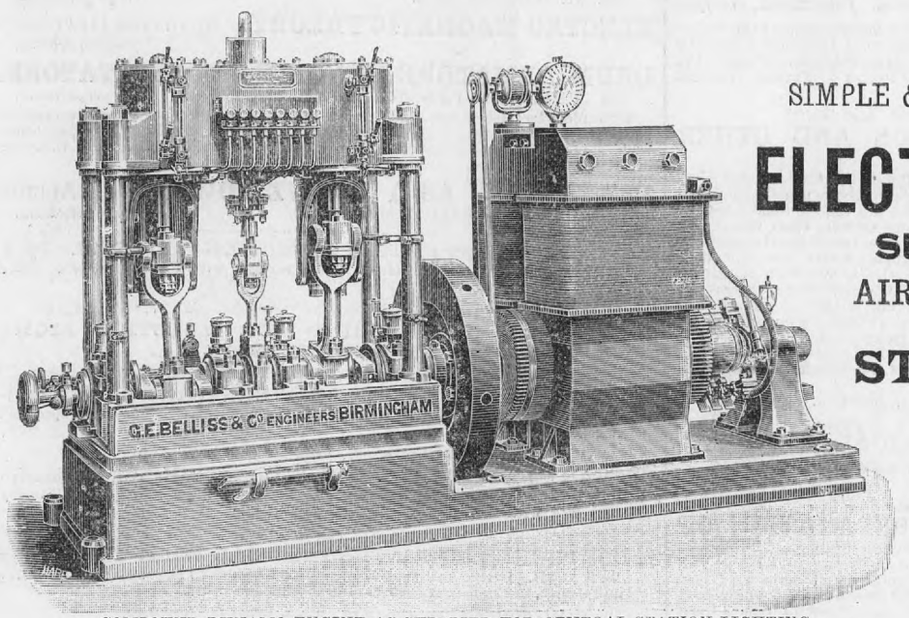

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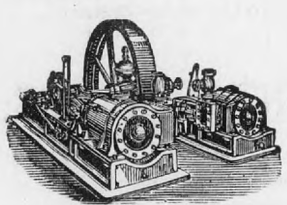

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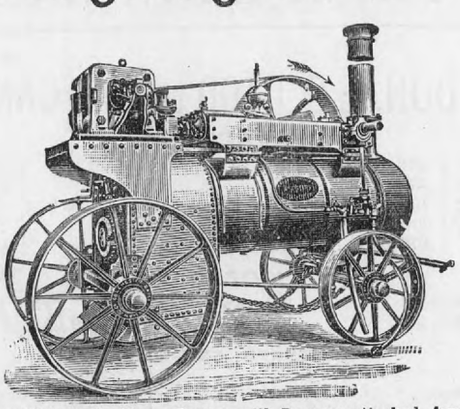

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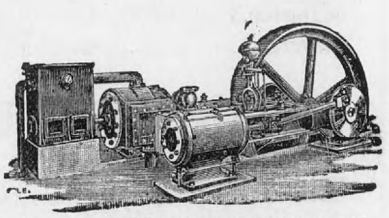

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No. 768.—Vol. XXX. FRIDAY, FEBRUARY 3, 1893. PRICE FOURPENCE.
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NOTES.

The necessity for a comparison between the suggestions put forward by the Committee of the Electrical Section of the Royal Commission for the Chicago Exhibition, and the recommendations of the sub-committee of the American Institute of Electrical Engineers as to the programme for the forthcoming Electrical Congress is not necessary, since the former were proposed in a very tentative fashion, and aimed at little else than a string of ideas from which programme makers might derive assistance. The provisional programme, of which we print an abstract in another column, contains some useful recommendations, and displays a good knowledge of the subjects with which it deals, as well as of the needs of the hour. That a set of definitions of physical quantities for international use should be contributed from America to Europe is a sign of the times; and whether the programme be adopted or no, or whether even any Congress be held at all, we welcome this report as an interesting landmark in the development of real American science.

The first definition is not well worded. If the impressed electromotive force is the ratio of the electrical activity to the instantaneous value of the current, what happens after the removal of the electromotive force acting in a circuit possessing self-induction? The activity of the circuit is at first unchanged, since the current is not altered instantly, so that, according to the definition, the electromotive force is the same as before. It is true that the dying magnetism supplies the electromotive force needed for maintaining the current, but this is not in any sense impressed upon the circuit, for the circuit itself supplies it. It would have been better to merely reproduce the definition, adopted by the Board of Trade Committee, for the volt, namely, the potential difference needed to drive a current of one ampere through one ohm.

Some definitions are given of quantities which are at present hardly ever used. Who wants a unit of reluctivity; and, if there be such a person, is he likely to receive any help from the definition that "the reluctivity of a medium at any point is the volume differential of the reluctance thereat"?

With the practical parts of the report we have more sympathy than with the theoretical. Among the terms which are recommended for universal use we are glad, and indeed surprised, to find that no change whatever is needed in the language commonly used in the editorial columns of this journal. "Voltage" is recommended as synonymous with the ponderous pedantry of "difference of electrical potential," with the slovenly "potential," with the slang "P.D.," or the far worse "E.M.F.," with the antiquated "tension," and with the often unscientific but sensible term "pressure." But our experience goes to show that, if only on account of tautology, the term "voltage" will not always suffice. Again, the use of "transformer" for "converter" has for long been our custom, and "dynamotor" for "continuous current transformer" for a necessarily shorter period. "Continuous current" is preferable to "direct current," but this is not a matter of importance.

In the same breath, however, the report recommends the use of "kilowatt" for horse-power. This is an altogether different matter, and one to which, if a real substitution is intended, we strongly object. For heaven's sake let those who have to employ the term be engineers first and electricians afterwards! We should much prefer to stick to I.H.P., B.H.P., and E.H.P., and let the kilowatt go by the board, if there need be a choice. But there is none; the kilowatt has its uses. While such reforms are going on, we should like to see the affected and pompous term "installation" abandoned. Engineers got on perfectly well with "plant," or "job," or "work," before they were corrupted by the accident of an exhibition at Paris. We find no difficulty in excluding "installation" from our editorial columns.

Of the seven names for units which are put forward, a majority stand a good chance of adoption at the Congress. The "mho" has been laughed at, but we are probably justified in saying that no one who uses units of conductivity employs any other name; but the same might be said for the use of the name "haf" as the reciprocal of a degree Fahrenheit. The "henry" is sure to be received, for it has been already well tried and only once stood in danger of becoming ridiculous when "milli-hens" and the like were suggested. The "œrsted" for magnetic reluctance and the "gilbert" for magneto-motive force are of rather doubtful value, but we hope that the pair of names, the "gauss" and the "weber," will be respectively adopted for what the report calls "the practical unit of magnetic intensity," presumably **B**, and for total lines of force or **N**. The much needed unit of illumination is likely to give rise to some discussion, the "bougie-metre" or the

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"candle-foot" are open to the objection that all other such compound names imply a product of the components, while in this case the former component is divided by the square of the latter, or is multiplied by the square of its reciprocal. We might then have "candle-toof.toof," on the "mho" principle, a term accurate enough to satisfy even M. Hospitalier, and hardly more uncouth than "mega-barads," "microboles," and "kilogramme-kines," which have been proposed without apology.

It would not be amiss if the Council of the Institution of Electrical Engineers were to allot an evening or two to a discussion of these proposals, the speakers being kept rigidly to the subject before the meeting, namely, the adoption, rejection, or moderate amendment of America's contributions to international electrical nomenclature. No good can come at this time of day from airy schemes for revolutionising our system of units, or from fads for increasing this practical unit by one-tenth and decreasing another to the same extent to make a fit. At the close of the debate the Council might perhaps reduce the general sense of the meeting to concrete resolutions which might be put to the vote of members only.

In another column we print an article by J. E. Moore, describing some measurements of the losses occurring in iron when subjected to alternating magnetic forces. The method adopted is a modification of Dr. Duncan's dynamometer method of analysing alternate current curves, the only change being that the alternating magnetic field caused by the current in the fixed coil of the dynamometer is replaced by the magnetic field whose variations are being investigated. The results are of great interest; but the method is a needlessly roundabout way of obtaining data from which to estimate the core losses of transformers. A much quicker and simpler method consists in winding a coil around the iron samples, and measuring with an ordinary wattmeter the power absorbed by the solenoid for different voltages. The average induction density in the core can be obtained from the voltage, the current frequency, and the section of the core; and the watts wasted per unit volume of the core can, of course, be at once found. Not only is this obvious method simpler, but it is more accurate than that suggested by Mr. Moore, since, while the voltage absorbed by the coil is a measure of the average induction in the core, the deflection of Mr. Moore's magnetometer depends on the induction in the air outside the core, where magnetic leakage difficulties are greatest.

The refraction of electric waves by large prisms and lenses made of pitch has been investigated by Herz and others, the result found being that the refractive index for these waves is about the same as that obtained with optical measurements. There is no reason to expect a close agreement, owing to the great difference in frequency of the electric and optical waves, which in most cases causes the prism to produce a wide spectrum. When the angle of the spectrum is large it is impossible to verify Maxwell's prediction, that the specific inductive capacity of a substance is equal to the square of its index of refraction, since the latter quantity can only be determined optically with light waves of short wave length, while the law is only supposed to be true for long waves, such as those occurring in electric oscillations. Maxwell's law is accordingly found to be accurately true for some substances, while for others it does not seem to hold. The present instance is a remarkable case in which the law is applicable when measurements made with ordinary light appear to show that the law is wrong.

Herr Ellinger has recently measured the index of refraction of alcohol by passing a beam of electric waves through a large prism containing about nine gallons of a 95 per cent. solution of alcohol, and measuring the refraction produced. The index found is very high—4·9—but it appears to agree very fairly with theory, since the specific inductive capacity was measured at the same time, and was found to differ very little from $(4{\cdot}9)^2$. The index of refraction of this liquid for ordinary light is generally given as 1·37, and as violet light is more refracted than red, and red light more than dark radiation, it would be natural to expect that the index for electric rays would turn out to be less than 1·37 instead of more. A specific inductive capacity of nearly 25 is, moreover, very high. The result is, however, not impossible, and is of great theoretical importance if it be confirmed.

Although the law has for many years provided that an assessor *may* assist a judge in trying patent cases, and that an assessor *must* be found if either side make an application, no such procedure, so far as we know, has ever been witnessed in English law courts until this week. Hitherto each party has endeavoured to retain the best counsel and the cleverest witnesses, and has relied on hired wit to win the judge. A frank and candid explanation of the whole case before the judge is not made, for it is nobody's business to make it. The witnesses are of course prepared to give the "whole truth," but they can only answer questions. In the case of Paine *v.* Thompson, relating to a patent "cyclone" dust collector, invented by Prof. V. Boys, and used in flour milling, Prof. George Forbes is acting as assessor, Mr. Justice Wills being the judge. We are very glad to see the adoption of a course which has been consistently advocated in these columns. The next step should be the appointment of witnesses by the Court instead of by the parties, but we understand that the Bar is strongly opposed to this.

Up to the present we have not felt able to advocate the general use of electric motors in place of hydraulic gear or auxiliary steam engines on board ship, but the effect of the recent frost on the "Benbow" discloses a weak point in hydraulic machinery which has no parallel in electrical work. The gear of the heavy guns has been not only disabled, but has suffered such serious injury that it has been found necessary to take the greater portion of it to pieces, and to forward it to the manufacturers for reconstruction and repair.

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At a late hour yesterday afternoon, and with some difficulty, we obtained a copy of the first Report of the Royal Commission on Electrical Communication with Lighthouses, and have made room for an abstract of it in another column. The recommendations contained therein will be gratifying to Sir Edward Birkbeck, Mr. Robert Bayley, and others, who have zealously advocated the cause of such electrical communication, and these recommendations are, we hope, the first instalment of a complete system.

Royal Institution.—On Saturday, February 18th, Lord Rayleigh will begin a course of six lectures on "Sound and Vibrations."

Personal.—Mr. W. Perren Maycock has commenced practice as consulting engineer, with offices at No. 96, George-street, Croydon.

Blackpool.—A Local Government Board Inquiry was held at Blackpool on Monday by General Crozier, R.E., into the application of the Corporation to borrow £26,000 for the purposes of electric lighting.

Tunbridge Wells.—At the meeting of the Town Council on Wednesday last Mr. Preece's report and recommendations with regard to the electric lighting of the town were received, but discussion on the subject was deferred for a month.

Cable Interruptions and Repairs—

Cable.	Interrupted.	Repaired.
Mozambique-Laurenço Marques ...	Jan. 25, 1893	Jan. 27, 1893
Cables actually interrupted.		
Cayenne-Vizeu	Sept 24, 1892	—
Senegal-Pernambuco	Dec. 26, 1892	—

Obituary.—The death is announced of Prof. J. Stefan, who presided over the International Scientific Committee of the Vienna Electrical Exhibition, and who carried out numerous researches on the propagation of sound, refraction, the polarisation and interference of light, the conduction of heat, &c.

Accumulator Cars in Berlin.—The Great Berlin Tramway Company has obtained permission to make experiments with secondary battery cars on one of its lines. It is intended to have the cars in service by May, and upon the result of the tests depends the granting of a concession for the establishment of a new tram line proposed to be worked by electricity.

Salford.—According to a statement made by the Chairman of the Gas Committee, the electric light installation in the central portion of the borough will cost more than £30,000, as originally stated. The Council have agreed that power should be asked to borrow £50,000 to meet the initial cost, and any extensions that may be necessary in the future.

Bolton.—The Gas and Lighting Committee have decided that application be made to the Local Government Board for sanction to borrow £40,000 for electrical purposes. The system to be adopted is to be the high pressure continuous current. Advertisements are to be inserted for an electrical engineer to advise on the proposed works, and to have charge of the construction, &c., at a salary of £200 per annum.

Electric Launches and the Merchant Shipping Act.—Lord Coleridge and Mr. Justice Charles last week quashed the conviction against the Southport Corporation for having an electric launch on the Southport foreshore lake for the conveyance of passengers without a certificate under the Merchant Shipping Act, 1854. Their lordships said it was absurd to think that a small electric boat on an artificial piece of water was ever intended to come within the Act.

Popular Lecturing Made Easy.—A correspondent informs us that a lecture was given in Edinburgh last week upon "The Electric Light in Our Homes." The title will be recognised as that of a book which has enjoyed an extensive circulation, if not a large sale. There is nothing remarkable in this, but we have received five sheets of manuscript in parallel columns containing extracts from the lecture and from the book side by side. They are for the most part word for word the same. We understand that no acknowledgment was made. It may be difficult to find something new to say about the advantages of electric lighting, but such plagiarism is insulting to the audience, discreditable to the lecturer, and shabby to the original author.

The Junior Engineering Society.—The eighth annual dinner of this Society was held on Saturday evening last at the Holborn Restaurant. The President, Dr. John Hopkinson, took the chair. Among those present were Sir George G. Stokes (vice-president), Sir Frederick Abel, Mr. W. H. White (vice-president), and Prof. John Perry (past president). Sir George Stokes, in reply to the toast of "Science and Technology," said some friends of his devoted themselves exclusively to abstract science, and even disliked the idea of its practical application. For himself, he thought that it could hardly be applied too much. The President of the Royal Society, Lord Kelvin, was one example of the advantages that came of that union of the two things.

The Telephone Companies.—The following *communiqué* appeared in the *Standard* of yesterday:—

> We have reason to believe that no foundation in fact exists for the doubt, expressed in the circular which has just been issued by the Association for the Protection of Telephone Subscribers, whether the agreements entered into by the New Telephone Company with that Association and with private individuals for the supply of telephones on its system upon advantageous terms are still binding since its so-called "amalgamation" with the National Telephone Company. Although provision has been made for the transfer of shares from one Company to the other, the New and National Telephone Companies have not been, in the strict sense of the word, "amalgamated," nor have the prior obligations of the New Telephone Company been extinguished. The objects of the recent arrangement between the Companies were to obviate friction and competition, and to facilitate the introduction of the improved system of telephony which the New Telephone Company was incorporated to promote, and no release of either of the Companies from any of its existing engagements was intended, or is in contemplation.

Union of German Electrical Engineers.—Under the title of the Verband der Elecktrotechniker Deutschlands, an association has just been constituted in Berlin. The members comprise the leading electrical firms, many scientific notabilities, and representatives of all the electrotechnical societies now scattered throughout Germany. The scope of the union is very varied, as in addition to being an electrical institution it will watch over the interests of the industry, and give reliable information concerning the views of electrical engineers. An instance quoted as showing the necessity of such an institution was the case of the recent Telegraph Act, and it is now intended that the union shall be of use in connection with the forthcoming legislation on electric light and power industries. All those either directly or indirectly interested in the different branches of electrical applications, and particularly industrial customers and municipal and other administrations, will be invited to join the union, which is to hold its first annual assembly in August or September next.

Light, Paper, and Eyesight.—An endeavour has been made to tint the paper of the latest evening journal in London to enable it to be read with comfort in a bad light. The tint which has been selected is green, but rays of this colour are not present in abundance in most artificial lights. As a result, with a bad smoky flame, the paper seems to be of a dirty grey colour, and were it not for the excellent quality of the paper and type, it would be very difficult to read. Under an arc lamp the green colour shows up, and we have found an unexpected difference in this respect between ordinary gas light and that of a good glow lamp. The best colour for the paper would be that in which artificial light is most rich, namely, yellow or orange—though there may be political reasons against the latter. The new journal, which is to be congratulated on having already received as a "short title" *The Gazette*, has made, at all events, a praiseworthy, though, we think, mistaken attempt to diminish eye-strain in this manner. We have further to congratulate the *Westminster Gazette* on being, so far as we know, the only daily newspaper besides *The Times*, which contains no advertisements of Harness' belts.

Storage Battery v. Overhead Trolley Cars in Boston.—What promises to be a bitter fight, says the *Street Railway Gazette*, is now inaugurated between the West End Street Railway Company and a concern calling itself the Cambridge

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Storage Battery Street Railway Company. The latter Company has petitioned for the privilege to run cars operated by storage batteries on the tracks of the West End Company, and thereby secure an entrance into the city of Boston. The law in the case is peculiar, and seems to protect the rights of both parties. In the first place there is a provision in the statutes that the lines of any one company may be used by any other company operating two miles or more of track. The reason for this is to afford better transportation for the public. Under this regulation it would seem that the Battery Company had a right to use the tracks of the West End Company; but the West End people were far-sighted enough to secure a clause in their original franchise which states that "no other street railway company shall operate on the lines of the West End Company without first securing the permission of the Board of Railway Commissioners." The matter will be taken into the Legislature, and what promises to be a very bitter fight is now well started.

York.—At the last meeting of the Town Council the minutes of the Streets and Buildings Committee, acting as the Electric Lighting Sub-committee, came up for adoption; and, according to the *Yorkshire Gazette*, the following discussion took place:—

Alderman Wragge asked if Mr. Crompton drew up the specifications for the electric lighting scheme, and whether he had tendered for the execution of the work on his own specifications. Further, he desired to know what were the services rendered by Mr. Crompton when he acted as consulting electrical engineer to the Corporation, and whether, when engaged, he gave an assurance that his own firm would not tender for the carrying out of the work?—Mr. Purnell inquired what proof they had that Prof. Kennedy, of Westminster, whom it was proposed to now engage as the engineer, had no partiality for any particular system or combination of systems—that he had no business connection with any electric lighting contractors; whether there was such a company as the City of London Electric Lighting Company; whether Professor Kennedy had carried out any work at all excepting the Westminster Supply Corporation's work?—Alderman Agar said it was true that the specifications were drawn up by Mr. Crompton, but they were very wide and not tied to any system. Mr. Crompton was released from his engagement to the Corporation in order that the Company to which he belonged might tender. With regard to the question whether Prof. Kennedy had any connection with any electric lighting contractors, they had his own word for it that he was not.—The report was adopted.

Earthing the Middle Wire.—Another argument in favour of earthing the middle wire of a three-wire system comes to hand from Berlin. In October, 1890, the electric lighting company laid down a length of about one mile of main with the neutral wire grounded, but were obliged to insulate it at the request of the telephone officials. Recently, however, numerous tests carried out by the electric light and telephone engineers have shown that earthing the neutral is beneficial rather than otherwise, so far as the single-wire telephone system is concerned. The Berlin telephone officials have suffered considerably from leakage currents emanating from the lighting circuits, the most marked feature of the disturbances being the letting down of the exchange annunciators. The tests consisted in producing faults on the lighting mains with and without the neutral being earthed, and noting the number of annunciators affected. In the first experiment 7,799 annunciators were disturbed when the neutral wire was *not* grounded, and 3,524 when it was grounded. Omitting Exchange V., where the neutral was earthed at the same spot as the exchange wires, the relative figures with the neutral insulated, and with it earthed, were 4,189 and 241.

Brighton.—Mr. T. Codrington, one of the Local Government Board Inspectors, held an inquiry on Tuesday into the application of the Corporation for sanction to borrow £37,700 for purposes of electric lighting. The Town Clerk and the Deputy Town Clerk represented the Corporation, and Mr. Hugh Verrall attended to express the views of a number of consumers of the light supplied by the Hammond Company, who feared they might be prejudiced by the action of the Town Council. Some difficulty was found in supplying the Inspector with figures and plans as to work done under the last loan, and attention was also drawn to an overdraft on capital account of £5,880. Eventually the inquiry was closed, subject to further information being forwarded to the Inspector. Mr. Arthur Wright, electrical engineer to the Corporation, in the course of his evidence, stated that it was proposed to change over from the two-wire to the three-wire system, but that it was not proposed "to pay a royalty to Dr. Hopkinson, as they were not using his system!" Mr. H. M. Stevens, Borough Accountant, stated that the total amount spent on the Electricity Works up to December 31st, 1892, was £46,884; the amount borrowed being £41,000. By the time the present loan is exhausted the Brighton Corporation will therefore have spent something like £80,000 on electric lighting.

The Three-Wire System.—A correspondent writing from Portugal, under the date January 24th, calls attention to the evidence given in the recent patent case about the brightening up of lamps on one side of the middle wire when the other side was short circuited. He says that, excepting Mr. Swinburne, the experts questioned on this point agreed that the brightening up of one side with the other short circuited proved that the system was *not* the three-wire system, *i.e.*, that the middle wire was not actually connected to the dynamo. Our correspondent says that anyone who has run a three-wire station, and intelligently observed what occurs, knows that this is wrong. "Let the positive side be loaded up until the differential current flowing through the middle wire causes a fall of two volts in that wire. The lamps on the positive side will only get 98 volts. That is to say, the middle wire will be two volts more positive at the feeding point. Therefore the lamps on the negative side will get 102 volts, and will be perceptibly brighter. Or to put it in another way, part of the excess current goes back by the lamps on the negative side." As the Court was not satisfied that there was evidence to show that the middle wire at the Sauchiehall Works was connected to the dynamo, we do not think that a discussion on this point is useful, so far as the case is concerned, but granting that a connection existed, it must be remembered that the dynamo was an alternator. It is extremely difficult and quite useless to argue about what would have happened, considering the complications which would be introduced by the armature reactions of old-fashioned machines. The result would probably be very different from that which would take place with the ordinary three-wire system.

The Need for Electrical Communication Between Lightships and the Shore.—Captain Knox, Captain Cosens, and Captain Bigley, Nautical Assessors, had a case recently before them which furnished a remarkable illustration of the need of electrical communication between lightships and the shore. It was an inquiry into the loss of the steamship "Dilsberg," on the Longsand in the Thames estuary, on December 9th last. Six of the crew were drowned, and the captain sustained injuries which terminated fatally. The "Dilsberg" got aground between noon and one o'clock, seven miles from the Longsand light, nine to ten miles from the Kentish Knock, and about seven miles from the Sunk. Blue lights were burned and rockets fired for assistance, but they did not appear to have been observed. At about midnight the steamer settled down. At daylight on the 10th, the weather having moderated a little, the port lifeboat was patched up and lowered into the water, and at about 10 a.m. the fifteen survivors got into it and pulled towards the Kentish Knock lightship, which was reached at about four o'clock. The master of the lightship commenced at 5.18 to fire signals for assistance. He continued firing for a considerable time, but it was not until 6.12 that he got an answer from the Longsand. The captain of the Longsand lightship, seeing the flash of a rocket thought it was a signal of distress from a vessel which he had observed in the morning apparently at anchor. He thereupon signalled to the Sunk lightship to that effect, and thought he was answered by a lightvessel fourteen miles in another direction. The weather was undoubtedly more or less foggy at the time, but it was clear that the prescribed signals of these lightvessels were either not seen or were misunderstood, and the assistance required by the Kentish Knock lightvessel was therefore not forthcoming. There had, said the Board of Trade solicitor, unquestionably been a failure on the part of the particular lightships in question in communicating with one another, and it was the desire of the Board of Trade that the whole of the circumstances should be fully investigated. The survivors from the "Dilsberg" were taken off the lightship on the morning of the 11th by the smack "Cordelia" and landed at Ramsgate.

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THE DIFFUSION OF LIGHT.

BY W. E. SUMPNER, D.SC.

The important part played by diffused light in general illumination is but little realised. It is well known that the great majority of bodies would be invisible if it were not for the diffused light scattered from their surfaces; but few seem to understand the great extent to which the illumination of rooms and open spaces is increased by the repeated reflections to which the light is subjected at the different diffusing surfaces it meets with before it is finally absorbed by bodies in the neighbourhood. In many cases of artificial lighting the illumination due to diffusion is four or even five times as important as that part of it which is due to the direct rays proceeding from the light sources within the enclosure considered; while, of course, daylight, although primarily all due to the sun, is in most cases almost entirely caused by rays which have suffered many reflections from clouds, or walls, or other diffusing surfaces.

Diffusion is, moreover, of importance in quite another way, for it alters the character of the illumination, and makes it much more pleasant for the eye to endure. The illumination at the base of an ordinary arc lamp at night-time is not nearly so strong as that of diffused daylight, yet it is much more tiring to the eye to look at an arc lamp in the street, although it may be surrounded with a good diffusing globe, than it is to look at a bright cloud on a summer's day. From measurements made by Mr. Trotter it appears that the maximum illumination on the pavement of Queen Victoria-street at night-time due to the arc lamps there is a little over one-half of a candle-foot [*i.e.*, the illumination caused by a standard candle at a distance of one foot], while the illumination of daylight on a bright day in London often exceeds 30 candle-feet. It thus appears that the eye can bear with comfort sixty times as much light from a diffusing surface, such as that formed by the clouds, as it receives when in the close neighbourhood of an arc lamp. But no one could long bear to look at 60 arc lamps at a distance equal to the height of an ordinary street lamp. This is not due in any way to the fact that the light is caused electrically in an arc lamp, since the general result is true of all artificial lights, and is due to the concentration of the rays on a particular part of the eye when proceeding from a small luminous area of great brightness. The dazzling effect of bright surfaces on the eye is not only unpleasant, but it causes the pupil to close up to a greater or less extent, and, as the amount of light received by the eye depends not only on the intensity of the illumination of the bodies viewed, but also on the area of the exposed portion of the eye, it is clear that any influence which causes a partial closure of the pupil of the eye produces the same effect as if the surrounding illumination were diminished. In estimating the usefulness of surrounding a naked arc with a good diffusing globe we must take into account both the absorbing power of the globe and the increased exposing power of the eye. If the globe absorbs 30 per cent. of the light of the arc, but at the same time so diffuses the light that the pupil of the eye increases in diameter by 20 per cent., and the area of the eye exposed by 40 per cent., the amount of light received by the eye is actually increased and not diminished by using the globe. This effect of diffused light on the eye is obviously of importance; yet no experiments appear to have been made on the subject, perhaps because they are rather hard to carry out. Until such experiments are made it is impossible to say to what extent this effect takes place; but the general taste for the use of opal globes, and other diffusers, has probably some solid foundation not yet completely understood; and the mere fact that such globes often absorb 30 or 40 per cent. of the light produced within them is not so important as is often imagined. One of the most useful properties of diffused light is that it does not cast shadows. However powerful may be the arc lamps lighting an area, the illumination never appears good if there are sharp shadows about. A photometer may declare that the average illumination is high, but the eye is the sole judge in these matters, and refuses to be satisfied. In an ordinary room, with walls covered with paper of average reflecting power, the illumination due to reflection from the walls is fully as important as that due to the direct rays of the lamp or lamps within it, and this diffused illumination, instead of varying with the distance from the lamp, is constant all over the room, casts no shadows, and is as well diffused as ordinary daylight.

In order now to get an estimate of the extent to which the action of the walls of a room increases the illumination, let us suppose that the lights within the room add up 100 candle-power, and that the average reflecting power of the walls, ceiling, &c., is 50 per cent. Then, of the light which is incident on the surface of the room, 50 per cent. is reflected back into the room again, and as this light is just the same as any other light, it is equivalent to an additional light of 50 candle-power. The rays from this second light strike the walls again, and those which are reflected anew form a third light of 25 candle-power, and so on. The sum of the series 100, 50, 25, $12\frac{1}{2}$, &c., is equal to 200, so that the effect of the walls is just as if the lamps within the room were of 200 candle-power instead of 100. Similar reasoning shows that if the walls and ceiling reflected 80 per cent. of the incident light, the illumination within the room will be as if the candle-power of the lamps, instead of being 100, were 500, and of this illumination that portion due to the walls is four times as important as that due to the direct rays of the lights. Such a result is quite possible to realise with well whitewashed surfaces. If we take an extreme case, and suppose that the walls, &c., are covered with mirrors reflecting about 92 per cent. of the light incident upon them, the equivalent candle-power within the room would be increased in the ratio of 8 to 100, or from 100 candle-power to 1,250, that is more than twelve times.

Light is, in fact, heat energy in a special form, and if it is produced at a regular rate by some light source within any enclosure, the amount of light within this space must go on increasing until the walls absorb the light as fast as it is produced by the sources. Thus, if Q be the quantity of light produced per second by the lamps, and Q′ be the quantity falling per second on the walls, we must have

$$Q' = Q + r\,Q',$$

where r is the average reflecting of the walls. For Q′ must consist of two parts, that which is absorbed by the walls, and that which is reflected. By definition $r\,Q'$ must be the latter quantity, and the former is equal to Q for the reason just stated.

Hence,
$$Q' = \frac{1}{1-r}\,Q,$$

and the increase of illumination by reflection must be in the ratio of 1 to $1 - r$.

The reflecting powers of a number of diffusing substances have been recently tested by the writer, with results shown in the following table:—

Table I.—*Reflecting Powers.*

	Per cent.		Per cent.
White blotting paper	82	Deep chocolate-coloured paper	4
White cartridge paper	80	Plane deal (clean)	40 to 50
Tracing cloth	35	„ (dirty)	20
Tracing paper	22	Yellow cardboard	30
Ordinary foolscap	70	Parchment (one thickness)	22
Newspapers	50 to 70	„ (two thicknesses)	35
Tissue paper (one thickness)	40	Yellow painted wall (dirty)	20
„ „ (two thicknesses)	55	„ „ „ (clean)	40
Yellow wall paper	40	Black cloth	1·2
Blue paper	25	Black velvet	0·4
Dark brown paper	13		

It thus appears that even a dull-looking wall will reflect as much as 20 per cent. of the light incident upon it. A wall of ordinary tint reflects from 40 to 50 per cent., while a good white surface reflects over 80 per cent. A clean whitewashed ceiling reflects as much light as an ordinary mirror, for although extremely good mirrors may be obtained which will reflect as much as 90 per cent. of the light incident upon them, measurements made with common mirrors do not show a greater reflecting power than 82 per cent.

A room with its surfaces well whitewashed thus needs only one-fifth of the candle-power to produce any given amount of illumination, that it would need if its walls, ceiling, &c., were

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all painted black. The reflecting power of the walls of a room is an important matter to bear in mind when judging the number of lamps needed to light it properly. Mr. Preece has given a useful rule by means of which an approximate estimate can at once be obtained of the number of arc or glow lamps needed in any given case. This rule is as follows: If arc lamps are to be used for halls, for large buildings, exhibitions, or railway stations, the lamps should be so arranged so that they shed uniformly over the surface to be illuminated the amount of light that corresponds with an expenditure of power in the arcs of one half a watt per square foot of the area to be lighted. For private house lighting, on the other hand, the number of glow lamps should be so chosen that the power they absorb is one watt for every square foot of surface on the floor space. By fixing, 8ft. above the surface, a 16 candle lamp absorbing 64 watts, this will illuminate 64 square feet; so that according to Mr. Preece's rule the area in square feet of the floor divided by 64 gives at once the number of 16 candle lamps, fixed 8ft. high, which will be needed to properly light the room. But it is evident from what has been stated above that a hard and fast rule of this kind can only apply to a room whose walls are of average reflecting power, and that in order to get satisfactory lighting it is necessary to take into consideration the optical character of the walls and furniture within the room. In this connection it may be interesting to reproduce some remarks of Mr. Kapp made some months ago at the Institution of Civil Engineers.* He there stated that "he made a practice of putting in wires suitable for larger lamps, if doubt existed as to the effect of wall decorations. A year ago he had to advise the owner of a large country house with regard to lighting. There were two rooms, each about 100ft. long by 30ft. wide. One room was a museum, used as a ballroom, filled with cases containing specimens of birds, and painted white inside. The other was a picture gallery, wainscoted high up with dark oak. The museum took $\frac{3}{4}$ watt per square foot, and it was then brilliantly lighted. The other room, with the old wainscot, required more than 2 watts per square foot."

This is a somewhat exceptional case; but it is taken from actual experience, and shows that one room may take three times as many lamps to light it to the same extent as another room of the same size. A little consideration will, however, be sufficient to show that in many existing cases the amount of light in a room could be doubled by simply removing the wall-paper and substituting another of a lighter tint. To double the number of lights in the room would not only be much more costly, but would actually in many cases not be so effective as this simple process.

In order to establish this, it is first of all necessary to find out the average reflecting power of the surface of a room, when the walls, ceiling, and floor have, as is usually the case, very different diffusive powers. This average value may be obtained by multiplying the area of every surface by the reflecting power of that surface, adding the products, and dividing the sum so obtained by the sum of the areas of the surfaces.† Thus, if A_1, A_2, A_3, be respectively the areas of the ceiling, walls, and floor of a room, and if the reflecting powers of these areas be respectively r_1, r_2, and r_3, the average reflecting power r may be taken as

$$r = \frac{A_1 r_1 + A_2 r_2 + A_3 r_3}{A_1 + A_2 + A_3}.$$

As an example, suppose the room is approximately cubical, so that A_2, the area of the walls, is four times as large as either A_1 or A_3. In the first instance assume that the tint of the walls and ceiling is dull. We may then take the reflecting power r_1 of the ceiling as 40 per cent., that of the walls, r_2, as 20 per cent., and that of the floor, r_3, also as 20 per cent. We then find that the average reflecting power r is 23·3 per cent., and the illumination produced will be proportional to

$$\frac{1}{1-r} = \frac{1}{1-\cdot233} = 1\cdot30,$$

or 1·3 times what the illumination would be if the surfaces of the room were black. If now the ceiling be whitewashed, so as to reflect 80 per cent., we get for r the value 30 per cent., and the illumination is increased in the ratio of 1·3 to 1·46. If, however, the walls be now covered with a light-tinted paper, reflecting 75 per cent. of the light, the average reflecting power r is

$$r = \frac{80 + 4 \times 75 + 20}{1 + 4 + 1} = 66\cdot7 \text{ per cent.},$$

and the illumination is now represented by the number 3·00, or more than double what it was before the change in the wall paper. Probably an average case for rooms is for the ceiling to reflect 80 per cent., the walls 50 per cent., and the floor 20 per cent. The average reflecting power then comes out to be 50 per cent., and the illumination is doubled by the reflections occurring within the room.

When the surfaces of a room are coloured, the illumination caused by the light is not only increased, but is altered in character by reflective action. Suppose the room has its walls covered with red paper, the average reflecting power of which for ordinary light is 40 per cent. In such a case it may happen that the amount of red light in the room is increased five times by the action of the walls. For, although the average reflecting power of the paper is only 40 per cent., the paper may reflect quite 80 per cent. of the red light falling upon it, absorbing all except, say, 10 per cent. of other kinds of light. In such a case the red light will be increased fivefold, while light of other hues will not be altered to any perceptible extent. The light within a room thus exhibits a strong tendency to become coloured to the same extent as the surfaces of the room.

The reflecting power of a white surface has often been taken advantage of in cases in which a uniformly diffused light is desirable. Thus in factories, in which rather delicate mechanical work is carried out, a suitable light has been obtained by reflecting light from well-whitewashed surfaces by placing arc lights within big funnel-shaped covers arranged so as to throw the light up to a ceiling, and from thence into the room. An arrangement of a somewhat similar kind has been used with excellent results in the lighting of large reading rooms. It appears from the fact that good white surfaces reflect fully 80 per cent. of the light incident upon them, that such arrangements as just indicated not only result in the production of a pleasant diffused light, but are also highly efficient. For instance, if a naked arc light be surrounded by an opal globe there is, as a rule, quite as much light absorbed by the globe as in the double reflection from two whitewashed surfaces, supposing the arc is placed within some such arrangement as that mentioned above.

(To be continued.)

* See the discussion on Mr. Trotter's Paper on "The Distribution and Measurement of Illumination." Proc. Inst. Civil Engineers, May, 1892.

† For the proof of this as well as of other formulæ given later on in this article the reader is referred to a Paper on "The Diffusion of Light," by the present writer, appearing in the *Phil. Magazine* for February, 1893.

MAGNETOMETRIC METHOD OF MEASURING LOSSES IN IRON UNDER ALTERNATING MAGNETIC FORCES.

BY J. E. MOORE.

In the *Electrical World* of June 3, 1892, there appeared a short article on the "Losses in Iron under Alternating Magnetic Forces." The experimental work in the article referred to was performed by a method suggested by Dr. Louis Duncan, which might be called the "Dynamometer Method." Shortly after the publication of this article, the writer had occasion to perform a series of experiments by a modification of this method, which up to that time, it is believed, had never been used. The fundamental object in these experiments was to establish a simple and accurate way of obtaining the iron loss for the predetermination of the efficiency of transformers. In previous methods the measurement of the induction **B** and the intensity of magnetisation **I** had been accomplished by measuring an induced E.M.F. To pass from the instantaneous values of E.M.F. to the corresponding absolute values of **B** or **I** is a laborious process, not to mention the inaccuracies that are apt to be involved.

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In order to measure all quantities directly, the sample of transformer iron is procured in the form of long strips, or wires, which are built up so as to make long rods. These are supplied with magnetising coils as if they were to be used for ballistic or magnetometer experiments. An alternating current of the same periodicity as that for which the transformer is to be used is passed through the magnetising coil. It produces in the sample waves of magnetism of the same periodic time as the current. Instantaneous values of the magnetising current can be measured by the method suggested by Dr. Duncan. The corresponding values of magnetisation can be measured by suspending a small helix of insulated wire near one of the poles of the long rod. By passing an instan-

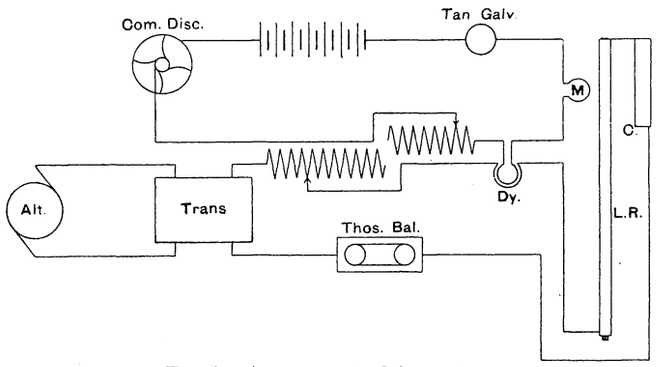
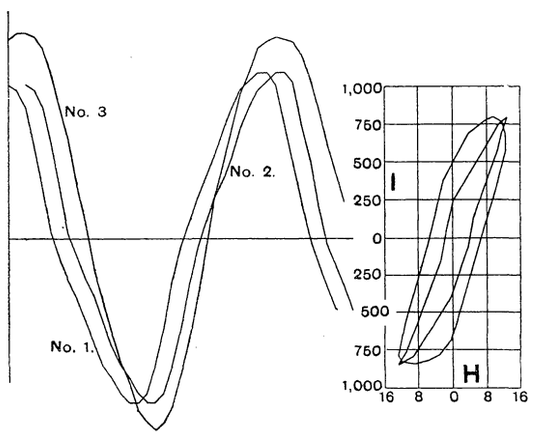


FIG. 1.—Arrangement of Apparatus.

taneous current through the helix at a definite point in each recurring cycle of magnetism in the long rod, the helix is made for a very short time a magnet, the strength of which is proportional to the number of turns of wire on the helix and to the current passing. It is readily seen that a deflection will result; and its amount will be proportional to the product of the strengths of magnetism developed in the long rod and the suspended helix during the short time the current is flowing through the helix. By making the instantaneous current to pass at different points in the wave of magnetism, different magnetometic deflections will be obtained at each point, and by keeping the mean strength of



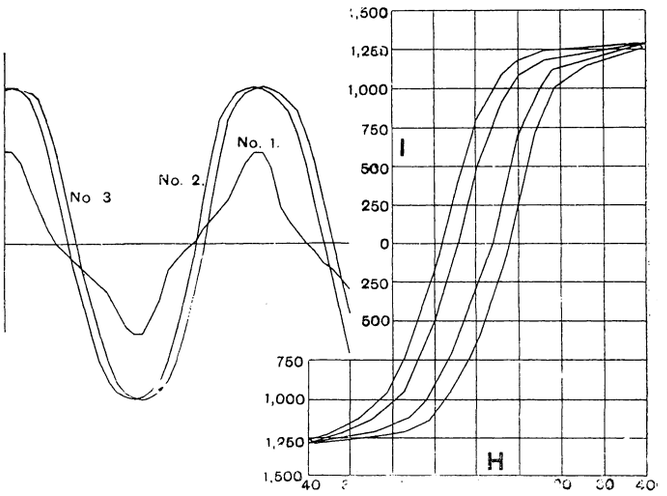
No. 1. Magnetising Force (as taken).
No. 2. ,, ,, (in Phase)
No. 3. Magnetisation.

Loss in Ergs per Cu. Cm.
As taken, 18490.
As corrected, 8608.

FIG. 2.—Experiment on Long Rod of Wires $\sqrt{C^2} = \cdot 9055$ amp.

the instantaneous current constant, the deflections of the helix will be proportional to the strength of magnetism in the long rod at the point in the wave of magnetism at which the instantaneous current passed. By this modification both quantities for obtaining the hysteresis loss may be read off directly. Since this method differs from the dynamometer method only in the use of the magnetometer, it will suffice here to describe this piece of apparatus alone.

The magnetometer M (Fig. 1) was made of a helix of insulated wire 2·5 centimetres in length, and 1·5 centimetres in diameter, suspended bifilarly within a stout wooden upright, which was made fast to a suitable base. A mirror was attached to the helix, which allowed its deflection to be read by a telescope and scale. The oscillations were damped by suspending from the under side of the helix a small copper plate, which was immersed in sulphuric acid. The length of the helix was carefully adjusted to be in the magnetic meridian. This could be easily tested by passing the instantaneous current through the helix; if no deflection occurred it was known to be in the proper position. The magnetising coil of the long rod LR was placed vertically, and before inserting the specimen, or beginning an experiment, a balancing coil C was so adjusted that no deflection of the magnetometer helix was caused when the full magnetising current was passing. At the end of the experiment the balancing coil served as a means of calibrating the magnetometer by passing a known continuous current through it.



No. 1. Magnetising Force.
No. 2. Magnetisation (in Phase).
No. 3. ,, (as taken).

Loss in Ergs per Cu. Cm.
As taken, 39620.
As corrected, 17280.

FIG. 3.—Experiment on Long Rod of Wires $\sqrt{C^2} = 2 \cdot 3025$ amp.

In Figs. 2 and 3 are shown results taken by this method from a rod 122·8 centimetres long made up of 40 No. 16 iron wires. The lag between the magnetising force and the resultant magnetisation, as caused by eddy currents is very plainly shown. In the results presented a correction is introduced by resolving the magnetising force in the direction of the resultant magnetisation, and subtracting from it the component of the eddy currents resolved in the same way. It is to be noticed that the corrected losses agree very closely with "static" hysteresis losses at corresponding magnetisations obtained by either the ballistic or magnetometer methods.

ELECTRICITY FOR CHEMICAL LABORATORIES.

The growing use of electricity in chemical operations, whether manufacturing, experimental, or purely analytical, has made it necessary to have some source of current in every laboratory devoted to technical research and to many others concerned with more conventional chemical operations. In a town where there is a regular supply, current can, of course, be laid on much as if it were to be used for lighting, although the facts that the normal pressure at which it is delivered, and that many electric lighting companies supply alternating currents, make the adoption of some special means for suiting the users' needs, occasionally necessary. Apart from this, however, there are many laboratories where no supply from without can be obtained, and the problem then arises how to find an efficient substitute which shall be neither unduly costly nor need excessive attention on the part of the user. Where power in any form is available it seems tolerably simple to put down a small dynamo; but this necessitates the use of accumulators, as it is but rarely that the ease and certainty with which any

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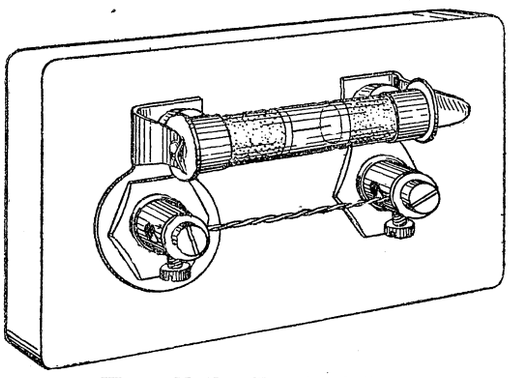
required pressure and output can be obtained by their means, can be dispensed with by a chemist whose needs may include the deposition of copper or nickel and the use of a miniature electric furnace on one and the same day. Primary batteries are not to be thought of, as they are either incurably messy and troublesome or they require such an enormous number of cells for a moderate output that their first cost and subsequent maintenance become serious items of expense. The thermo-electric battery has deservedly won a bad name for itself, because it has claimed to do too much, but used for its proper purpose, namely, to supply a small current for an indefinite time without attention, it has much to recommend it. By using it in conjunction with storage cells a fairly simple and practical generator can be provided which will satisfy most of the requirements of a modern chemical laboratory without adding appreciably to the work of the place, which is often fully as heavy as can be efficiently performed by its occupants. An arrangement of the kind has stood the test of experience in the laboratory at Freiburg, and is described in a recent number of the *Chemiker Zeitung* by Dr. Karl Elbs.

The following are the chief features of the plant. There are eight small accumulators, with a capacity of eight ampere hours apiece, and a Gülcher thermo-electric battery of 66 elements. The accumulators are divided into two groups of four, and can be coupled in series or parallel, as may be required. A resistance box with resistances of 2 ohms down to 0·1 ohm and a Gaugain galvanometer are provided, and a commutator by means of which the direction of the current can be reversed through the galvanometer without affecting the main circuit is also fitted. The thermo-electric battery is heated by gas, and needs no governor or thermostat, as the variation produced by fluctuation of the gas pressure is not large. Its mean voltage is 4·1, with an internal resistance of 0·68 ohm. When the gas pressure varies from 20 to 35 mm., these values vary from 3·8 and 0 65 to 4·3 and 0 75 respectively. Under ordinary circumstances, the current is practically constant, and for one hour the consumption of gas is only 170 to 180 litres, costing at Freiburg three pfennige. To get as good an output with primary batteries, either two large Bunsens in series, or 60 Meidingers coupled in four groups of 15 cells in parallel, would be requisite. The accumulators are of the German Post Office pattern, each cell containing one positive and two negative plates attached to a porcelain cover, and immersed in sulphuric acid of sp. gr. 1·15 contained in rectangular glass cells of a capacity of about a litre. Each cell gives a mean voltage of 2·05, the internal resistance is 0·05 ohm, and the maximum output 8 ampere hours, as stated above, with a maximum current of 3 amperes. The thermo-electric battery and the accumulators are generally used together, and by shifting the connections of the two groups of cells and of the members of those groups, arrangements for work of the most varied character can be made, care being, of course, taken that the current delivered by any one cell does not exceed 3 amperes. The accumulators are connected in parallel for charging, and each group can be charged separately or the two groups in parallel as may be more convenient. The complete charging of the accumulators can be effected in 30 hours, but the natural pauses of work general suffice to allow the thermo-electric battery to keep them fully charged, so that stoppage for the express purpose of recharging is rarely necessary. If the accumulators are kept clean they will retain their charge almost undiminished for months. The experience gained at Freiburg shows that no appreciable injury results from keeping the whole apparatus in the laboratory itself, exposed to what fumes may arise, while if a specially trying atmosphere is expected, the simple precaution of covering the whole with a cloth is a sufficient safeguard.

As far as can be seen the plan that has been described is a convenient one, and likely to be appreciated by all those who have had to put up with the malodorous nitric acid cell as a source of current. In these days when a big town has current supplied from central stations almost as a matter of course, one is apt to forget that all places are not equally favoured, and that the scientific or technical worker isolated by the exigencies of his position is a man and a brother after all, and deserves occasional consideration.

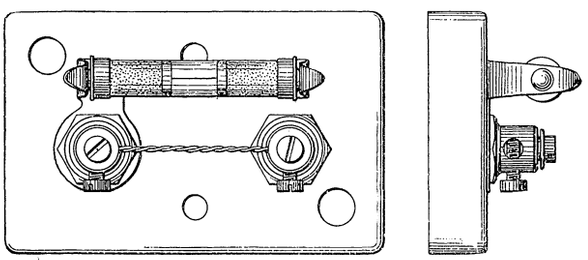
THE WATSON-MORDEY SHORT-BREAK FUSE.

The careful work that has been done on the practical and theoretical determination of the melting point of fuses is of little or no avail in the design of cut-outs for high voltages. When such a fuse "goes," the wire is wholly or partially volatilised, and an arc is easily formed across the metallic vapour. A three-foot break is not sufficient to prevent the formation of such an arc, and mechanical shutters to cut it off have been tried, but have given place to large porcelain blocks which enclose the long fuse wire, and appear to absorb the heat so quickly that an arc cannot be maintained. While convenient enough in an engine-room or transformer station, space cannot be found for such an arrangement in a boxed-in transformer.



Watson-Mordey Short-break Fuse.

At the last reception evening of the Institution of Civil Engineers, among various objects of interest exhibited by the Brush Electrical Engineering Company, we noticed some new cut-outs which have been designed for high voltages, but which are of very compact design, and well suited for placing inside the cases of even small transformers. The device consists of two fuses, one a simple fuse arranged to melt at a certain current, and the other a fine wire placed in shunt. The fine wire fuses



Front and Side Elevations of Watson-Mordey Short-break Fuse.

immediately after the main wire, but the arc is at once "killed" by the action of a non-conducting powder packed in a glass tube. The action is probably mechanical, splitting up the arc as the London police disperse an unauthorised street procession. Mr. Mordey informs us that he has never succeeded in forcing an arc through one of these tubes, and that he would be prepared to make them only one inch in length if worth while. The action of the shunt in preventing arcing at the main fuse has been severely tested. The shunting was proposed by Mr. Mordey in the discussion on Mr. Cockburn's paper in 1888. It is hardly necessary to add that the base of these cut-outs is of glazed earthenware, and that no metal parts are visible at the back.

Electric Lighting in Parliament.—The electric light has at last found its way into the House of Lords. At a quarter to 3 o'clock on Tuesday afternoon last the House was, for the first time in a public sitting, lighted by electricity. The ten clusters of Swan-Edison lamps suspended from the ceiling are said to be a very appreciable improvement upon the gas sunlights which they have superseded.

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THE SIMPLIFICATION OF THE QUADRUPLEX, AND THE IMPORTANCE OF ITS ACHIEVEMENT.*

BY D. H. KEELEY.

If there is any one thing more than another in the domain of practical telegraphy that hangs on the consideration of fine points, it is the successful operation of a quadruplex system, and to those who have had opportunity for inquiring into the philosophy of the thing, this fact is more than patent, inasmuch as it is found that a very serious difficulty exists where at the outset none whatever is apprehended. As a matter of fact, when the quadruplex was a novelty and not yet in extensive use, the text books were silent on the one vital, but seemingly unimportant, point to which the delay in developing the system was referable, and it was some time before the really difficult part of the problem was appreciated and understood by any excepting those immediately concerned in its conception. However, that time is past, and the student of to-day in consulting his text book will find the whole anatomy of the quadruplex laid bare, and the devices introduced to obviate the difficulty that is due to an *inherent d fect* are taken into account as an essential part of the whole. That, at any rate, is the point of view from which this paper is written; and its object is to show, in the first place, that in the established system of quadruplex telegraphy there is an inherent defect whose obviation has encumbered the fundamental principle with complex apparatus—thereby, from a theoretical standpoint at least, demonstrating its inadequacy; and, in the second place, to show how, by building upon a different but equally simple principle, the same practical results can be secured with much less machinery.

With this end in view, a little consideration can now be given to a comparison of the different principles involved, and, incidentally, the whereabouts and character of the inherent defect to which allusion has been made will be perceived, and the method proposed for its elimination understood.

For convenience of elucidation it will be well to start with the conception that a quadruplex is a combination of two duplexes. A duplex is a system in which the recorder at each end of the line is so arranged as to be unaffected by currents outgoing, while free to respond to currents incoming. In the quadruplex, therefore, the distant recorders respond to the home keys or transmitters, and the home recorders respond to the manipulation of the distant transmitters; the result of which is that a single conductor is made to afford four distinctive circuits. These circuits, however, are not precisely similar, because the constitution of a quadruplex is such that the duplex element cannot be lost sight of, and a system of this kind is, therefore, necessarily always regarded as having *two sides;* the apparatus on one side (one of the two duplexes) being operated by currents differing in polarity or in degree from those operating on the other side. The trouble has been to obviate not only the liability but the *possibility* of an interference of one side with the other.

The several methods of quadruplex telegraphy that have been invented are comprised in two general classes. (1) The *polar systems*, or those in which the receivers on the one side are actuated by increase and decrease of a normal current, and on the other side by reversals of that current, and (2) the *straight current systems*, or those in which the receivers are actuated by three different strengths of current of a given and unchanging polarity.

We can best consider them separately under distinctive headings, and assume a practicable type as embracing the whole in each instance.

The Polar Quadruplex.

It is the polar quadruplex that has found favour in practice; but it presents several undesirable features, and, excepting where dynamic currents are available, is expensive to maintain, in consequence of large batteries being required for its exclusive use.

According to this method, the signalling battery is arranged in two sections. One of the transmitters operates to put one or both of the sections to line; and the other transmitter operates to reverse the direction of the current. The receiving apparatus consists of polarised and neutral electro-magnets. The armature lever of the polarised instrument is normally held against its limiting stop by the − current of the smaller section of the battery, that traverses the line when both of the transmitting keys are at rest (upraised), and it remains in the same position when the key that puts the second section of the battery in circuit, is depressed; but it passes freely over to its front stop or signalling contact when the + current, from one or both sections of the battery, traverse the circuit: hence the polarised instrument responds to the manipulation of the reversing key. The armature of the neutral instrument is responsive to both − and + currents, but it is held back by a retractile spring exerting a greater force than the magnetic attraction due to the current from the smaller section of the battery. This latter can, therefore, be reversed repeatedly and continuously, thereby producing signals on the polarised receiver, without in any way affecting the neutral instrument. Whenever the increment key is depressed, however, the current from both sections of the battery traverses the circuit, the retractile force is insufficient to withstand the magnetic attraction imparted to the neutral receiver, and its armature passes over to its front stop or signalling contact; the neutral relay is thus responsive to the manipulation of the increment key.

So far the action appears to be smooth and satisfactory, and one might think he could go to work and set up his quadruplex; but he will discover, as did many an early investigator, that his knowledge is as yet incomplete. It will be found that while no effect is produced on the neutral relay by the changes of polarity of the smaller section of the battery, there is a marked interference when the current of both sections together is traversing the circuit. When the increment key is depressed the neutral receiver responds; if now, the reversing key is depressed, a short false signal will be produced on the neutral receiver. The reversal of the battery by the reversing key momentarily withdraws the current from the circuit, and in that brief interval the magnetic attraction of the neutral receiver drops sufficiently to allow its armature to fall back from its signalling contact.

Here, then, we have the inherent defect of the system clearly defined. It resides in this lack of continuity of current.

Divers devices—perhaps multitudinous is a better word to describe their number—have been worked out with a view to obviating this ill effect of the current reversals. Out of them all, the clever arrangements due to the ingenuity of Messrs. Gerritt Smith and F. L. Jones have been sifted and adopted in the standard quadruplex of the telegraph companies. There is not much to choose between these two devices; they are distinctive types, and have gone a long way to make the quadruplex what it is. Smith puts an extra coil on the neutral receiver core and connects it in circuit with a condenser shunting a considerable resistance. The current from both sections of the signalling battery charges the condenser, and the instant the current is withdrawn the condenser discharges through the shunted resistance and the extra coil on the neutral receiver, the magnetic attraction of which latter is thereby maintained. Jones substitutes an induction coal for the condenser; the secondary wire is in circuit with the extra coil on the receiver, and the primary is traversed by the current from both sections of the signalling battery; the instant the current is interrupted an induced current traverses the extra coil, and, as in the other case, retains the armature attracted.

Either of these devices necessitates the use of heavier currents than would be required for the mere production of signals on the receivers, because the condenser discharge and the induced wave have to impart nearly the same degree of magnetism as the transmitted current, so it is found that the coils traversed by the transmittted current in the standard quadruplex of to-day are not designed to produce a maximum magnetic effect, whereas the coils traversed by the seconday currents are designed to that end and wound to suit the high potential of the condenser and induction coil discharges.

It is seen now that the feature of heavy currents has been dragged into and made a necessary part of the standard quadruplex, in consequence of a defect that seemingly could not in any other way be surmounted.

Let us see whether this feature of heavy currents is attended with any considerable drawback.

In consequence of electricity being as a general thing now so plentiful and cheap, it might at first sight be considered immaterial, from an economical standpoint, whether heavy or light currents were used in the operation of the quadruplex; but we have to bear in mind that only a small percentage of the telegraph wires of this Continent are supplied by dynamos, and that, as regards the vast majority of cases, the customary galvanic battery is in use the world over, and its cost is just as great now as it was fifteen or twenty years ago. This fact, dealing with the quadruplex alone, is in itself worth looking at; but when we go further and consider the circumstance that in the course of operation of a polar quadruplex, the positions of the transmitting keys are at times such as to throw the entire current + from one end and − from the other into the line, whence it follows that the line becomes inordinately charged, and by induction would interfere with every other circuit running parallel with it were they not also supplied with otherwise unnecessarily large currents in order to obviate the ill effects occasioned in them—we can appreciate the very great importance of this question.

A few years ago, before the days of the quadruplex, our telegraph circuits were equipped with receivers designed to afford a maximum of magnetic attraction, and the necessity for anything like large currents did not exist. The ordinary run of the old relays measured in the neighbourhood of 300 ohms, and we could get good work out of them over long distances. To-day the ordinary run measures 150 ohms, and without going into calculations

* Paper read before the Canadian Society of Civil Engineers.

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we can see that on a given line the latter instrument will be less efficient than the former, and to make it answer our purpose an increased current must be supplied. So we have perforce reduced the sensitiveness of our apparatus and increased our currents; and this it appears is the only way we could keep pace with the quadruplex, for had the more sensitive instruments with comparatively weak currents been retained, the induction from the quadruplex circuits would have rendered the ordinary single circuits well nigh inoperative.

We see in all this, then, that the advances made in telegraphy, while admittedly very great from a practical standpoint, have been at the sacrifice of an economic and a scientific principle.

Is it now too late to rectify this error and to return to the old and economical practice that was departed from? Perhaps if an improvement in quadruplex apparatus, recently devised with a view to dispensing with the necessity of heavy currents, had been hit upon some twelve or fifteen years ago, this regrettable departure from the old practice might have been averted; and even now it might suggest the practicability of going back to first principles, if the advantages to be gained thereby were considered of sufficient importance to warrant the reversion.

The improvement refered to is in connection with, and might now be taken into consideration under the head of

The Straight Current Quadruplex.

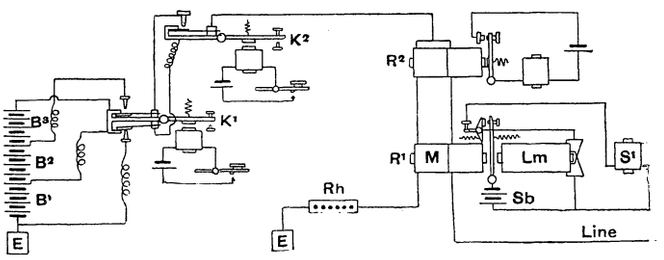
In this system the signals are produced, as has already been stated, by three different strengths of current of a given polarity. This method of transmission was for a long time the favourite hunting ground of inventors seeking a solution of the problem of sextuplex telegraphy. It appeared to be an easy matter to form a quadruplex on this plan, and add thereto the reversing key of the polar system and thus obtain as many as six circuits in a single conductor. It, however, came about in the long run that the formation of the quadruplex itself, according to this method, was extremely problematical. As a matter of fact, there never was a straight current quadruplex in practical operation. The difficulties that were presented in the way of its successful adoption have, however, been investigated in many quarters, and the invention, as a whole, has in the course of time been improved to an extent that warrants its now being characterised *the simplified and perfected system.*

That this simplified quadruplex is fairly calculated to fill the bill already outlined for the practicable operation of the general telegraphs on currents of much less power than are at present employed, will be recognised in view of the fact that the straight current quadruplex, as a system, presents none of the objectionable features of the polar system already pointed out. There are no reversals of the current to occasion disturbance in one of the receivers, so the necessity for extraordinarily large batteries for the operation of devices such as those described is done away with; and there is no need to charge the line beyond the voltage of the maximum current emanating from one end alone, because a system of this description is operative with either like or unlike poles to line, so there are no ill effects due to induction communicated to circuits adjacent to the line upon which this quadruplex may be in operation. The importance and value of the invention need not, perhaps, in view of these facts be further emphasised.

The straight current quadruplex in its simplest and perfected form is shown in the accompanying diagram. It will be noticed that the signalling battery is in one unbroken series, with its −pole to earth. The terminal and two top wires are connected with the transmitters, which operate to put the main line in connection with the battery at some one of the three points tapped according to the position of the transmitter levers, and in this way the requisite three strengths of current are presentable for the transmission of signals. The battery being in one unbroken series with one pole constantly to earth, is rendered available for the supply of current to other wires or circuits independent of the quadruplex; just as in the case where several Morse circuits are supplied from a single battery common to them all in one of the regular main offices. This is a feature of great advantage, as it obviates the necessity for separate and exclusive batteries for the operation of the quadruplex circuits. This arrangement of the battery and transmitters was supposed to have originated quite recently, along with a further improvement of the writer's to be described further on. But an examination of the files of the United States Patent Office disclosed the fact that its invention was anticipated, as far back as January, 1877, by Benjamin Thompson of Toledo, to whom it was patented (No. 195,055) in September of that year; and it is perhaps due to the unfortunate circumstance of its being covered in conjunction with an unwieldly and inadequate mass of receiving apparatus, that it never worked its way forward to the recognition that its merit deserves. As will be seen by an examination of the diagram, the transmitters are so connected that when both of the levers are upraised the line is to earth; when K^1 alone is depressed, the line connects with B^1; when K^2 alone is depressed, the line connects with B^3, and when both K^1 and K^2 are depressed, the line connects with B^2. It follows, therefore, that K^1 sends the minimum current to line; K^2 sends the maximum current to line; and when both keys together are in action, an intermediate strength of current goes to line. At the distant end there are two receivers. One of them is an ordinary duplex relay, R^2, connected in the usual way; a retractile spring holds its armature with a force superior to the magnetic effect of the minimum current, but it is responsive to the intermediate and maximum currents; R^2, therefore, freely and readily responds to the manipulation of the transmitter K^2. The other receiver comprises the distinctly unique feature that has raised the straight current quadruplex to its present perfection. Its contrivance is such that the sounder or recording instrument operating in its local circuit responds promptly and accurately to the manipulation of K^1, under the action of the minimum and intermediate currents, while the maximum current produces upon it absolutely no effect whatever. In this arrangement the sounder is operated directly by the armature lever contacts, and there is consequently no enfeeblement of the signals and no uncertainty whatever about its action. In consequence, the transmissions on both sides are equally rapid and reliable. For the information of those interested in the solution of the problem involved, a detailed explanation of the receiver R^1 is given in the accompanying note.

A test which the writer was enabled to make, in conjunction with Mr. H. Bott of Ottawa, on a line between this place and Toronto, nearly 300 miles long, showed that the apparatus would respond properly to currents (=·038 amp. max.) derived from batteries of 150 cells at each end of the line. On the selfsame line wire the standard polar quadruplex is regularly operated with currents (=·070 amp.) derived from batteries of 275 cells at each end of the line; which, under certain positions of the transmitting keys, produces in the circuit a current of (·070 × 2 =) ·140 amp. max. from the combination of the (275 × 2 =) 550 cells.

The comparison speaks for itself.



We have now arrived at the conclusion of this Paper. Its purpose has been to show that the practice of telegraphy to-day, despite the many advances that have been made in the service in one way and another, is not so scientific as we find it to have been so long as twenty years ago. An endeavour has been made to show that the development of the polar quadruplex, now so extensively used, has occasioned this departure from first principles, and how the now perfected straight current quadruplex would admit of a return thereto. And the question submitted for consideration is, Would it be worth while now to return to the original practice and continue in that good old way?

Note.

In the straight current quadruplex the receiver on one side responds to the stronger currents, and the receiver on the other side responds to the weaker currents. It is obviously an easy matter to prevent the former being interfered with by the currents intended for the latter side, as it is only a matter of adjustment of the retractile force on the armature lever. On the other hand, it is equally obvious that an electro-magnet cannot be constructed to respond to weak currents and at the same time be unaffected by strong ones. As, however, the signals are, in practice, always taken from a second instrument, operating on a local circuit of the receiver or relay, it is possible to so arrange the intervening mechanism that the local circuit shall be closed only when the currents designed therefor are traversing the magnet coils. In the construction of the instrument, therefore, a supplementary lever is hung in such a way as to hold the armature lever in an intermediate position, between its limiting stops, when attracted by the weaker currents. A strong current will attract the armature with sufficient force to carry it beyond the intermediate position, and when there is no current the armature lever falls back to its rear limiting stop. It then becomes only necessary to connect the local circuit in such a way that it shall be closed in the intermediate position of the lever, and open when the lever is in either of its extreme positions, in order to meet the requirements of the case. That, at least, was the assumption; but the idea proved impracticable, in consequence of a brief con-

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tact, completing the sounder circuit, that was found to obtain in the passage of the armature lever between its extreme limiting stops every time the strong current was applied or withdrawn. This difficulty has never been successfully dealt with until now. In the receiver R^1 an auxiliary electro-magnet, Lm, wound to produce a considerable counter E.M.F., is placed directly behind the relay armature, so as to act thereupon in opposition to the main circuit coils m. In the normal condition, with no current traversing m, the armature lever is held against its back stop by a light retractile spring in the usual way. When a weak current, say the minimum, traverses m, the armature lever is attracted to the intermediate position; this closes the circuits of Lm and S^1; the retractile power (that is, what the magnetic attraction in this case becomes) of Lm is delayed by its own counter E. M. F. until the attraction of m has grown sufficient to retain the armature in the position to which it was drawn, so the closed circuit of S^1 remains undisturbed. The same action attends the intermediate current; so S^1 responds to the minimum and intermediate currents. When the maximum current traverses m, the armature lever is carried from its intermediate position, and S^1 opens, but the circuit through Lm remains uninterrupted. If the current again decreases, the lever returns to its intermediate position, and S^1 closes; but if the maximum current is entirely withdrawn, the armature lever will, in consequence of the steady pull exerted on it by Lm be drawn sharply back to its rear limiting stop. And if, when the armature is resting in the latter position, the maximum current is applied to m, the armature lever will pass directly over to the front limiting stop, in consequence of the counter E M. F. of Lm robbing it of any retractile power during its passage across the contacts in the intermediate position. There is, therefore, no hindrance to the forward movement of the armature, and there is an acceleration of its movement rearward; hence the maximum current can be applied and withdrawn at pleasure, without in any way affecting the local circuit by which the sounder S^1 is operated.

EXPERIMENTAL RUNS WITH A BUDAPEST ELECTRIC CAR.*

One of the cases in which electric traction is applicable, while horse-power is out of the question, is that in which steep inclines have to be surmounted; and another case is that in which high speeds are required. Owing to the comparatively great weight of the electric car and its machinery the adhesion of the wheels to the rails is greater and should enable considerable inclines to be easily surmounted. In order to experiment on this subject a trial line was constructed, with inclines of 1 in 10 and 1 in 19, on which trial runs were made, which proved that even inclines of 1 in 10·42 can be easily surmounted, so that in very steep lines the difficulty of the brake would be greater than that of climbing the incline. The results of the tests are fully given in the table below:—

	No. of Experiment.			
	1	2	3	4
Weight of car.....(tons)	4·13	4·13	4·13	4·13
Load .....(tons)	2·40	2·40	0·37	0·37
Total weight of car...(tons)	6·53	6·53	4·50	4·50
No. of driven axles	2	1	2	2
Length of trip in yards ...	34·0	34·0	32·8	32·8
Incline	level	level	1 in 18·95	1 in 10·42
Time of trip in seconds ...	51	50	8	14
Speed, miles an hour	13·7	13·95	8·37	4·77
Revolutions per minute of motor	549	560	337	192
Volts	282·5	285	266	260
Amperes	26·0	24·5	54·0	68·0
Watts	7,345	6,982	14,364	17,680
El. energy used, E.H.P. ...	9·85	9·35	19·25	23·70
Tractive force, lbs. per ton				
On the horizontal	33·6	33·6	33·6	33·6
On the inclines.....	...	...	118·2	215
Total tractive force lbs.	33·6 × 6·53 = 219·0	219·0	(33·6 + 118·2) × 4·5 = 683·0	(33·6 + 215) × 4·5 = 1120·0
Mechanical horse-power ...	8·14	8·29	15·27	14·30
Efficiency— $\frac{\text{Mech. H.-P.}}{\text{El. H.-P.}} \times 100$	82·57%	88·62%	79·41%	60·37%
Losses by friction of gearing, &c., and conversion of energy	17·43%	11·38%	20·59%	39·63%

* From the *Zeitschrift für Elektrotechnik*.

All experiments were carried out at night, in order that the fluctuations of pressure due to the working of the line might be avoided. The car was always started outside the trial line proper. Every set of observations is the mean of a series. The car with which the experiments were conducted was an ordinary car of the Budapest Electric Tramway Company, with simple chain gearing of 11:31 from the motor to the axle. As the motor was not sufficiently strong to carry the fully loaded car up the steep inclines, the experiments on these parts of the road were done with a smaller load. The efficiency dropped while ascending the hill owing to the speed of the motor being so low.

These experiments go to show that the electric car is capable of working on lines where the steepness of the inclines would render horse traction out of the question.

THE REFRACTIVE INDEX OF ELECTRIC WAVES IN ALCOHOL.*

BY H. O. G. ELLINGER.

The refractive index was determined for alcohol of 96 per cent. strength. A preliminary investigation showed that alcohol was transparent to the waves. The alcohol was then placed in a prism-shaped vessel of wood, 1 metre high, 1·15 metre long, and having an angle of 8° 16′, holding 90 litres. In order to show the Hertz spark in the secondary reflector, the primary reflectors had to make an angle of 33deg. with one another. This gives an index of refraction for alcohol of about 4·9, a value which accords very fairly well with theory, as the specific inductive capacity (from an average of several observations) has a value which differs but little from $(4·9)^2$.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TO-DAY) FRIDAY, February 3rd.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. "Description of the Pumping Engines and Water-Softening Machinery at the Southampton Water Works," by William Matthews.

SOCIETY OF ARTS.

8 p.m. Howard Lecture (4): "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Theory and Practice in Electrical Science" (with experimental illustrations), by Alexander Siemens, M.Inst.C.E.

MONDAY, February 6th.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at Westminster Town Hall Presidential Address, by W. A. M. Valon.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture (2): "The Practical Measurement of Alternating Electrical Currents," by Dr. J. A. Fleming, F.R.S.

TUESDAY, February 7th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be further discussed: (1) "Smelting Processes for the Extraction of Silver and Gold from their Ores," by Henry F. Collins, A.R.S.M. (2) "The Erection of Silver-Lead Smelting Works in Mexico," by James W. Malcolmson, Wh.Cc. At this meeting the monthly ballot for members will be taken.

WEDNESDAY, February 8th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Some points in the Chemical Technology of Oil Boiling, with an account of a New Process for preparing Drying Oils for Decorators' and Artists' use." By Prof. W. Noel Hartley, F.R.S.

THURSDAY, February 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting "Experimental Researches on Alternate Current Transformers." Dr. Fleming's reply to the Discussion. Paper to be read: "Note on Testing Alternators." By W. M. Mordey.

FRIDAY, February 10th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting. After which the following Papers will be read: (1) "Recent Determinations of Molecular Refraction and Dispersion," by Dr. J. H. Gladstone, F.R.S.; (2) "The Separation and Striation of Gases," by E. C. C. Baly.

* Abstract from *Wied. Ann.*, No. 1, 1893, p. 108.

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THE PRESENT POSITION OF THE ALTERNATING MOTOR PROBLEM.

Of all the problems in electrical engineering which have taxed or are taxing the energies of some of our most fertile inventors and practical engineers, that which seems to be one of the longest in finding an effective solution is the alternating motor problem. It may, indeed, be said that some of those who have worked the hardest in this direction have abandoned the simple alternate-current motor as an impossibility, and this probably was the cause of the intensity of the *drehstrom* fever whilst it lasted. It is interesting to observe, therefore, that although there has been a subsidence of the feeling that the rotary-phase motor was the solution, not only of the alternate-current motor problem, but of all questions in power transmission and distribution, the latest addition to the already long list of single current motors comes from one of the high priests of multiphase currents. In our last issue we gave a description of a motor designed by Mr. C. E. L. BROWN, which, in reality, is not so much a new motor as a conglomeration of old motors, salted with the practical ingenuity which Mr. BROWN has so usefully displayed in this class of machinery. At this time, therefore, when renewed interest centres round the alternating motor, it may be well to consider how far we have got in the ten years, or thereabouts, that have elapsed since a motor capable of working with alternating currents first was wanted.

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The original idea was that any motor would work with alternating currents if only both field-magnets and armature were laminated; but it was soon found that the output was almost *nil*, and that the current in the armature coils under the brushes, were like short-circuited secondaries on a transformer, and gave rise to considerable heating and sparking. Then came Dr. HOPKINSON with his historical lecture at the Institution of Civil Engineers in 1883, in which he showed that an ordinary alternating dynamo would run as a motor synchronously with the generating dynamo. After this ELIHU THOMSON struck a new vein in a motor, in which the alternations of magnetism in the magnetic circuit, set up by a primary or magnetising current, gave rise to currents in the rotating armature, which, normally symmetrical to the magnetic axis, were placed in an unsymmetrical position by various devices, so as to produce a rotary effort. Now, as an evolutionary process the TESLA motor and all multiphase motors would follow from this as particular devices for producing an induction current in a rotating coil unsymmetrical to a magnetic axis, and the motor of Mr. BROWN, just referred to, is another particular case of this class of motor. The TESLA motor, which was brought forward in 1887, was an independent creation, and for a time was thought to be *the* solution of the question. Next, after being enveloped in mystery for some months, the GANZ alternating motor was described, and turned out to be a synchronous motor, which, by a commutating device for rectifying the magnetising current of the field magnets, was made self-starting, and was asynchonous within certain limits without losing its rotary effort. Since this time no real novelty of principle in alternating motors has been developed. What has taken place has been to improve, combine, and adapt for specific purposes.

How then, at the present time, does the question of adapting alternating motors for specific purposes stand? There may be said to be two distinct problems: (1) Transmission of power; (2) Distribution of power. For the first, on a large scale, the question of whether the motor will start itself, or must be started by an independent apparatus, such as a group of secondary batteries charged from the exciter, and in turn operating the exciter as a motor, is not of vital importance, and for this class of work the synchronous alternating motor has proved itself very effective, simple, and of high plant efficiency. For this purpose also the three circuit multiphase motor has shown itself admirably adapted. For transmission work motors only need to be able to carry an overload to the extent of, say, 50 per cent. without stopping or appreciably slowing, to effect all that is needed, whilst the absence of commutators, and the possibility of transforming up and down to and from the line makes them applicable to any voltage that insulating materials will stand. The transmission problem, in fact, has met with two very satisfactory solutions.

When, however, we come to distribution of power, we are met with quite another condition of affairs. The requirements are absolutely different. No motor (steam, gas, hydraulic) meets the requirements of power distribution as does the direct current electric motor; if only we could do away with the commutator. This, which in properly attended machinery on a large scale gives with moderate voltage no practical trouble, is the bane of the electric motor. No alternating motor with a commutator can be considered a solution of the problem of power distribution, it is merely a motor which can be applied to an alternate-current supply system. The multiphase motor, of course, gets over the difficulty, but multiphase electric distribution is already seen to be almost too complicated to become the solution of the problem. Hence we are brought back to the single current alternating motor, commutatorless and asynchronous. Does such exist? There is little doubt that the motor described by Mr. BROWN, and illustrated in Figs. 7, 8, 9 of the article in our last issue, is the nearest approach to this ideal so far developed. It is commutatorless, it works normally with a single alternate current, it will start with a torque double of the working torque, by a simple and *commutatorless* arrangement of double winding the speed within certain limits can be varied, and the plant efficiency is high. Whether this solution is a final one remains to be seen, but all indications at present point to the induction motor first invented by ELIHU THOMSON as the motor of the future. What device will be adopted to produce the unsymmetrical position of the active motor coil remains to be seen. The short circuiting devices of ELIHU THOMSON acting by only closing the circuit of an unsymmetrical coil, is only the commutator in probably a worse form. The multiple-phase method producing a magnetic axis unsymmetrical (considering any one coil) with the axis in which the inducing magnetism acts, is complicated. The arrangement of Mr. BROWN depending on the rotation of the coil itself into any unsymmetrical position, after the magnetic induction has acted, is certainly simple, and, at all events, opens up a new branch.

THE CAMBRIDGE UNIVERSITY ENGINEERING LABORATORY.

A general committee, consisting of a remarkable collection of able and distinguished men, has been formed to appeal for financial help in carrying out the equipment of an Engineering Laboratory at Cambridge. It is noteworthy that the preliminary subscription list, as well as the committee list, contain a number of names of non-university men.

Nearly two years ago a Report was communicated to the University of Cambridge on a proposed Engineering Laboratory, and we called attention to it in these columns with nothing but the best wishes. There was then no hint, or none that we detected at the time, of an engineering Tripos, and with a slight reservation on the score of the attempts which are made at certain establishments to turn out ready-made engineers, though indeed this was distinctly discountenanced in the Report, we unhesitatingly welcomed the proposal. A little more than a year later an engineering Tripos was advocated, and this departure we as unhesitatingly deplored; it is as much at variance with the spirit of the older Universities as indeed it is with that of the Laboratory Report. Of the four acknowledged objects of the Laboratory—that it makes the student's knowledge of mechanical principles more real by bringing him into contact with material examples; that it gives him practice in those kinds of experimental work which he may afterwards have to perform in professional life; that it teaches him how investigations are to be conducted, and gives him some experience in this higher work; and, lastly, that it endeavours to contribute to the common store of knowledge by affording opportunities and appliances for original research—the second alone suggests the utilitarian *Brod-Wissenschaft*, and points to the danger, as Lord PLAYFAIR recently put it, of the degeneration of the University into a bread-and-butter institution. The same authority quotes from EPICTETUS that though sheep eat grass, it is not grass, but wool, which grows on their backs; and while it was said at first that neither the workshops nor the laboratory at Cambridge attempted "to supersede the practical training which a pupil must receive in the office of an engineer, or in engineering works," it seems necessary to

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remind students, at all events, that though engineers must assimilate mechanical science, it is not engineers, but men capable of becoming engineers, that a University laboratory, or even a Tripos, can produce. Lord Justice BOWEN said on a recent occasion that to teach the rising generation how to snatch greedily at mental improvement, with the sole purpose of disposing afterwards at a profit of what they learn, is to narrow and injure education; and, quoting from PLATO, he added, "the sort of instruction which aims at the acquisition of wealth or of mere cleverness is illiberal and mean, and unworthy of the name of education."

With these reservations, which we feel to be necessary when one of the older Universities thus stoops to compete with technical colleges, we continue to wish every success to the Engineering Laboratory at Cambridge, and feel sure that in the mathematical atmosphere of the place, under the warm influences of the ardour of research and genial financial showers, the dry problems of inextensible cords on frictionless pulleys will ripen into life, and fruits comparable with those of the other Cambridge laboratories will be brought forth in due season. In his introductory lecture delivered at Cambridge two years ago, in concluding a review of the engineering laboratories of this country, Prof. EWING said that the services rendered by Prof. KENNEDY at University College would not soon be forgotten. "He found the engineering laboratory no more than a means of private research. He left it an instrument of education." After our rather coldly critical attitude towards the teaching of engineering at Cambridge, we gladly congratulate Prof. EWING on his views of the object of a laboratory. It has been suggested, nay even urged, that a professorial chair is of so little pecuniary value in itself that the use of a well equipped private laboratory is but a fair reward or bait whereby the services of an able professor may be retained. There seems little fear that Prof. EWING will regard his laboratory in this light, and we repeat the hope, which we expressed on a former occasion, that it may find some generous benefactor as did the Cavendish Laboratory in the Duke of DEVONSHIRE.

THE FORTHCOMING INTERNATIONAL ELECTRICAL CONGRESS AT CHICAGO.

The following is an abstract of the report of the Sub-Committee appointed by the American Institute of Electrical Engineers, to consider a provisional programme for the International Electrical Congress of 1893. The Sub-Committee consisted of Prof. W. A. Anthony and Messrs. Carl Hering and A. E. Kennelly.

To begin with, the Sub-Committee recommends the ratification of the units, terms, symbols, and definitions adopted by previous International Electrical Congresses, as a mere matter of form and an act of courtesy to preceding Congresses.

New Units.

The Sub-Committee is aware that objections are raised by some to the establishment of units not already in universal use. Past experience, however, has, they state, shown that the proper time to establish units is *before* their need is universally felt, in order to avoid the introduction by different persons or nations of units of different values, a contingency very likely to arise if not anticipated by concerted action.

The following recommendations are made:—

The value of the practical unit of magneto-motive force to be one-tenth of the absolute unit, that is, equal to $1/4\ \pi$ ampere turn. The value of the practical unit of magnetic flux to be 10^8 absolute units or lines. The value of the practical unit of magnetic intensity to be 10^8 absolute units, that is, 10^8 lines per square centimetre. The value of the practical unit of reluctance to be 10^{-9} absolute units. The value of the practical unit of electrical conductivity to be 10^{-9} absolute units, that is, the reciprocal of the ohm. The value of the practical unit of illumination to be a bougie-decimale at the distance of one metre.

It having been announced that a proposition will be made at the Congress to change the values of some of the practical units which have been adopted by previous Congresses and are already in universal use, among these being the ampere and the farad, it is urgently recommended that such changes should not be favoured, since they would necessarily be followed by great confusion, and would of necessity have to be accompanied by some change in these well established names in order to distinguish the new units from those now existing.

Names for Units.

The following new names are suggested:—

For the practical unit of magneto-motive force, the name "gilbert." For the practical unit for magnetic flux, the name "weber." For the practical unit of magnetic intensity, the name "gauss." For the practical unit of magnetic reluctance, the name "oersted." For the practical unit of inductance, the name "henry." For the practical unit of electrical conductivity, the name "mho. For the practical unit of illumination, the name "bougie-metre."

It has been suggested to name the units "kilowatt-hour" and "ampere-hour." The Committee, however, recommends that inasmuch as these terms explain themselves, and are not longer than some others in use, to give them special names would burden a system of nomenclature unnecessarily.

Concrete Standards.

The ampere and ohm and volt are defined in the same terms as in the recent Report of the Board of Trade Electrical Standards Committee (see *The Electrician*, December 9, 1892, page 152).

In order to create as little confusion as possible by the introduction of the set of units which are to become the universal standards, and in order to distinguish them readily from the true theoretical or abstract units defined in terms of the absolute units, it is recommended to call the former simply "amperes," "ohms," "volts," &c., or more specifically "standard amperes," "standard ohms," &c., and to call the theoretical units, "true amperes," "true ohms," &c.

The standard candle, it is recommended, shall be taken as equal to the light from a lamp like that known as the Hefner-Alteneck standard amyl acetate lamp, which is to be defined by its dimensions and the height of the flame. The Sub-Committee recommends that no action be taken by the Congress in the matter of a universal wire gauge.

Notation and Symbols.

The system suggested to the last Congress by M. Hospitalier is recommended.

Definitions.

The following definitions are suggested:—

The impressed electromotive force is the ratio of the total activity in an electrically conducting circuit to its instantaneous current-strength.

The inductivity at any point in an isotropic medium is the ratio, added to unity, of $4\ \pi$ times the intensity of magnetisation there existing, to the magnetising flux-density. Inductivity is synonymous with "permeability." The electro-magnetic dimensional formula is $L^\circ\ M^\circ\ T^\circ$; the conventional symbol is μ.

Inductance.—(*a*) Self inductance is the ratio of the total magnetic induction linked with and established by an electric current to the uniform strength of the same. The inductance of a conducting circuit is constant when its environing medium has constant inductivity. (*b*) The mutual inductance of one electric circuit upon another is the ratio of the total magnetic induction linked with the second, due to a uniform current in the first, to the strength of that current. The mutual inductance between two electric circuits is reciprocally equal when the environing medium has constant inductivity. The electro-magnetic dimensional formula is $L^1\ M^\circ\ T^\circ$. The absolute unit is one centimetre; the practical unit, one "henry."

The reluctivity of a medium at any point is the volume differential of the reluctance thereat. Simple definition: Reluctivity is the reluctance per unit volume. The electro-magnetic dimensional formula is $L^\circ\ M^\circ\ T^\circ$. The absolute unit is one C.G.S. unit of reluctance per cubic centimetre; the proposed practical unit is the same or about one "oersted" per cubic earth quadrant.

The resistance of copper known as Matthiessen's standard shall be defined as follows:—The resistance of a soft copper wire one metre long, weighing one gramme, is 0·14365 B.A. units at 0° C.

The north pole of a magnet to be defined as being that which seeks the geographic north pole, and the south pole that which seeks the geographic south pole.

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Expressions.

The Sub-Committee also suggest the adoption of the following expressions: "simple" alternating current for the usual alternating currents in which there is practically but a single phase; "di-phase" alternating currents for two alternating currents whose phases differ in time by 90 or 270deg.; "tri-phase" alternating currents for three alternating currents whose phases differ in time by 60 or 120deg.; "poly-phase alternating currents for such as have more than three phases.

Universal Use.

The more universal use is recommended of the term "voltage" as synonymous with "difference of electrical potential" or P.D., in place of the terms "potential," "tension," or "pressure," the use of which in this sense it is recommended to abandon; of "transformer" instead of "converter"; of "dynamotor" for a continuous current transformer; of "continuous current" instead of "direct current"; of "kilowatt" instead of "horse-power"; of the metric system of weights and measures.

Programme.

Regarding the programme for carrying out the work, it cannot be too strongly urged, the report states, that an International Congress is the place to close, but not to open a discussion on questions about which international agreement is to be had; it is therefore urgently recommended that action be taken at once to open the discussion of such matters now, in order that expressions of opinions, and, if possible, agreements, may be arrived at prior to the meeting of the Congress. To this end the Committee recommends that the suggestions embodied in the report be printed and sent to all the leading electrical and physical societies and journals in America and abroad, with a request that they aid this work by making them public, by freely discussing them, and by sending copies of such discussions and any further suggestions to the General Congress Committee of the Institute, care of the Secretary, 12, West Thirty First-street, New York City. It is suggested that a sub-committee of the Institute should prepare from time to time a classified summary of such discussions and send them to the leading electrical and physical journals for publication and present a final summary of this international discussion at the Congress. It is recommended also that the Institute should invite other societies to co-operate with it by appointing special committees to discuss and report to their respective societies on these international questions and to publish their conclusions in the electrical journals of their country.

Meetings.

Regarding the meetings of the Congress, it is recommended that, as in the Paris Congress of 1889, the meetings be divided into (*a*) *General Meetings*, one at the opening and one at the closing of the Congress, to be devoted to the consideration of general questions and those on which agreements are desired, and to the reading of papers of a general character; (b) *Sectional Meetings* for the reading of all other papers.

Papers.

It is suggested that specific invitations be extended by the Congress Auxiliary to prominent electrical engineers and physicists to prepare papers on specified subjects to be read and discussed at the Congress meetings. Also that a general invitation be extended for other papers, which are to be submitted, not later than July 15, 1893, to a committee on papers appointed by the Chairman of the Congress Auxiliary. The Committee suggests that papers should be solicited by the General Congress Committee of the Institute on the work of the early electricians of America and other countries, considered from a modern standpoint, and their importance in the development of the science of electricity, including descriptions and illustrations of models and apparatus used.

Membership.

It is suggested, in conclusion, that the membership of the Congress be divided into delegated members and members; that the fees for each shall be $5; that only delegated members and members be admitted to the meetings, and be permitted to take part in the discussions; that anyone shall be entitled to become a member; that delegated members shall be appointed by governments, physical and electrical societies, and shall be approved by an international committee, whose decision shall be final; that questions on which international agreement is desired by the delegated members, whose decisions shall be submitted to the whole Congress for approval or rejection in part or in whole, but not for alteration.

INSTITUTION OF ELECTRICAL ENGINEERS.*

MR. PREECE'S PRESIDENTIAL ADDRESS.

Telegraphy.

The instrument that we have principally developed in England is the automatic fast-speed apparatus, based on a principle of preparing messages for transmission by punching, devised by Alexander Bain in 1848, and improved in its mechanical details by Mr. Augustus Ströh in 1866. This has been my special pet, and with the electrical assistance of Mr. J. B. Chapman, and the mechanical skill of Mr. J. W. Willmot, all the ills that telegraphs are heir to have been routed, and the practical speed of working has been multiplied more than six-fold. We have, step by step, won all along the line: 75 words per minute have become 500; a possible 130 has become an actual 600. Duplex automatic working over cable lines is possible, and modes of working have been introduced that were thought at one time chimerical and impossible. All these things have been done without recourse to the Patent Office. The Hughes typewriter has this year been successfully duplexed between London and the Continent, a problem which had hitherto baffled all attempts at a satisfactory solution.

One of the arguments used against the proposed transfer of the telegraphs to the State was the notion that invention would not be fostered by a Government department. This has been entirely falsified. Telegraphy has been advanced in this country more rapidly by the British Post Office than by any private undertaking, and we have certainly shot ahead of our smart cousins on the other side of the Atlantic, from whom, however, I am proud to say, I learnt so much on my visits in 1877 and 1884. An accident in the drafting of the Act of Parliament of 1868-69 transferring the telegraphs from the hands of private companies to that of the State, has led to a tremendous development of newspaper reporting in England. Few people are aware of the immense business done for the Press. When Mr. Gladstone spoke at Newcastle, at the National Liberal Federation, in 1891, 390,778 words were signalled to different parts of the country. The news transmitted is chiefly commercial and financial, amounting to 2,775,000 words per day. We public servants rely on public criticism, andour sole object is to serve our masters, with a conscientious determination to do our duty to the best of our ability.

Submarine Telegraphy.

The growth of submarine cables about the world is extraordinary. The total mileage, which in 1852 was 87 nautical miles (nauts), now reaches a total of 139,594 nauts, of which 14,479 nauts belong to various Government administrations. Between this country and the Continent all the cables (with the exception of those to Norway, those to Spain, and those forming the connections with the Eastern Telegraph Company's system) now belong to the respective Government administrations, and are all maintained by them. The British Post Office owns and maintains those to Holland and one of those to Germany, while those to Belgium and France, containing 37 wires, are joint property, but maintained by the British Post Office.

Next to strong tides, rocky bottoms, anchors, and shallow water, the greatest enemy to submarine cables, more especially in the tropics, has proved to be the teredo of various species; but this depredatory worm has been utterly routed by covering the gutta-percha core with a lapping of thin brass tape laid on spirally. A remarkable thing about this little insect is that, whereas 20 years ago it was practically unknown in our English waters, it has now gradually spread all round our coasts, with the exception, perhaps, of the North Sea. A new cable about to connect Scotland and Ireland is being served with brass tape. Perhaps the most remarkable history of a cable is the following:—In 1859 the light cables laid in 1853 from Orfordness to Holland were picked up and replaced by a heavier one. A few nauts were sold to the Isle of Man Telegraph Company, and had an extra sheath laid on. This cable was submerged between that island and St. Bees, where it remained until 1885, when it was replaced by a three-core cable. It was again put under water in 1886 as part of the cable between Uist and Harris, in the Hebrides, where it still lies, as good as ever. The durability of submarine cables is remarkable. That laid between Beachy Head and Dieppe in 1861 is still working, and

* Abstract of an address delivered January 26, 1893.

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that laid between Beachy Head and Havre in 1870 has broken within the last month for the *first* time.

Lightning Protection.

There is no more perfect apparatus in existence than the lightning protector. In 1892 not one single accident was recorded to any high-class telegraph instrument in the whole of the United Kingdom.

Railway Signalling.

The enormous development of electrical engineering upon our railways is shown by the following return from one system only :—

Midland Railway Telegraph Plant, December 31st, 1892.

Approximate.

S.N. block instruments	4,350
Block bells	2,645
Signal repeaters	2,500
Light repeaters	640
Message instruments	1,736
Instruments of other kinds	3,108
	14,979
Mileage of wire for block	5,712
„ „ other purposes*	5,582
	10,294

* Exclusive of P.O. wires.

Telephony.

The demand for communication between distant places has necessitated the application of much special attention to the method of constructing lines and of arranging circuits. It is in this latter field that I have been a diligent worker, and the application of the so-called "K R" law has proved of material benefit in connection with the problems of long-distance telephony. It is a law which implies that the number of signals that can be transmitted per second through any circuit depends solely on the capacity (K) and the resistance (R) of the circuit. It is very much the fashion to deny the accuracy of the K R law. This is probably the result of ignorance of its meaning or of its interpretation. Some speak of it as empirical, others scoff at it as imaginary, and some sneer at it as an impossible law ; but it is a law that has determined the dimensions and speed of working of all our long submarine cables ; it determines the number of arms a circuit can carry on the multiplex system, the speed attainable with the Wheatstone system, and the distance to which it is possible to work quadruplex ; it is a law that has enabled us to bring London and Paris within clear telephone speech of each other, and which will probably before the year is out enable Dublin and Belfast to speak to London—a message of peace to Ireland as solid and substantial as any promised political proposal. The New York and Chicago trunk line is 950 miles long, and it is built with 435lb. (or No. 8 S.W.G.) copper wire. This wire gives a resistance of 2·06 ohms per mile, which is easily verified ; but it is said by Mr. Wetzler to have a capacity of 0·0158 microfarad per mile, which cannot be verified, and which is absurdly high. 0·0158 microfarad was a measurement made by me in England on an old line, but I have frequently pointed out that owing to the use of earth wires the capacity of our English lines is very much greater than that of American lines. Mr. Edison discovered this in 1872 when he came to England to introduce his automatic system. Moreover, I have also pointed out that induction still further diminishes this capacity. The Paris circuit does not exceed 0·005 microfarad per mile. I should estimate the Chicago circuit at 0·004 microfarad per mile, and the K R at 7,500, which gives a result that quite accords with the opinions that I have heard expressed by those who have tried the two circuits as to the relative efficiency of the Paris and Chicago lines. My American friends would have done better if they had used thicker wire. I should have specified 600lbs. per mile ; but if it had been in England I should have used 1,000lbs., for we cannot dispense entirely with cables and underground work as they have done in the States, and the increased capacity introduced must be compensated for by reduced resistance. As a matter of fact, I once proposed 1,200lbs. wire for a circuit between London and Berlin—a distance of 760 miles, including a cable 55 miles long.

The beneficial effect of induction as a negative capacity is observed when working a circuit telegraphically with automatic high-speed apparatus. Thus, on two copper wires 450 miles long, making 900 miles altogether, the speed on each single wire was 120 words per minute, and on metallic circuit—

Loop *viâ* different routes.....120 words per minute.
„ on same poles.....150 „ „

So that the improvement effected by induction was 25 per cent.

There is no difficulty in measuring R of a metallic loop. The Wheatstone bridge determines it at once. There is more difficulty in obtaining K. It cannot be measured directly. But with a metallic loop of copper, partly overhead and partly underground, there are several modifications required, due to electrostatic and electro-magnetic induction, which are at present beyond the reach of formulæ, and render it difficult to determine the capacity except approximately from the telephonic effects themselves. Thus the capacity on the London-Paris circuit proved to be only one-half of that obtained by calculation, and every long circuit will require its own K to be determined by comparison with an empirical K R scale. Such a scale I have determined by careful experiment on artificial cables. I have recently devised a new form of cable, which will probably quadruple the rate of telegraph working to America ; and I may say with all confidence that there is no theoretical reason whatever why we should not converse between London and every capital in Europe, while it is not impossible to speak even across the Atlantic.

Electro-Chemical Industry.

The electro-chemical industry is, financially, one of the most important in this country. Electro-plating was started by Elkington at Birmingham in 1840. There are now about 170 electro-platers in Sheffield, and over 100 in Birmingham. Christophle, of Paris, deposits annually six tons of silver. An interesting process, by which phosphorus was separated from corundrum, a mineral phosphate, by the dissociating effect of the terrific heat of the electric arc, was developed by Readman, Parker, and Robinson, at Wednesfield, near Wolverhampton ; but though the right to use this mode of producing phosphorus was purchased at a very high figure by those who have the monopoly of that business, it does not appear that it has been put to practical use at present.

Electric Lighting

The cost of wiring is a great deterrent to the introduction of the electric light into small tenements and into houses held on short tenures. The materials used must be of the most perfect kind, otherwise insecurity is incurred ; but there are expensive practices of wood casing and of ornamentation which want reform. The Cheap Jack is the curse of the industry, and the absence of specification and of inspection the danger of the user. The early pioneer alternate-current systems, which have done so much to further the development of electric lighting, were, however, costly in their coal bills, owing to great losses of energy in their iron and copper ; but the transformer of the present day is as perfect in efficiency as the dynamo. These losses have practically disappeared, and modes of switching transformers in and out at will have removed every difference of cost between high pressure and low pressure systems. The prejudice against high pressure is still strong, but time and experience will eradicate it as they ultimately eradicate every fallacy. The prejudices against high-pressure steam and against high speed on railways were once equally strong ; but those prejudices survive only as "bees in the bonnets" of a few.

If a full load could be maintained during the whole 24 hours, electrical energy could be manufactured for one-third of a penny per supply unit, and this is equivalent to gas at 2d. per 1,000 cubic feet. The potentiality of economy in electric lighting is thus beyond the dreams of the gasman.

Water power abolishes the coal bill, but it must be remembered that the cost of maintenance of machinery and of the erection and upkeep of conductors limits the distance to which the energy of falling water can be economically transmitted. The proposal to light New York by currents generated at Niagara is at present financially absurd. It is doubtful whether it will be commercially advantageous at Buffalo, 30 miles away, but it is certain that at Tivoli it can be so applied with advantage and profit.

Electric Traction.

The use of electrical energy for working railways is making gigantic progress in the United States, and has commenced to make a serious move in the United Kingdom. The City and South London Electric Railway has proved a decided success, and next week will record the opening of a still larger enterprise on the elevated railway of the Mersey Docks in Liverpool. When last I visited America, in 1884, there was only one electric railway in work, and that was in Cleveland. One company alone, the General Electric Company of the United States, working the Thomson-Houston and Edison systems, has now—

Road in contract and under operation	440
Cars	8,856
Miles of line in operation	4,628

Thus the average length of electric railway is 10·5 miles, and the average number of motor cars in use about two per mile. The power used is over 100,000 H.P. Speeds of 40 miles an hour are sometimes obtained in the open country, but in the crowded streets this rate is much reduced. All these railways are worked with overhead conductors, by what are known as trolley lines. Such a line is at work in Leeds, and the South Staffordshire tramways have just started the same practice. Considerable experiments have been made to work tramcars by accumulators carried on the

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car. They have met not with much success, owing to the cost of renewals. The Birmingham Central Tramways are, however, persevering in this direction, and they are now giving an extensive trial to a new form of accumulator—the Epstein—the proprietors of which have adopted the novel plan of undertaking to renew the accumulators at the rate of 1½d. per car mile.

Theory.

In the Presidential address which I delivered to the Society of Telegraph Engineers and Electricians in 1880, I took the opportunity to formulate the theoretical views of electricity that I had acquired at the feet of Faraday. It is not given to every boy to have his great ambitions realised. One of my ambitions as an earnest listener to Faraday's simple and delightful lectures was to be his assistant, and in almost the last investigation he undertook on electric induction in underground wires it was my privilege to see much of him, and to prepare many experiments for him. Early in 1854, at his wish, I carried out for Mr. Latimer Clark certain experiments on the comparative effect of increments of voltage in increasing the rate of transmission of signals through long telegraph circuits. It was found that variation of voltage had no effect. Currents from 31 and from 500 cells sent through 768 miles of gutta-percha-covered underground wire showed precisely the same velocity. These experiments were sent by Faraday to Melloni, who had prompted the wish, and Melloni ("Faraday's Researches," Vol. III., p. 577) remarked: "The equal velocity of currents of various tensions offers a fine argument in favour of the opinion of those who suppose the electric current to be analagous to the vibrations of air under the action of sonorous bodies." This is to be found in the very last contribution inserted in the greatest work ever published on our science, "Faraday's Experimental Researches in Electricity." Faraday's views were subsequently expounded and extended by Maxwell, who said: "Faraday, in his mind's eye, saw lines of force traversing all space, where the mathematician saw centres of force attracting at a distance; Faraday saw a medium where they saw nothing but distance; Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids" (Maxwell, "Electricity," Vol. I., p. 10). Since that period I have never regarded electricity as anything else but as a form of energy, and its effects as modes of motion of the molecules of matter and of the ether that fills all space; and during my long apprenticeship of 40 years I have never examined one experiment or considered one fact that was not explicable on this theory.

It must be distinctly understood that I apply the term *electricity* to that form of energy which we as engineers utilise in the service of man. I do not apply it, as some physicists do, to a mere imaginary factor of this energy, sometimes called "quantity," and even honoured with a unit—the *coulomb*. I use it in the same sense that we use the terms *light*, *heat*, and *sound*, which are universally acknowledged to be forms of energy. In my address as President of the Mechanical Section of the British Association at Bath in 1888, I pointed out the great confusion that arose from this misapplication of terms, and I suggested that the disturbing factor—the vague subjective unreality of the physicist—might be called by some other term. I now go further, and suggest that the term be abolished altogether. We can do without it. It is not wanted. We have excluded the coulomb from our new legal system of C.G.S. units.

It is a misfortune that a beautiful hypothesis like Maxwell's electro-magnetic theory of light has been discussed almost solely by mathematicians. Its consideration has been confined to a small and exclusive class. It has not reached the public; and this is to be regretted, for after all it is the many, and not the few, that determine the acceptance or refusal of a theory. The existence of the ether is now thoroughly comprehensible. Light is now regarded as an electro-magnetic disturbance. The eye is an extremely sensitive and delicate electro-magnetic instrument. The difference between luminous, thermic, and electro-magnetic waves is one of frequency and form. We thus have to consider the propagation of these waves, not only in the conductor and in the dielectric in the direction of the circuit itself, but in the ether at right angles to this direction. The former produces currents in the conductor, and the latter induction and secondary effects in contiguous conductors. Thus it is easy to see why electric and magnetic lines of force are at right angles to each other, and each of them perpendicular to the line of propagation of the primary electro-magnetic wave, and why the transversal disturbances are secondary waves of electro-magnetic energy which can be transformed into electric currents of opposite direction whenever contiguous conductors lie in their path so as to be cut by these lines of force in the proper direction. Induction is thus mere transformation of energy whose direction and magnitude are easily calculated.

It is by following out this line of thought that I have recently succeeded in sending messages by Morse signals across the Bristol Channel between Lavernock and Flat Holm, a distance of 3·1 miles. The electro-magnetic disturbances were excited by primary alternating currents in a copper wire, 1,237 yards long, erected on poles along the top of the cliff on the mainland. The radiant electro-magnetic energy was transformed into currents again in a secondary circuit, 610 yards long, laid along the island. The strength of these secondary induced currents complied almost exactly with calculations. The results attained, the apparatus used, the precautions taken to separate effects of induction from effects of conduction; the elimination of mere earth currents from electro-magnetic disturbances in air, will form the subject of a separate Paper, for their proper consideration would be too tedious for an address. I allude to them now only to illustrate the existence of one of the greatest proofs of the truth of a theory, viz., the practical development and verification of a conclusion predicted from mere theoretical considerations.

The advance of our knowledge in this branch of electrical development has been very much retarded by the phantasies of visionary mathematicians who monopolise the columns of our technical literature and fill the mind of the student with false conclusions. I have no sympathy with the pure mathematician who scorns the practical man, scoffs at his experience, directs the universe from his couch, and invents laws to suit his fads. The American, in his quaint, humorous way, said, "Theory without practice is absolutely a worthless commodity; practice without theory is worth about 15 dollars a week; but when both are well combined in one man of sound judgment, the combination is worth up to 10,000 dollars a year."

My sympathies are with the earnest worker who asks Nature direct questions by sheer experimental prodding, who elicits from her stronghold the secrets of her prison-house, who presents gratuitously to the world the efforts of his labours in plain language, and who is willing modestly to follow in the footsteps of his great masters—Faraday, Maxwell, Kelvin, Von Helmholtz, and Rayleigh. Such men are to be found on both sides of the Atlantic. Our own proceedings chronicle the work of Hertz, Tesla, and Elihu Thomson. I must not exclude the teacher, the much-abused professor, who combines practice with theory, and who, in our technical institutions, is training up a body of youths destined to carry on the great work in the future. Amongst these able men there is no one who has earned a more richly deserved reputation than my predecessor in this chair (Prof. Ayrton).

Conclusion.

Although my practical experience extends over 40 years, my personal reminiscences commence with the reign of the Queen, and are, therefore, coincident with the Victorian era. Progress is advancing with such rapid strides that, when the time comes for my son to chronicle to some institution of ethereal engineers his experience of 50 years' observation, the people of his day may look back with pity and amusement at the backwardness of the times of 1893. Even this address may be quoted as an illustration of the ignorance of the great Victorian period.

Cannot the electrical engineer claim some share in the progress of the world? Has he not annihilated space and bridged the ocean? He has extracted the precious metals from their stony bed, and brings to our very hearths the tamed energy of the roaring torrent. Commerce, civilisation, politics, and life have all been benefited by his skill and invention, and history cannot fail to record the names of those, among whom are many members of this Institution, who, in this great Victorian era, have done so much to discharge one of the highest duties of man, the fulfilment of the functions of the true engineer.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

BY PROF. W. CAWTHORE UNWIN, F.R.S.

Water Power Storage.

Prof. Unwin commenced by saying that he must add a word or two to complete his last lecture on the special conditions of power storage in water power systems. The need of storing power derived from waterfalls arose out of different considerations from those which applied in the case of steam power. A river flowed day and night with an energy which varied seasonly but not from hour to hour. The work to be done necessarily in some cases varied, and in by far the larger number of cases there was no demand for work to be done during the greater half of the twenty-four hours. If no means of storage were found, a large part of the natural supply of energy flowed away and was wasted. But there was another reason in the case of water power for using storage. Nearly the whole cost of water power was due to interest and depreciation on the

* Abstract of third Howard Lecture delivered before the Society of Arts January 27th.

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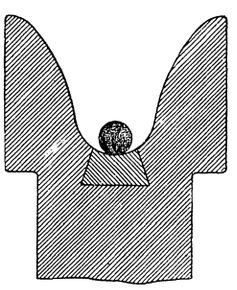
permanent works, machinery and structures. Nearly nothing was due to daily working expenses. With steam power only about one-third to one-half of the cost was due to permanent charges, and the rest of the cost arose out of wages and fuel. If water power machinery stopped for twelve hours out of the twenty-four there was no sensible diminution of the working expenses, and the cost of horse power was doubled. It would appear in the course of the lectures that the most characteristic advantage of water power as compared with steam power was that the former permitted the use of storage of energy by means neither complicated nor difficult.

There were two distinct methods of storage in hydraulic systems, accumulator and reservoir storage. Perhaps, on superficial consideration, it would hardly appear likely that it would be profitable to pump water to be used for power purposes. There were cases, however, where it was so. One of these was the system of hydraulic transmission originated by Lord Armstrong. The system of hydraulic transmission was used, and could only be used, advantageously to work a great number of intermittently working machines. A single engine, working nearly continuously, pumps water which actuates a great number of intermittent motors, in which the fluctuation of demand varies a great deal, especially from minute to minute. Storage in that case was essentially necessary. Perhaps it was the invention of the accumulator, a means of storing the energy of pressure water, that the success of the hydraulic system was mainly due. The hydraulic accumulator was simply a vertical cylinder, with a heavily-loaded plunger, into which water was pumped. One very large accumulator of the London Hydraulic Power Company, the diameter of which was 20in., the stroke 23ft., and which worked under a pressure of 750lb. to the square inch, large as it was, stored only 2·4 H.P. hours, a very insignificant quantity. What made an accumulator so important was that its rate of discharge was very great. The accumulator he had mentioned would probably supply 100 H.P. for 1½ minute, hence, like the flywheel, the use of the accumulator was limited to regulating for short periods of time, and could not be used to average the variation of demand during the twenty-four hours.

If a suitable site could be found reservoirs could be built of very large capacity at a cost which would not be large per unit stored. At Zurich, for instance, where they pumped water for power storage, there was a reservoir of a capacity of 353,000 cubic feet at an elevation of 475ft. That reservoir stored 5,284 H.P. hours. That was enormous as compared with the storage in an accumulator. Both at Geneva and Zurich very remarkable and expensive systems for utilising and distributing water power had been for some time in successful operation. In both cases water flowing out of a large lake with comparatively small fall was utilised to furnish a very considerable amount of power. In both cases it was found convenient and economical to use the low pressure turbines in the river to pump water to a reservoir at a great elevation, and use the pumped water for motive purposes. At Geneva the Rhone was made to afford a clear fall varying from 5½ft. to 12ft. There had been, or shortly would be, erected 18 low pressure turbines giving an aggregate power of over 4,000 H.P. A reservoir was constructed 390ft. above the lake capable of storing, allowing for loss in motors, 4,180 H.P. hours. The reservoir was a covered reservoir of expensive construction, but he found that its cost did not exceed £2. 4s. per H.P. hour stored. It required very little maintenance, and he supposed it did not add 3s. per annum to the cost of horse power supplied. On the other hand, the energy stored would, without that reservoir, have gone to waste, and the energy saved was sold for £8 per horse-power per annum.

Telodynamic Transmission.

The first method of transmission of power to any considerable distance was by wire rope. Telodynamic transmission was first applied by M. Hirn in connection with the re-opening of idle factories at Logelbach, near Colmar in Alsace, in 1850. One of the factories was worked at a distance of 80 metres from a steam-engine, by a steel band on wooden pulleys 2ft. in diameter, the steel band being about 2½in. wide. This was used for eighteen months, transmitting 12 H.P., when an English engineer, Mr. Tregoning, suggested the use of a wire rope cable ¼in. diameter. The same pulleys were used, a groove being turned in them to carry the cable. That cable worked for years; but iron pulleys were substituted for the wooden ones. A second transmission was soon erected with pulleys 10ft. in diameter and a cable ½in. in diameter. M. Hirn confessed that the chief difficulty was the construction of the pulleys, and it was not until he had adopted a dove-tailed groove, bottomed with gutta-percha, so as not to wear the rope, that the problem was solved. The cables were at first of iron, but were now of mild steel; the largest was about an inch in diameter, and the pulleys were from 12ft. to 15ft. in diameter, and in the throat of the pulleys there was a dove-tailed groove, which was filled up with gutta-percha, strips of pine wood, or bits of old leather or canvas belting, the last, he believed, being best. The power transmitted was equal to the product of the tension into the speed. The maximum speed was about 100ft. per second, and a one-inch rope running at that speed could transmit 330 H.P. The pulleys were usually from 300ft. to 500ft. apart. In 1862, M. Hirn stated that he knew of 400 cases of wire rope transmission. The largest telodynamic rope in existence was one constructed by Messrs. Rieter of Winterthur, the rope used being six stranded, and each strand consisting of six wires. There was a hemp core for the whole wire, and each strand also had a hemp core, thus making the rope more flexible. The longest transmission he knew of was at Freiburg, the distance being just over a mile (6,500ft.). M. Hirn had hoped to make his wire cables last a very long time indeed, eight or ten years at least; but that had proved not to be practicable, for they had not been found to last for much more than a year. A little difficulty had been found with the stretching of the rope when first erected, but that was got over by passing it several times through grooved rollers with a considerable pressure before erecting it. As the supporting pulleys were expensive, and were a cause of waste of power, it was desirable that the spans should be large, and spans of from 300ft. to 500ft. had been adopted, and as this led to a considerable deflection of the cable, the pulleys must be placed high enough to keep the wire off the ground, the slack side in some cases having additional pulleys.



The two principal sources of loss of work with telodynamic transmission were the friction of the journals supporting the pulleys and the resistance due to stiffness of the rope. Zeigler's experiments gave for the friction of the journals 1·14 H.P., and for the work expended in bending the rope 0·625 H.P., a total of 1¾ H.P. at each pulley station. When transmitting full power the efficiency of the system was remarkably high (0·962 for each pulley station); there was no other mode of transmission to corresponding distances involving so little loss of work, except electrical transmission.

Telodynamic Installations.

At Oberursel, near Frankfort, there was an important cable transmission installation for supplying from 64 to 154 H.P. to a cotton mill. The fall above the mill was about 264ft., but was at such a distance that it could not have been utilised by ordinary means of transmission. Two tangential impulse wheels were erected, and the power was transmitted to a distance of 3,160ft. in seven spans, the diameter of the rope being ⅝in. Another important transmission arose in a curious way. In 1864 there was an explosion in a gunpowder factory at Ochta, near St. Petersburg, and it was determined to reconstruct the factory and work it by means of wire rope transmission, in order to secure the condition that the dangerous buildings should be at a distance from each other.

The best known instance of wire-rope transmission was probably that at Schaffhausen. After a period of great trade depression there was a revival of industry in the town between the years 1840 and 1850. In the last-named year Herr Heinrich Moser, of Charlottenfels, constructed a canal, and erected the first turbines at Schaffhausen. It then occurred to him that it might be possible to render useful the immense volume of water passing through the town, and the extraordinary winter of 1857 and 1858 favouring an examination of the bed of the river, the erection of a weir across the river was suggested, and the construction of a power house on the right bank, with turbines of 500 H.P. on a fall of 6ft., and transmission of power across the river to the factories on the left bank of the river. A company was formed in 1864 to carry out the works, and the weir was constructed during favourable seasons. The turbine house contained three turbines of 200 H.P., 260 H.P., and 300 H.P.; they were ordinary low pressure axial flow turbines, with vertical shafts driving horizontal shafts. There was a transmission of 200 H.P. to factories on the hill above the turbines. From the same shaft about 22 H.P. was taken off by a subsidiary wire rope transmission, which passed down the right bank, and a small transmission went across the river. There remained about 530 H.P. to be dealt with by the main wire rope transmission which passed directly across the river. The principal transmission across the river was by means of two cables, with a single span of 385ft., the diameter of the pulleys being 15ft., running at 80 revolutions. The two principal rope driving pulleys were not keyed on the horizontal driving shaft, but ran

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loose on it. If the tension of either of the two driving cables varied, the bevelled gearing revolved and equalised the strain. The gross power in the horizontal driving shaft in the turbine house was about 530 H.P., or, allowing for friction, 500 H.P., 250 H.P. for each rope. The ropes were 1in. in diameter, and ran at a speed of 62ft. per second. Either rope was capable of transmitting a large fraction of the whole power. Perhaps the most interesting feature was the single line, which transmitted an aggregate of 27 H.P. to ten small workshops The Schaffhausen installation had been an entirely successful undertaking, and had very greatly benefited the industries of the town. In the year 1867 there were only 13 renters of the power, who paid an annual rental of £345. In 1887, the latest date to which he had details, there were 23 renters, paying to the water power company an annual rental of £3,300. The charge for power in 1887 varied £4. 16s. to £6 per horse-power per annum delivered at the mill. The total cost of the work appears to have been reckoned at £29,360 originally, and this, by writing off, stood at £24,634 in 1887. There was a greater loss of power in wet and frosty weather than was originally anticipated. A spinning factory had complained that the running was not so regular as they would like, and this led to the construction of a new power station, and the adoption in the new works of electrical instead of wire rope transmission. In some excellent lectures delivered before that Society in 1891 by Mr. Gisbert Kapp, the method of transmission by wire rope was compared with the method of transmission electrically, very much to the disadvantage of the cable transmission. "Till recently," said Mr. Kapp, "rope transmission held the field absolutely, not because it was perfect, but because there was nothing better. Now, however, we have something better in electrical distribution, and the flying ropes are being steadily replaced by the electric conductors." The use of the words "steadily replaced," the lecturer thought, was based upon a wrong impression. The wire ropes had not been replaced at Schaffhausen by electrical conductors, but an additional power station had been erected, and electric transmission had been placed alongside cable transmission. It happened accidentally that at the only visit he (the lecturer) had made to Schaffhausen in recent years the rope transmission was working perfectly, while the electrical transmission was *hors de combat*, the motor having been burnt up by a lightning discharge.

A very interesting transmission was begun at Freiburg in 1870, when a company was formed partly to acquire and work the forests near the town, partly to utilise and sell water power, and partly to carry out a scheme of water supply. A dam 40ft. high was constructed across the river Sarine, in a ravine where it was impossible to erect factories; about 300ft. above the ravine the company acquired some level land. There was an effective fall of 35ft. and an available 1,700 H.P. The system was working perfectly well, and power was sold at the rate of £8 per horse-power per annum. Girard turbines were used. In 1872, a company was formed to utilise the water power of the Rhone some distance below Geneva at Bellegarde. The total power available was estimated at 12,000 H.P. The original project, which was on a very large scale, had been only very partially carried out, and the working was not very successful. The power was sold at from £8 to £12 per horse-power per annum. There were five Jourdan turbines capable of developing 630 H.P. each, and a wood pulp factory, a butter mill, a copper refinery, and othes works were now driven by these turbines. The turbines were in a very deep gorge, and the distance to the farthest factory was 3,000ft. The greatest span was 630ft., and the largest ropes were 1¼in. diameter, the largest he knew of; the speed was 66ft. per second. He (Prof. Unwin) visited Bellegarde some little time ago, and though the whole of the transmission was working, it had that aspect which places got which were not paying a sufficient interest on the capital expended; the works were not kept up as well as they might be, and there was grumbling on the part of the consumers that the water company were not doing as much as they ought in repairing the turbines and so on. This was a case where they went to a new country and expected the factories to come to them. There were no actual works on the spot, and the factories did not come fast enough, and the power company got more or less into arrears in the payment of interest on the capital, and so the thing had not succeeded; but at the same time mechanically there had been no failure.

The most recent, and one of the largest installations of telodynamic transmission, was at Gokak, in the Southern Mahratta Country, which was carried out by MM. Escher and Wyss, of Zürich. The river fell over a high cliff, and had motive power enough for many industries. There were three turbines of 250 H.P. each, and these drove a cotton mill of 20,000 spindles. The total fall acting on the turbines was 180ft.; the turbine wheels were 67in. in diameter, and ran at 155 revolutions. They were impulse turbines, with partial admission, on horizontal axes, each turbine axle carrying a driving pulley. There was a sluice valve worked by hand, and a disc valve controlled by a relay governor to each turbine. The shafts of the turbines carried wire rope pulleys 11½ft. in diameter, the rope speed was 93ft. per second, and the ropes 1in. in diameter. There were three ropes, one from each turbine. The installation had been perfectly successful. He heard they were going to double the power, and in the new transmission were going to try electric transmission. There were two reasons for that, one being that in India they wanted experience in comparing the two systems under conditions in which they could get exact data about each, and the other that if they adopted rope in the new transmission they would have to carry the ropes underneath the existing transmission.

El-ctric and Telodynamic Transmiss on compared.

The telodynamic system was adapted to the transmission of power to distances which were large when compared with the distances to which power was ordinarily transmitted; but it could not seriously compete with electrical transmission in cases where the distance to be covered was reckoned by many miles. It had the peculiar advantage that it transmitted the energy developed by the prime mover directly, whereas in electrical distribution there was a double transformation. The efficiency of transmission to such distances as those at Schaffhausen was very great; it was uncertain whether a similar amount of power could be distributed to an equal number of consumers electrically with less waste of energy in the process. Then the telodynamic transmitters, which had been at work, some of them, since 1864, had been at work continuously without serious stoppage, and had only failed to return an adequate profit where they had been undertaken on a scale too large for the amount of industry requiring to be supplied with power. On the other hand, it might be admitted that telodynamic transmissions, simple as they were mechanically, involved considerable cost. The cost of maintenance of the cables was great; they had to be replaced annually, and experienced workmen had to be employed to make the long splices in the ropes. One disadvantage of the telodynamic system was that no means were to be found of directly measuring by numerous or continuous observations the amount of power delivered to each consumer. So long as the power was distributed to very few consumers, it was possible to assess with practicable fairness the charge to each without measurements of the power; but in proportion as the consumers became more numerous the difficulty of the system in that respect became more serious. It was not possible by increasing the size of the cable to transmit an indefinitely large amount of power. Cables became unmanageable if the rope was too large in diameter; 300 H.P. was about the limit for a single cable. It was also an inherent characteristic of the cable system that the efficiency decreased rapidly when the distance increased beyond certain moderate limits. On the most favourable interpretation of the experiments made at Oberursal, the efficiency would fall to 0·6 for a 5,000 metres transmission, an efficiency by no means excessively good.

PURIFICATION OF MERCURY.*

BY W. JAEGER.

The method of purification of mercury adopted by the Reichsanstalt for accurate work is worthy of notice. The raw material is the quicksilver supplied by the Idria mines in iron bottles, which is particularly good, and can be used for most purposes after simple filtering. To get rid of the heavy metals the mercury, after filtering and drying, is twice distilled *in vacuo*, during which process care must be taken to avoid every trace of grease and other impurity on the glass or rubber used. For this reason the distilling apparatus is exhausted by means of a mercury pump without cocks, all shutting off being done by mercury; the pump is connected to the still by a glass tube with no cock, which is stopped by melting off when the exhaustion is complete.

After distillation, since electro-positive metals (alkalies or zinc) might still remain, it is deemed advisable to subject the mercury to further purification by electrolysis. As liquid, out of which the mercury is precipitated, a solution of mercurous nitrate is used, which is obtained by the action of nitric acid on an excess of mercury.

Details are given of the electrolytic process employed; and the chemical tests of Dr. Mylins proved that there was no trace of metals except a very small quantity of iron, which probably came from the apparatus used in the test, and there was no residue of any kind after evaporation.

Electricity on Board the Chilian Armour-Clad "Capitan Prat."—Electricity has been adopted on board this warship to a large extent as the motive power in the manœuvring of the guns and turrets.

* Abstract from *Wied. Annalen*, No. 1, 1893, p. 209.

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FIRST REPORT OF THE ROYAL COMMISSION ON ELECTRICAL COMMUNICATION WITH LIGHT-HOUSES.

[ABSTRACT.]

The Commission having been issued on June 13th, the first meeting was held on the 18th, and then adjourned until July 19th, by which time charts showing the number of casualties and loss of life on outlying shoals had been prepared, and other valuable information had been obtained. A tour of inspection of lighthouses and light-vessels was commenced on Aug. 15th. The investigations were confined to those points on the coast at which the records of wrecks and loss of life had been heaviest in the last ten years, but much useful general information, together with a considerable amount of local evidence, was obtained in the course of the cruise. Other parts of the coast remain to be visited, but their claims stand over for early investigation, and will be dealt with in a future report. The labours of the Commissioners were greatly facilitated by the assistance received from the Admiralty, the Trinity House, the Commissioners of Irish Lights, and of Northern Lighthouses, the Mersey Docks and Harbour Board, and at Scilly from Mr. Dorrien-Smith. In October further evidence was taken and the first report prepared. It was finally adopted at a meeting on December 8th.

Speaking generally, the need for electrical communication for the purposes referred appears, the Commissioners say, to be greatest in the case of certain light-vessels marking outlying shoals beyond reliable range of the shore for sight or sound signalling. The crews of these vessels, consisting usually of about seven men, keep a regular look-out night and day, and can, therefore, be relied upon to give notice of vessels in distress, which is not the case with lighthouses, where there are only two or three keepers, and where, consequently, a responsible look-out seawards cannot be maintained with the existing staff. On the other hand, in many instances cable communication with these vessels would involve a considerable initial outlay, and although the experiment in the case of the "Sunk" proved that, where the circumstances are favourable, and with the adoption of recent improvements, the difficulty of maintaing communication with such vessels can be overcome, yet, pending further experience, the Commissioners only recommend immediate action to be taken in five cases which appear to be among the most urgent, and where the conditions are comparatively favourable. They also recommend one pile-lighthouse for immediate attention.

With regard to shore lighthouses, there are some which occupy such a commanding position, and can be connected with the telegraphic system at such trifling cost, that they have no hesitation in recommending that these be dealt with at once, for, although no constant look-out is or perhaps could be kept in them, there was evidence that the light-keepers may often be able to give valuable notice of wrecks or of vessels in danger, which could not otherwise be communicated without serious loss of time. The number of such lighthouses is not large, because it is probable that the system of communication with the Post Offices, coastguard stations, Lloyd's stations, and Mersey Docks and Harbour Board signal stations will shortly leave comparatively few important points on the coast unconnected. It is recommended that 19 shore lighthouses be immediately connected.

The case of lighthouses situated on islands or isolated rocks appears, it is said, to present the greatest difficulty. A recent experiment in connection with the Fastnet failed owing to the difficulty of maintaining the cable; but there was evidence to show that is was carried out under unsatisfactory conditions, and that if a similar attempt were made with improved appliances the difficulty of direct communication could be overcome. Three such lighthouses are recommended for connection with a continuous cable.

The experiments lately made at the Needles for establishing electrical communication without a continuous cable may also prove of practical utility. It is recommended that one rock lighthouse should be connected by this system.

Recommendations.

1. Immediate telephonic connection of the Goodwin (North Sand Head), Kentish Knock, Shipwash, Hasborough and Scarweather light-vessels.

2. Immediate connection of the Gunfleet Pile lighthouse.

3. Immediate electrical communication by aërial wires without delay between the telegraphic system of the country and the following 19 shore lighthouses, viz., Start Point, Anvil Point, Needles, Orfordness, Girdleness, Noss Head, Cantick (Orkney), Mull of Cantyre, Corsewall (Stranraer), Mull of Galloway, Douglas Head, Point of Ayre, Nash (both lighthouses), Bull Point, Hartland Point, Minehead (Dungarvan), Hook Point (Waterford), and Bailey (Howth . Of these, two have already been connected, advantage having been taken of the General Post Office engineers being in the vicinity of Bull Point and Hartland Point to connect those places by telephone with the coastguard line.

4. Connexion of the Tuskar Rock-lighthouses on the Island of Caldy and Lundy with the mainland by means of continuous cables.

5. The Commissioners state that they have found it difficult to determine which rock-lighthouse would be the most suitable station for further testing the system of communication by a non-continuous cable, as recently tried by the Telegraph Construction and Maintenance Company at the Needles, but after careful consideration they are of opinion that the Fastnet would be the best adapted for the purpose, and would prove a valuable station for giving notice of disabled vessels and for communicating storm-warnings; they, therefore, recommend that that lighthouse should be selected for the experiment.

The estimated cost of carrying out the electrical communications herein recommended is as follows:—

I.—LIGHT-VESSELS.

Name.	To be connected by telephone with	Cost of cable and laying.	Cost of land lines.	Total cost.
		£	£	£
Goodwin (North Sand Head).	Broadstairs Coastguard Station.	1,270	55	1,325
Kentish Knock..... ...	Kingsgate C.G.S.	3,531	44	3,575
Shipwash	Aldborough C.G.S.	2,056	44	2,100
Hasborough	Hasborough C.G.S.	2,282	38	2,320
Scarweather	Mumbles C.G,S. or Post Office	2,057	88	2,145

II.—PILE LIGHTHOUSE.

Name.	To be connected by telephone with	Cost of cable and laying.	Cost of land line.	Total cost.
		£	£	£
Gunfleet	Walton-on-Naze C.G.S.	1,414	121	1,535

III.—SHORE LIGHTHOUSES.

Name of lighthouse.	To be connected by telephone with	Estimated cost (approximate).
Start Point.....	Hallsands C.G.S.	£125
Anvil Point	Swanage P.O. or C.G.S.	85
Needles	Totland Bay P.O. or C.G.S.	200
Orfordness	Orfordness P.O. or C.G.S.	85
Girdleness	Torry P.O.	70
Noss Head	Ackergill P.O.	110
Cantick (Orkney)	Longhope P.O.....	160
Mull of Cantyre.....	Admiralty Station	50
Corsewall (Stranraer)	Kirkcolm P.O.	195
Mull of Galloway	Drummore P.O.	215
Douglas Head	South Quay P.O.....	30
Point of Ayre	Admiralty Station, Port Cranstal.	70
Nash (both lighthouses) ...	Llantwit-Major C.G.S.	160
Bull Point	Croyde and Ilfracombe coastguard line.....	—
Hartland Point	Clovelly and Bude coastguard line	—
Minehead (Dungarvan)... ..	Helvick Head Admiralty Station	210
Hook Point (Waterford) ...	Fethard P.O.....	265
Bailey (Howth)	Howth P.O..... ..	85

IV.—LIGHTHOUSES ON ISLANDS OR ISOLATED ROCKS.

Name.	To be connected by telephone with	Cost of cable and laying.	Cost of land lines.	Total cost.
Caldy	Tenby C.G.S. ...	£7,731	£122	£853
Lundy.....	Croyde C.G.S. ...	3,465	149	3,614
Tuskar.....	Rosslare C.G.S..	1,496	226	1,722

V.—ROCK LIGHTHOUSE TO BE CONNECTED WITH NON-CONTINUOUS CABLES.

Name.	To be connected by telephone (combined with Morse Sounder) or by Mirror Galvanometer with	Cost of cable and laying.
Fastnet	Crookhaven	£3,800

It is assumed that the lighthouse authorities will provide the mooring chains, swivels, bow-sheaves, deck-leads for veering cables, and all fittings and appliances for securing the cable drums and windlasses between decks in the case of the light-vessels, and for any builder's work that may be requisite in the case of the lighthouses.

The Commissioners are of opinion that a grant for this purpose should be made out of Imperial funds, and they estimate the amount at £8,000.

They are further of opinion that when connection is established between a light station and a Post office which is not constantly open, an alarm bell should be placed in the room of the telegraphist. They propose to visit other portions of the coast another season, and to take further evidence, especially as regards engineering questions relative to cable communication with rock lighthouses.

The report is signed:—Mount-Edgcumbe (Chairman), Henry L. Mulholland, Edward Birkbeck, F. L. M'Clintock, G. S. Nares, John A. Kempe, R. C. Munro-Ferguson, W. H. Preece, Garnham Roper (Secretary). December 8, 1892.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan.* 20, 1893.

Rapid Transit in New York.—The two most absorbing topics in electrical circles at present are the questions of rapid transit in New York and the policy of the General Electric Company in regard to the incandescent lamp. The Rapid Transit Commissioners, who, it will be remembered, offered the franchise at auction on December 29th, seem still undecided as to their course. It now appears probable that the immediate demand will be met by an extension of the present elevated railway system, using steam, presumably, and that eventually an electric underground route, similar to the Metropolitan in London, will be adopted. One of the propositions which seems to meet with the most favour is to grant additional powers to the Manhattan Elevated Railway Company, enabling it not only to occupy other streets, to broaden its road bed and extend its tracks, but also to extend its structure another story, so as to permit the running of express trains on the upper level while the accommodation trains will use the lower tracks. The interest which electricians have in this question all hinges on the possibility that electricity may be employed as a motive power, whatever plan may be decided upon. But since the present management of the elevated railways has not seemed to favour the substitution of electricity for steam, and as the underground system provides for the employment of electricity, most of those in the profession favoured the latter plan. It is not yet definitely known what course will be taken in regard to this matter, but it seems probable that, for the present at least, we shall have no underground system.

The Incandescent Lamp Question.—The General Electric Company has preserved a discreet silence up to this time in regard to the policy it intends to pursue towards lamp manufacturers; but its recent action by which it obtained an injunction against the Sunbeam, Columbia, and Illinois Incandescent Lamp Companies seems to point strongly to a policy of enforcing legal rights to the utmost. It had been thought by many that while the Company had the undoubted right to put a stop to all manufacture of lamps outside its own establishment, that this course would antagonise public opinion to such an extent as to deter it from going so far. This action has, therefore, come somewhat in the nature of a surprise.

The Westinghouse Lamp.—In the meantime all eyes are turned towards the new Westinghouse lamp, about which so much has been promised and so little has heretofore been made public. While the exact nature of this lamp is not yet publicly known, I am in a position to state more definitely than before just what it will be. The description published in *The Electrician* of November 11, 1892, is, as far as it goes, correct. The shape of the bulb does not differ materially from that of the Edison lamp, except that it is somewhat more slender, and the lower part instead of being closed terminates in a thick bottle-mouth, which is carefully ground to a slightly conical shape; into this fits tightly a ground glass stopper, which extends into the interior of the globe; the leading-in wires are of iron, and to the interior terminals of these are attached the filaments. It is stated that the atmosphere within is one of attenuated nitrogen; but, if this be so, I cannot understand on what grounds the Westinghouse Company makes its claim of increased life and efficiency. To ensure against admission of air after the stopper is inserted a cement is run around, which hermetically seals the junction. This, it is claimed, will soften with heat, and enables the manufacturers to withdraw the stopper and filament at any time, and to renew them without destruction of the bulb. This would seem to introduce a new objection to the lamp, namely, that if this cement would soften by heat it is in danger of being softened in the course of ordinary use of the lamps, which would lead to the destruction of filaments. None of the lamps have yet been placed on the market, nor is it known when they will be.

The Chicago Exhibition.—A new departure in electrical journalism was made by the *Electrical World*, in its issue of January 21st, by the publication of a two-page half-tone illustration of the proposed electrical fountains at the Chicago Exhibition.

CORRESPONDENCE.

USEFUL FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I lately published a rule for finding the heat losses in a copper conductor (dynamo or line) rapidly and approximately as follows:—

(1) With a density of 1,000 amperes per square inch, every 1,000 cubic inches means a loss of 1 H.P. (2) For greater accuracy, add to the horse-power thus obtained one-tenth of its value. (3) For other densities of current, multiply the value thus obtained by the density and divide by 1,000.

Mr. Denny Lane, of Cork, has furnished me with the following equally convenient rule for measuring water-power:—

With a hydraulic motor of 75 per cent. efficiency, it takes 1 acre of water 1 foot deep to give 1 H.P. for 1 hour with 1 foot of fall.

I have long used a somewhat similar formula:—

With 80 per cent. efficiency, 1 cubic metre per second falling 1 metre develops 10 H.P.

These and similar formulæ are of such extreme value in many preliminary engineering calculations that I am tempted to add a few more, and if your correspondents would add to the list something valuable might be attained. I got the following from Lord Kelvin twenty years ago:—

A metre is three feet, three inches and three-eighths, which is easily remembered.

I have long used the following measures of the degree, minute, and second, in terms of a radius = 1. The degree is the only one not very exact, but it is easy to remember the third and fourth figures:—

Rule: After the decimal point, 1° is one nought and a one (exactly 0·0175). 1′ is three noughts and a three (exactly 0·00029). 1″ is five noughts and a five (exactly 0·000004848).

Yours, &c.,
34, Great George-street, Westminster, S.W., GEORGE FORBES.
January 31, 1893.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook will be ready on Thursday next. The book will contain more than 1,000 pages, and several new and useful features have been added. The price of the Directory and Handbook will be, as previously, 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

TENDERS INVITED.—The Town Council of Huddersfield invite tenders for a telephone exchange switchboard connecting up the existing departmental lines, and fixing and connecting additional telephone lines. The tenders must be in by February 9th. Further information is given in our advertisement columns.

——— The Directors of the *Yorkshire Post* newspaper have invited during the past week tenders for lighting their premises by electricity.

——— The Directors of the Jesmond and Gosforth Steam Laundry Company (Limited) are inviting tenders for the electric lighting of their large new premises at Gosforth. Particulars can be obtained of Messrs. Oliver and Leeson, 30, Moseley-street, Newcastle-on-Tyne.

——— The Galway Electric Company invite tenders for a new dynamo. Some particulars appear in our advertisement columns, and conditions may be obtained on application to the Company.

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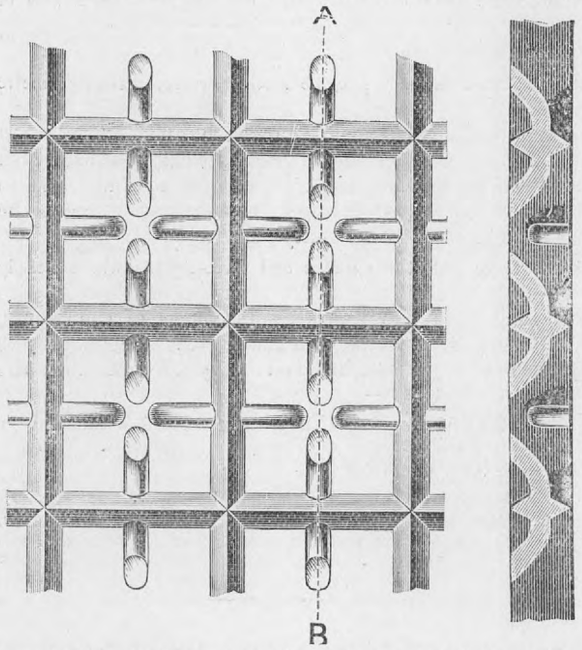
TENDERS INVITED.—The authorities of the Telegraph Department of Florence have recently invited tenders for the supply of 20 tons of galvanised telegraph wire of 5·08mm. diameter, and 100 tons 4·31mm. diameter. The tenders are due to-day (Friday).

PERSONAL.—Mr. G. Stegmann has been appointed sole agent in London and district for the electric light and bell fittings manufactured by Messrs. Lockerbie and Wilkinson, of Birmingham.

GORDON (J. E. H.) AND CO. (LIMITED).—A meeting of this Company was held at the offices, 11, Pall-mall, London, W., on Monday, when it was resolved that the Company be voluntarily wound up, and that Mr. J. D. A. Norris, of Suffolk House, Laurence Pountney-hill, London, E.C., be the liquidator. It will be remembered that an attempt was recently made to convert this concern into a joint-stock company under the title of Gordon and Fell (Limited), but without success.

MESSRS. STONE AND CO.—This firm are forming a branch of electrical engineering at their works at Deptford for the manufacture of a large number of electrical requisites.

THE E.P.S. COMPANY.—This Company are introducing a new grid, called the Patent "Claw" Grid, for use with their negative plates generally, and for both denominations of plates in selected instances. The illustration shows the peculiar construction which enables a large pellet, and consequently a large amount of paste or other active material, to be used in the electrode, while



the conducting surface is largely increased, and the grip for such active material applied by the peculiar "claw" shape ensures that the porous lead or peroxide is firmly held in position, while permitting perfect freedom for expansion or contraction in the mass of the pellets of the active material.

HEAVY HYDRAULIC MACHINERY.—Messrs. J. and W. Weems, Perseverance Iron Works, Johnstone, Scotland, who make a speciality of lead presses, have just constructed and delivered to a well known electric manufacturing firm, for covering electric and telephone cables from ⅛in. to 3in. diameter in continuous lengths, and any desirable thickness of lead, an hydraulic press, 33in. diameter, cylinder and ram; and they have another press in course of construction, nearly finished, 28in. diameter, cylinder and ram, for the same purpose. This firm have supplied special machinery to the principal lead pipe and electric cable manufacturers of the world.

STEAM SAVING APPLIANCES.—The Chadderton Ironworks Company send us their new catalogue of steam saving appliances. Descriptions are given, accompanied by illustrations, of McDougal's patent steam traps, anti-primers, mechanical stokers, a combined steam drier, a water and dirt separator, and other devices manufactured by the Company at their works at Chadderton, near Manchester. The Company claim economy and safety for their specialties.

MESSRS. EDMUNDSONS (LIMITED).—This firm have just issued a list of the principal electric light installations carried out by them in different parts of the country. The list occupies nine pages, and represents about 170 installations, including several steamships.

THE "DEMON" WATER-MOTOR.—Circulars sent us by Mr. Pitman show that this motor, which is of the Pelton or Thirlmere type, is now fitted with a throttle valve governor.

BARRY ISLAND.—At a meeting of the Barry and Cadoxton Local Board on Monday last it was resolved to give the Board's consent to the Barry Company's Bill for the construction of an electric tramway to Barry Island, on condition that the tramway line was moved to the north side of the road instead of being put in the centre.

BOLTON.—The Town Council on Wednesday decided to borrow £40,000 for electric lighting purposes.

BRIGHTON.—A Sub-Committee has been appointed to consider the question of introducing the electric light in the Brighton School of Science and Art.

BRISTOL.—The Electric Lighting Committee of the Town Council at their last meeting decided, as the result of Mr. Preece's report upon the tenders received for supplying distributing mains for the electric lighting installation, to accept that of Messrs. Siemens Brothers and Co. (Limited), at £17,200, subject to certain modifications, bringing the tender down to £16,580. The tenders ranged from about £14,700 to £24,000, there being three tenders lower than that of Messrs. Siemens Brothers and Co. Mr. Preece, however, reported that these latter tenders did not comply with the specifications. It is stated that the rejection of the lowest tender is to be made the subject of discussion at the next meeting of the Council.

COLCHESTER.—At the last meeting of the Town Council a confirmatory resolution was carried that the Council apply to the Board of Trade for a Provisional Order enabling them to produce and supply electricity for public and private purposes within the borough. The Council a month previously had passed the resolution, which, however, it was necessary to confirm in accordance with the rules of the Board of Trade.

COVENTRY.—The subject of introducing the electric light into Coventry has been made the occasion by the *Coventry Times* for an illustrated article on the subject of the application of electricity to various industrial and domestic purposes.

ELECTRIC LIGHT ON THE STAGE.—A feature of the performance at the London Alhambra is a celebrated female dancer "lit by electricity." The effect is described in some of the London papers as "lovely."

GLASGOW.—In connection with the public electric lighting installation, the central station is now reported as practically complete. The engines and boilers are all in position and in working order, the mains in the leading thoroughfares are finished laying, and there is now little more work to be done. Private customers the Corporation expect to be able to supply in the course of the current month.

HERTFORD.—The Mayor and other members of the Lighting Committee of the Town Council have recently visited the works of Messrs. Head and Co. to inspect the plant for the generation of Dowson gas. The Council have a proposal before them for using gas engines worked by Dowson's gas for their electric light installation in the town.

HULL.—At the last meeting of the Electric Lighting Committee of the Corporation, Mr. Holder, the Chairman, announced that the electrical exhibition held in connection with the inauguration of the electric lighting installation had proved a great success, and had been largely attended.

LECTURES.—There has been quite a plethora of popular lectures on elementary electricity lately, and amongst others we note a course of University extension lectures by Mr. H. L. Calender at Plymouth; lectures by Mr. F. G. Baily on "Electric Traction" at Liverpool; by Mr. Barber-Starkey at Shrewsbury; by Mr. J. M. Coone on "Electricity and the Electrical Transmission of Power" at Fowey (Cornwall); by Mr. R. Hammond on "Electric Lighting" at Burton, and by Mr. Brennand at Blackburn; and a course of lectures at the London Institution by Prof. Silvanus Thompson.

LIVERPOOL.—The Parks Committee of the City Council have declined the application of the Liverpool Electric Supply Company (Limited) for permission to lay mains under the grass land in Sefton Park. This is a confirmation of a previous resolution of the Council.

THE LIVERPOOL OVERHEAD RAILWAY.—Lord Salisbury, on the occasion of the opening of the Overhead Railway at Liverpool, will be presented with a novel inkstand. By pressing a button placed on the stand an ingenious device will enable his Lordship to start the train.

LIMEHOUSE.—It has been decided to prepare a statement showing the probable cost of lighting this district by electricity in comparison with the price at present paid for the gas lighting.

MAIDSTONE.—In reference to the electric lighting of Maidstone, Mr. Hawtayne has presented a scheme to the Local Board, in accordance with the resolutions passed in October last. He proposes to erect a supply station at the sewage works with a capacity for 2,000 16 c.p. lamps, and suggests that the supply should be

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confined to private lighting until such time as the profits from this source justify the extension of the electric light to the public lamps. The idea of utilising water power has, we understand, been abandoned as impracticable. Mr. Hawtayne estimates the outly on plant and extension of mains at £10,450, and recommends that a sum of £16,000 be borrowed in order to obviate the necessity of a second appeal to the Local Government Board. He further recommmends that 8d. per unit be charged. The Lighting Committee of the Local Board are considering the report, and it is proposed to issue a digest to the ratepayers, who will be canvassed as to the support they are prepared to give to the scheme.

North Kensington.—At the last meeting of the Ratepayers' Association the subject of the electric lighting of the district came up for discussion, and it was suggested that representation should be made to the Vestry urging the purchase of the undertaking of the local electric lighting company, in order that the light might be supplied direct by the local authority.

Rottingdean Electric Railway.—No memorial having been presented against the Bill before the Standing Orders Committee for sanctioning an electric railway from Brighton to Rottingdean along the seashore, the Bill passed this stage unopposed. All the necessary statutory deposits have been made.

Runcorn.—The General Purposes Committee of the Board of Commissioners will recommend the Board at the next meeting to instruct Messrs. A. Hall and Co., of Liverpool, to prepare a specification and estimate, and report on the question of the electric lighting of the town.

Scarborough.—We are asked by Mr. A. A. Campbell-Swinton, Managing Director of the Scarborough Electric Supply Company (Limited), and London Representative of Messrs. C. A. Parsons and Co., to announce that the Scarborough Electric Supply Company (Limited), recently incorporated, have decided upon the site for a central station at Salisbury-street, on the west side of the town, near the railway, and building operations will be commenced forthwith. The contract for the engineering plant (including engines, alternators, condensers, boilers, &c.) has been secured by Messrs. C. A. Parsons and Co., of Newcastle-on-Tyne, whose tender (Mr. Swinton adds) was the lowest, and who guarantee their steam turbine alternators at the lowest steam consumption per unit at all loads.——A special meeting of the Town Council was held on Monday last to discuss the minutes of the Sanitary and Lighting Committee, under which power has been given to the Scarborough Electric Light Supply Company (Limited) to increase the pressure of their electric supply from 1,000 to 2,000 volts. The Committee further recommend that 45 per cent. of the capital expenditure of the Company on their undertaking shall be the maximum amount of depreciation permitted. The minutes were confirmed.

Southampton.—At the last meeting of the Town Council a discussion arose in respect to the installation of the electric light at the public offices. The opinion was generally expressed that the immense increase in the shipping of the port which was likely to result from recent arrangements with the large shipping companies should be made the occasion of the Council's agreeing to an extensive installation of the electric light in the borough, and would probably necessitate the building of new public offices. After some considerable discussion it was decided to defer the further consideration of this subject.

Southport.—Last week the first experiment in the public lighting of this town by electricity took place. The landing stage of the North Lake was lit by a 2,000 c.p. Brush arc, and an electric pleasure launch was lit by a 300 c.p. "Midget" and a 50 c.p. incandescent. The experiment was considered satisfactory.

Whitechapel.—At the last meeting of the Board of Works a resolution was moved by Mr. Catmur that it be an instruction of the Streets Committee to consider the question of the electric lighting of the district and to report to the Board. He said the time in which they had now to act was limited, and it would be a misfortune if the matter was allowed to be lost sight of. The motion was adopted.

COMPANIES' MEETINGS & REPORTS.

Eastern Telegraph Company (Limited).

The forty-first half-yearly ordinary general meeting of the Eastern Telegraph Company (Limited) was held on Thursday, January 26, 1893, at Winchester House, 50, Old Broad-street, London, Sir John Pender, G.C.M.G., M.P., presiding.

The SECRETARY read the notice convening this meeting, and the minutes of the previous half-yearly ordinary general meeting.

The CHAIRMAN: Before I move the first resolution I will go in detail over some of the accounts, so that you may have impressed on your minds more clearly the results of the working of the last six months. The gross revenue for the half-year under review amounted to £352,391, as against £354,939 in the corresponding period, or a decrease of £2,548. In analysing the message receipts we find decreases in the traffic with certain places, which are almost recouped by the increases in other directions. There is no very considerable fluctuation anywhere, and the amount received from our investments in other companies is practically the same as in the corresponding half-year. The total working expenses for the half-year to September 30, 1892, amounted to £98,797, as against £97,131, or an increase of £1,666, the details of which are as follows:—General expenses in London £9,120, as against £9,412, being a decrease of £292. The working expenses at the stations were £74,486, as against £73,098, an increase of £1,388. Special repairs to buildings at stations are less by £1,461; but, on the other hand, we have written off £1,754 more for depreciation of cable stores, the result being a net increase of £1,666 in the total working expenses.

The expenses attending repairs and renewals of cables, &c., amounted to £37,636, as against £47,047, a decrease of £9,411. It will be seen from abstract C that, in addition to keeping our own cables in a state of efficiency, we have been working for the South African, the West African, and the Brazilian Submarine Telegraph Companies. You are aware that we are all in friendly relation with each other, and we work very much on the co-operative principle. The amounts received from these companies, together with our having to expend less cable on our own repairs, have had the effect of reducing the expenses under this head, which has enabled us, notwithstanding the reduction of £2,548 in our receipts, to carry forward to next half-year £62,847, against £57,509, or an increase of £5,338. I think that that is a very satisfactory statement, and I may mention to you that our ships which have been employed in repairing these cables of other companies have earned us £15,610 this half-year.

As you will have noticed from paragraph 6 of the report, we offered to the holders of the Five per Cent. Debentures, redeemable at par in 1899, the option of exchanging their security for the Four per Cent. Mortgage Debenture Stock of the Company. This offer was responded to by holders of nearly one-half of the Debentures. The Debentures being to bearer, we had to reach the holders through the medium of bankers, brokers, &c., who had presented the last coupons for payment, and in cases where our circulars have not reached the holders we shall be glad to consider the application of any one who is still desirous of effecting the exchange. All particulars as to terms can be obtained at the Company's offices. We have only about £100,000 of these Debentures now to deal with, but, as I have stated, it is rather difficult to reach the holders. The exchange we suggest places the holders of the Mortgage Debenture Stock in a better position than is held by those who have the old bonds. This is standing to-day at something like 7 premium, while the Debenture Stock is at something like 10 premium. To those who want a permanent investment the Four per Cent Perpetual security which we offer is beyond all question a very safe and sound one.

When storms occur we suffer by telegraph communication interruptions, and to-day our connection with Cairo by the land lines there is interrupted through a storm. During the last month we have had many repairs to make, but I am glad to say that every year we gain more experience, which teaches us how to deal with these repairs, and establish our cable system as a sound and reliable property. When I tell you that in the last month we have had ten broken cables to repair, and, as Sir James Anderson reminds me, we have taken out twenty-one faults, you will see it all proves that we have our property very much in hand, and that our ships are generally employed, although it may appear to some of the shareholders that we have a large number of vessels. The system we have adopted of duplicating our cables also makes our system so reliable that the public rarely know if any interruption takes place.

I might, gentlemen, give you all the details of our working in the past half-year, as I have them all before me, but I have given you the principal figures, and I think that they may probably satisfy you that all the details connected with our working are very carefully watched.

Before I ask you to adopt the resolution which I am about to propose, I think I might make a few general remarks. I have just referred to the number of breaks we have had, but the cables are now pretty well in working order, and I hope that before 24 hours are over our land line communications between Cairo and Alexandria will be restored. We have, indeed, at this moment received an announcement that our land lines are now in order to Cairo. The work of repairs has been carried out very quickly. This leads me to refer—but I will do so very briefly indeed—to Egypt, where we have several large stations. We have a very important traffic with that country. I frequently go to Egypt, and I see the working of the English administration there, and I believe there is not a better governed country in the world than Egypt at the present time under English administration. Men of experience are in charge of affairs there, and they are working with unselfish motives. Their only selfishness, indeed, is that they may command the respect and the gratitude of the people of Egypt by their just and wise government. You heard the other day of some little difficulty having arisen there, but it will prove insignificant when dealt with by the men who are representing our interests, and, first of all, Egyptian interests. I have no fear of any trouble arising out of it, and the only reason I refer to it is to tell you we have no politics in this Company. The better Egypt is governed the greater will be the traffic over our telegraph system in connection with that country. We are in very friendly relations with Turkey, and I may say that, however slow the Turks may be in many ways, they are very sharp in making a good bargain, and they take very great care of the money part of their interests. We desire, however, to deal with them in a just and fair way, and although our progress may be slow in connection with that country, it is always going on in favour of our system.

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Rather a remarkable speech was made the other day by a man who has attained now a European reputation. I mean Mr. Rhodes. He was dealing with what we called some years ago "the Dark Continent," upon which he has thrown light. It is men like Mr. Rhodes who are required in developing a new country. He has shown great ability, great energy, and, I might almost say, adventurous courage, backed with a considerable amount of audacity. He is at the present time endeavouring to open up Africa, as you may have seen in the speech to which I am referring, but which I need not allude to in detail, except in so far as to state that he proposes eventually to carry through Africa on to Cairo a telegraph system, which he thinks some day will enable him to carry telegrams from the Cape to Europe for something like 2s. 6d. against our 9s.; but I should like to show you, on the map we have prepared, the country through which this projected line is to be carried. It is a vast distance from the one point to the other, but Sir James Anderson will explain to you the route by which it is proposed to carry the line and the country through which it is to pass. It is to traverse countries besides those which are under the control of either England or Mr. Rhodes. The Mahdi has a portion of the country, and I think that by the time Mr. Rhodes gets his line to Wady Halfa our arrangements will have enabled us to have paid off our debentures, and we shall then probably have a capital very little more than that which he proposes to use for carrying his telegraph system through Africa. In the meantime, however, everything that he tackles—every territory that he passes through, depends upon his finding gold, and if he finds gold he must of necessity become a feeder to us for a great many years to come. I thought I might mention these facts in order to relieve the minds of any of our shareholders, and to let them see that, instead of the proposed line being a competitor for twenty years to come, it is much more likely—if it goes on—to be a feeding line to us. When, however, it does get to Cairo—and I hope the country will be so developed as to let him get there—we shall be very ready and willing to meet him upon his own ground; and, looking at the greater security which, I may say, exists in a submarine system as against a land line, I think the chances are that we shall not only be able to do the work more accurately and more quickly, but also probably more cheaply than by the proposed line. At the same time I wish him all success in opening up this dark country. It is, however, a very long step from Cape Town to Wady Halfa, and when they get to Wady Halfa they will get into the hands of the Egyptian Telegraph Executive. We may also reckon our speed there at minutes compared with hours by the land lines. As regards competition by it, I feel convinced that there are a very few in this room who will live to see it.

We have just settled, through the Eastern Extension Company—with which this Company is very closely connected—the question of a slight advance in the rate to Australia. As you are aware, the reduction which took place in the rate to these Colonies was very serious—from 9s. 4d. to 4s., the Governments guaranteeing to make up one-half of the loss that might result from the reduction, thus increasing, to some extent, the value of our property by its being backed in this manner. They found, however, that the loss of revenue was not being recouped as rapidly as they had expected, and they therefore asked for an advance of the rate by 9d. We did not think we ought to stand in the way of the wishes of our co-partners in the business, because we took the other half of the guarantee. The alteration in the rate has accordingly been successfully carried out, and, as far as we can see at the present time, we shall, I believe, get back a little more of the former revenue, and thus reduce the loss we sustained by the very large reduction which was at first made in the rate. I think that this pretty much constitutes all that I had proposed to say to you, and I do not think I can wind up my remarks in a better or more encouraging manner than by repeating that we have a very valuable concern, that your property is increasing in value, and that it is likely to be more valuable as time goes on.

I find that there is one matter which I have overlooked. Since I had the pleasure of addressing you on the last occasion, we have made a contract with Her Majesty's Government, in which India is interested, to lay a cable from our system at Zanzibar to Seychelles and to Mauritius. For this we shall get a subsidy for 20 years of £28,000 a year. The new cable will also be an additional feeder to our system. I think this will be acceptable news to you. Altogether, I think we are probably in as strong a position to-day as we have ever been since I have had the pleasure of addressing you.

Before I propose the resolution, I think it will interest you very much if you will allow Sir James Anderson to point out where Mr. Rhodes hopes to carry his land line through Africa. This is a very important matter, and I think that the more our shareholders understand the question, the more they will be pleased with the Company in which they are so much interested.

Sir JAMES ANDERSON (the Managing Director): The line goes at present from Cape Town to Fort Salisbury, and the tariff over that line is 5d., that is, up to Fort Salisbury. Indicating the points on the map, he continued: Then this territory where Tetè is situated is Portuguese, and leave will have to be obtained to cross it. The Portuguese Government, however, have given concessions to other people, so that this proposed telegraph line will not be allowed to be put up there for nothing. After crossing this territory they will come up here to this Lake Country, Lake Nyassa, and further on Lake Tanganyika. On the west it is the Congo sphere of influence, and on the other it is the German sphere; but the Lake itself is neutral. If the line is carried along German territory, they will want to share in the tariff; and if the route is by the Transvaal, they will demand some concession; while if a cable is laid through the Lakes it will be very expensive. When you get to Uganda you are on safe ground, but here you are surrounded by very hostile tribes, and further on the Mahdi will have to be reckoned with, and I do not think that a line will be got there very easily. Then Khartoum, where Gordon was killed, is to be gone through, and so on afterwards into Wady Halfa, where the Egyptian people will have to be dealt with, and they are not likely to carry the traffic for nothing. It will cost in out payments alone something like 3s. 1d. to get from Cape Town to London. It will therefore be seen that if by the proposed new route the rate be 4s., it will leave only 11d. to maintain that portion of the line to be erected all the way from Port Salisbury to Egypt. There is a railway being projected from Mombassa to Uganda—we have a cable at Mombassa; a railway is being built from Delagoa Bay to Pretoria in the Transvaal—our cable connects Delagoa Bay; and a railway is also being made from Beira into the Transvaal. There are therefore three railways in course of construction from the coast into the interior. There is nothing in the history of the world to show that telegraphy or commerce will increase for many years unless it gets to the sea. It is hardly conceivable that anything worth calling commerce will ever grow on this 5,000 odd miles of land line excepting where there is gold, which can hardly be hoped to be found over the whole 5,000 miles. We may therefore look forward to continuing to be the carrying line for commercial traffic from the coast to the interior, for the natives, who do not wear clothes, are not in the habit of sending telegrams.

The CHAIRMAN: I will read what Mr. Rhodes said. "This line to Egypt, provided the Mahdi is 'squared,' will cost £300,000 to £400,000, and we have lying to the east and west of the coast (that is our system) cables which cost over £3,000,000. We are now charged 9s. 6d. a word for our communications, but when we can get to Egypt by the telegraph I am referring to, we shall be able to do it for 1s. 7d. from Egypt to England, or, in all, about 2s. 6d. against 9s. 6d. a word." That is the statement, but I think we have shown you pretty clearly that he has difficult ground to go over, and that for a long period of his working he must be feeding us all the time, and moreover, that our finances are so arranged in regard to our Cape cables that at the end of the 20 year's contract we shall have paid off our debentures, and have our cables for practically a very small sum. Therefore, if it comes to a question of competition, I am quite sure that we shall be able to do the work as cheaply as Mr. Rhodes; but, as I have said already, that will not occur in our lives. There are some young people present, and Africa may be developed in their time, but it will not be developed to the extent Mr. Rhodes expects in his time or ours. The resolution that I have to propose is as follows:—

"*That the report and accounts of the Directors to September 30, 1892, submitted to this meeting, be and the same are hereby received and adopted.*"

The VICE-CHAIRMAN (Lord Tweeddale): I beg to second the resolution.

The CHAIRMAN: If any gentleman has any question to ask or any remark to make I shall be very glad to hear it before I put the motion. If no one has anything to say I will put it, and those who are in favour of it will please hold up their hands. To the contrary. Carried unanimously. I feel, in a sense, a little disappointed, for I think this is the first time that I have ever addressed you without there being some gentleman who was desirous of saying a word, and I am always ready to answer any questions. The next resolution is—

"*That George Garden Nicol, Esq., who now retires, be and he is hereby re-elected a Director of the Company.*"

The MANAGING DIRECTOR: I have much pleasure in seconding the motion.

The CHAIRMAN: I may tell you that Mr. Nicol is one of our oldest Directors, and has, in fact, been associated with the Company from its inception. He then put the resolution in the usual way, and it was carried unanimously.

Mr. NICOL: Gentlemen, I thank you for the honour you have done me.

The CHAIRMAN: The next resolution is as follows:—

"*That John Denison Pender, Esq., who now retires, be and he is hereby re-elected a Director of the Company.*"

The VICE-CHAIRMAN: I beg to second the resolution.

The CHAIRMAN: As you are aware, Mr. John Denison Pender is my son. He has been trained to this work, and I hope, as time goes on, he will prove to be a better man than his father in carrying it on. He then put the motion in the usual way, and it was carried unanimously.

Mr. PENDER: I beg to thank you, gentlemen.

The CHAIRMAN: The next motion is to come from the body of the meeting.

Mr. COOPER: I beg to propose:—

"*That Mr. Henry Dever and Messrs. Welton Jones and Co., both of whom now retire, be and they are hereby re-elected auditors of the Company for the current year, at a remuneration of £100 each.*"

Mr. C. BURT: I have very much pleasure in seconding the motion. These gentlemen are well-known as accountants in the City of London, and no better men could be found for this work.

The CHAIRMAN put the motion, and it was carried unanimously. Continuing, he said: I think it is right at this time, when so much is being said about companies and the way they keep their accounts, to tell you that from the time we formed this Company we thought it a wise and prudent thing, in the interests of the shareholders, and also for the protection of the Directors, that we should have first-rate competent accountants, who would be responsible for the accounts as between the Company and the shareholders, and I can say with great confidence that that duty is faithfully and well performed by our present auditors. I think that closes the whole of the proceedings of this meeting.

Mr. H. T. BURGESS: I beg to propose that the best thanks of this meeting be given to our excellent Chairman and to the Directors of this Company. I think that if you were to go through the whole of the City of London you would not find such an able body as we have to manage this business. I think they deserve the very best thanks of this meeting, and we wish them very many happy new years.

Mr. WOOD: I second the motion.

The resolution was carried unanimously.

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The CHAIRMAN: On behalf of my colleagues and myself I return you our very best thanks. This is not the first occasion by very many times that you have paid us a similar compliment, and I can only say that we try, as far as lies in our power, by carefully looking after your interests, to retain and to increase your confidence in us.

The proceedings then terminated.

Direct United States Cable Company, Limited.

The thirty-first ordinary general meeting of this Company was held at Winchester House, 50, Old Broad-street, London, on Friday, January 27, 1893, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. T. Finnis) read the notice calling the meeting, and the minutes of the last ordinary general meeting, which were approved by the present meeting, and signed by the Chairman as correct. The Directors' report was taken as read.

The CHAIRMAN: Before asking you to approve the report, I shall as usual go over the details of the working of the past six months. The revenue for the half-year, after deducting outpayments, amounted to £43,629, and the working and other expenses, including income tax and depreciation of spare cable, but exclusive of cost of cable repairs, to £18,982, leaving a balance of £24,647 as the net profit of the half-year, making, with £3,730 brought forward from the previous half-year, a total of £28,377, which has been appropriated as follows:—Interim dividend of 3s. 6d. per share for the quarter to September 30th, £10,624; interim dividend of 3s. 6d. per share for the quarter to December 31st, £10,624; transferred to reserve fund, £4,000; balance carried forward £3,129, making a total of £28,377. The revenue, as compared with that of the corresponding period of the previous year, shows a reduction of £1,773; but under all the circumstances, and looking to the depression existing in many departments of trade, we have, I think, good reason to be satisfied with this result. The expenses in London show scarcely any variation in the items, and on the whole they are within £5 of the same amount as in the corresponding period of 1891. The expenses at stations, on the other hand, show as follows:—Increases of £122 in salaries, £100 in maintenance, £95 in petties, £126 in rent, fuel, and light, and £172 in repairs and renewals, with a reduction of £55 in printing and stationery. The above increases are mostly due to the new receiving station at 39, Mark-lane, and, with the further addition of £319 for Continental agencies, an item which did not appear in the accounts for 1891, the increase of £868 in the stations expenses, as a whole, is accounted for. In the further expenditure, a saving of £158 is shown in Directors' fees. The expenditure in the aggregate exhibits an apparent increase of £1,309, but it must be pointed out that this includes £1,000 written off the acquisition of Patent Rights account, an item that did not appear in the accounts for the corresponding period, and the real increase is therefore £309 only. Turning to the reserve fund, it will be seen that that account is credited with £4,271 for interest on the investments, £3,611 for profit on security realised, and with £4,000 transferred from the revenue account, while, on the other hand, £6,301 is debited for cost of repairs, leaving the balance standing at the increased figure of £260,298. The investments now stand at a cost of £234,152, but their present market value is nearly £260,000. Now, gentlemen, that is not an unsatisfactory state of things to put before you, and I think at a time like the present, when companies are being brought very much before the public, and when they are being very carefully looked into, I might give you some little idea of the position of our Company in comparison with the other telegraph Companies working in the same seas—namely, the Anglo-American, the Western Union, and the Commercial Companies. At the present moment, if you take into account the dividends and the value of the properties in the market, our Company is paying probably the highest rate of interest of any of the others that I have mentioned. We pay practically 5⅞ per cent., against the Anglo-American Company's 5 per cent., against the Western Union's 5½ per cent., and against the Commercial Company's 3 15-16 per cent. The Commercial Company occupies the peculiar position of its stock being at a large premium, while those of the other Companies are at a very large discount; but the people who are our constituents—the shareholders generally in this Company—all stand with their property at a reduced rate. In other words, we may call the present value of our cable something like £460,000, as against a much higher figure in the case of the other cables. For instance, each of the cables of the Anglo-American Company stands at an average of £712,500 against, as I have said, £460,000 in the case of this Company. Altogether, therefore, we stand in the position of having written our cable down to a lower price, and at that lower price the dividend that is being paid to-day is practically, or it ought to be, about 6 per cent., but really we are paying you 5⅞ per cent. Altogether the figures which I have given you show that, taking our concern from every point of view—as to value, as to the dividend paid, and as to reserve fund—we stand above any of the submarine telegraph companies working to America. That may be so far satisfactory to you, and it is always satisfactory to be informed from time to time respecting the real value of one's property. Before going from that point I may mention that we are watching very closely the working of the system. We are carrying our traffic speedily and correctly. We have also just opened a new office in Mark-lane, and if you were passing there and were to look inside, you would see that it is an office which apparently belongs to a thriving concern. You will observe from the newspapers from time to time that our work is recognised as not being inferior to that of any other Company, and, perhaps, in some respects, it is better. Altogether we have no reason, although we are a single-cable Company, to feel other than pleased at the position we occupy among the Atlantic Cable Companies; and one of the advantages that we have—of course, we have to pay more or less for it—is that if anything were to occur to any of our lines, we have 12 months in which to repair them before we can lose any portion of our revenue. The other Companies guarantee us, as we more or less guarantee them, against breaks occurring. Our cable is getting old, as you know, but at the same time, when we have effected repairs—and we have had rather more repairs than we like—we have materially strengthened our cable, so that at the present time, although it is about 18 years old, I believe that our cable, our main cable, is very little inferior, seeing what we have done to it, to what it was when it was originally laid down—very little, if anything, inferior. That is also a comfort to you looking to the future. I think, therefore, that I may congratulate you and ourselves upon occupying the position which we do fairly and respectably, and, upon the whole, profitably. I should like to see bigger dividends, but when you look at the depression which has prevailed one way and another; when you look at the fact that there are in the Atlantic now 10 cables and when you remember the further fact that science has enabled us to duplex those cables and do the work of some 20 cables, the wonder is that we occupy as profitable a position as we do at the present time. It takes a long time for commerce to grow up to the requirements of our cables, but we have done an enormous amount of good to commercial people generally by giving them facilities for turning over their capital so much oftener than they could have done by the postal system. I believe that the growth of telegraph enterprise is certain. Had it not been that these cables were duplexed as regards their carrying power, we should probably have received a little more than we are getting to-day, but we have this advantage—that as the increase in the traffic goes on—and growth there is—we shall be for a long period of time able to meet it, and we are not, we think, in any danger now of having new cables laid to compete with those already existing, which are so largely ahead of the requirements of the commercial world. Before I leave the subject altogether of our telegraph system I think I may refer to a death that has occurred lately. On the last occasion when I addressed you I had the deep regret of announcing the death of two of our Directors, as well as the death of a man whose name is associated with submarine telegraphy from its inception—I refer to Mr. Cyrus Field, the two Directors we lost being Admiral Mayne and Mr. Ford. To-day I have to announce the death of a man who has been very conspicuous indeed in connection with submarine telegraphy—I allude to Mr. Jay Gould. Probably no man who ever lived did so much for himself in such a period. Whether he benefited submarine telegraphy or not I am not going to say, but this I may tell you, that he was the largest holder of telegraph shares in the world, and as such I recognise him; and in referring to his death I will only say this: that if he did not do a great deal for us in one way he did in another by carrying on an extended system. I believe there is no system more extended in the world than the system of land telegraphy in America at the present moment. Therefore, his name will be associated with the progress of telegraphy, and whenever its history generally is written I do not think it will be possible to leave his name altogether out of record. I think I have now exhausted all the remarks that I have to make. We have opened another station, as I have said, and we are putting our people at Ballinskelligs into more comfortable quarters. We have also still on hand the lawsuit which I referred to on the last occasion, when I gave you all, I think, good advice, in telling you that if you ever quarrel with a Frenchman never go to law with him. That is my experience. When this suit is to be finished I cannot tell you, but I do not think it is doing us much harm, although it has done us no good. With these remarks I beg to move:—

"*That the report of the Directors, dated January 13, 1893, together with the statement of accounts to December 31, 1892, annexed thereto, be and the same are hereby received and adopted.*"

Mr. E. M. UNDERDOWN, Q.C., seconded the motion.

The CHAIRMAN then invited discussion, but no shareholder rising to address the meeting, he put the resolution, and declared it carried unanimously, adding that that closed the business.

Mr. HANCOCK proposed a vote of thanks to the Chairman, Directors, and officials of the Company. He came to the conclusion long ago, and had no doubt whatever on the point, that this Company's was the best of the whole of the Atlantic cables. In manufacturing it Messrs. Siemens strove to give the Company a first-class cable, and he thought they had succeeded. It was very evident—and this was an important point—that those who had the manufacture of the cable and the sending of the messages performed their duties very skilfully, as was shown by the results attained. Their property was a growing one, and the value of the shares was being more and more appreciated by the public. It was very satisfactory to them to see that that was the case, and altogether he felt that the shareholders must feel unbounded confidence in the Directors for their watchfulness in protecting the interests of the Company.

Mr. JOHN NEWTON seconded the motion, and said he trusted that the Board would not assume, from the sparse attendance on that occasion, that the shareholders felt any less interest in the proceedings of the Company. Probably the circumstance that so few were present was owing to the fact that the Directors now circulated an excellent report of the proceedings among the shareholders. He was surprised that their shares did not stand better in the market, for they were an excellent investment, and the position of the Company was most satisfactory.

The resolution was carried unanimously.

The CHAIRMAN, in reply, said: On behalf of my colleagues and myself, I thank you very warmly indeed. With regard to the French suit, I have often heard it said that one reason why an Englishman can never get satisfactory settlement of an action in France is that the French people do not like the money to leave the country; and possibly that is the case in connection with the suit between the Anglo-American Company and the Paris and New York Company. As to the French Company having a very large surplus of capital at command, I am afraid that this is not the case, and they are paying no dividend at all. The consequence is that,

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if our people gain the suit, they might not obtain much material advantage by their success; but, at all events, we have so far gained the day, and we will live in hope of some benefit accruing to us, hereafter in connection with this matter. With reference to Mr. Newton's remarks they were quite true, and I have very often found that if companies are prosperous, there are very few shareholders at the meetings, while if they are in a bad state the attendance is very considerable. Our submarine telegraph companies have now got such a firm hold of the confidence of the public, that our Four per Cent. Debentures—I speak of the Eastern Company over whose meeting I presided yesterday, the South African Company, and the Eastern Extension Company—are quoted to-day at from 10 to 12 premium. That is a very remarkable evidence of the confidence which the public have in these undertakings now. The submarine telegraph system is growing and becoming stronger as it grows, and I am all the more glad to say this now when I see Mr. Newton present. He has been with us almost from the very beginning, and he used to criticise us—in fact, he used to come to our meetings to curse, while now he attends them to bless. That is a great compliment to the Companies, but I think it is also an indication of Mr. Newton's good sense and judgment.

A SHAREHOLDER inquired the proportions of the traffic originating in America and at this end of the system.

The CHAIRMAN: I will answer you in a sort of half-and-half way; I will not do so in a direct manner. As a rule, younger people have greater energy than old people, and we find that illustrated both by the Australian and the American people. Everyone in America wants to be a "boss." In England everyone wants more to keep what he has got, and is not very ready to run risks to get more. But it is good for our Companies that risks should be run, because they involve telegraphing. I might, therefore, say offhand that probably more of the telegraphing comes from our colonies and from America than goes from this country. That will suffice to give you a rough idea of the position.

The proceedings then terminated.

Anglo-American Telegraph Company (Limited).

The ordinary general half-yearly meeting of the proprietors of this Company was held at Winchester House, Old Broad-street, on the 27th ult., the Most Hon. the Marquis of Tweeddale presiding.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the minutes of the last meeting, these being confirmed and signed as being correctly drawn up.

The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN said: Gentlemen, the half-year, which came to a close on December 31st, has proved a disappointing one so far as our traffic receipts are concerned. The first half of the year showed an increase of £10,035; the last half a decrease of £4,669. The explanation is that business has been dull, and the dulness is reflected in our traffic receipts. Competition has been as keen as ever, and more costly to all interested in Atlantic Cable Companies. We have no reason to suppose that the pool companies have in consequence suffered more in proportion than their rivals. Probably the contrary would prove to be nearer the truth. Happily our repairing ship "Minia" has benefited the revenue account to the extent of £3,000 earned in repairing the Direct United States and Western Union Company's cables. Our expenses are very considerably lower; the items of working and law expenses are less by £1,368, and repairs of cables £4,123. Allowing £613 loss incurred by the fire in Newfoundland, there is a net decrease in expenses of £4,878. Then you will note that we have credited the renewal fund with a sum of £2,021, being the amount of unclaimed dividends up to 1882—ten years ago. This sum is unquestionably the property of the Company, and we believe that the proprietary will approve of its being merged in the renewal account. It is not probable that, after so great a lapse of time, many dividend warrants will be presented for payment. Whenever they are presented they will be paid. The renewal fund had only for the first time reached a figure in excess of that which your Directors have always held should be set aside for renewals of cables, viz., £1,000,000. They decided, after due consideration, to carry the amount—viz., £1,619—to the revenue account, or, in other words, to make that amount available for dividend, thus enabling your Directors to recommend a dividend at the rate of 30s. per cent., as against 28s. 6d. in 1891—making a total distribution for the year of £2. 15s. per cent. on the ordinary stock. This may appear to some a very poor dividend; but it must not be overlooked that a large portion of the seven millions of the Company's capital is water—not less than half—on which the present dividend would pay at the rate of 5½ per cent.—not a bad return on the capital of a Company which has a reserve worth considerably more than a million. The report informs you that our cables are in good working order and condition. I may add that I believe our system to be in a very high state of efficiency, reflecting credit on our *employés* both ashore and afloat, upon whose energy and skill and accuracy the success of our Company so much depends. The appeal in the French Courts makes no progress, and is not likely to make any so long as M. Barboux, our counsel, and M. Waldeck Rousseau, counsel of the French Telegraph Company, are occupied in the Panama litigation. I do not think that the report or accounts call for any very lengthened remarks on my part. I have only to say, in addition, that we have begun the year tolerably well. The increases recorded up to the present time are satisfactory, and if these be continued during the year, which is not impossible, we may look forward to a better return than we have been able to submit to you to-day. I have now to move:—

"*That the report of the Directors and accompanying statement of accounts to December 31, 1892, submitted to this meeting be, and the same are hereby received and adopted, and that the following dividends as recommended by the Board be now declared and paid, less income-tax, that is to say:—*

"*1.—A final dividend of 17s. 6d. per cent. upon the Ordinary Consolidated Stock for the year ended December 31, 1892, making (with £1 17s. 6d. per cent. interim dividends already declared and paid by the Board by way of dividends on account) a total dividend for the said year of £2. 15s. per cent. on the said Stock.*

"*2.—A final dividend of £1. 15s. per cent. upon the Preferred Ordinary Stock for the year ended December 31, 1892, making (with £3. 15s. per cent. interim dividends already declared and paid by the Board by way of dividends on account) a total dividend for the said year of £5. 10s. per cent. on the said Stock.*"

The DEPUTY-CHAIRMAN (Mr. Francis A. Bevan) seconded the motion.

Mr. DAVIS desired to know when the French appeal case would be settled. It had been said from time to time that the case was going on satisfactorily, but surely the time had now arrived when some definite information should be obtained as to how long it was to go on. He would suggest that if it was a bad debt they should mark it off; but if it was a good one, it should be put to their credit.

Mr. EDWARD CLARK, who said that he had been a shareholder for a great many years, although he had never attended one of the Company's meetings before, wished to ascertain how much inward and how much outward traffic there was. He was in a position to say that their rival Company—the Commercial—was making great strides in order to get the business on this side, and he wished to know whether the Directors were taking steps with a view to meet such a possibility. One suggestion I would wish to make, namely, that if there were any vacancies on the Board, he hoped that they would be filled up by practical, business men, who were in touch with the telegraphing world.

Mr. CHESTER said that for several years they had had the question of the Deferred shareholders and their interest in the Company brought before the shareholders. Time after time they have been told that when the reserve fund reached a million sterling the Deferred shareholders would have the benefit of any surplus. Their investments, which placed a great responsibility on the Board if they fell in value, were put down at a million sterling in the revenue account, and were worth £990,000, and he wished the Chairman to give them the assurance that the interest from the renewal fund, as well as that from their investments, should henceforward be credited to the dividend fund.

Mr. GARNER asked whether they could bring about the conversion of the Ordinary and Deferred stock if it were desirable.

A SHAREHOLDER agreed with Mr. Chester that the interest on the renewal fund ought to be divided amongst the shareholders. He thought that the Chairman at previous meetings was disposed to do so.

Sir JOHN SWINBURNE said that he happened to be in the unfortunate position of having invested in the stock twenty-nine years ago something like £1,300 or £1,400, which was now written down to £800. What he now received was about 2½ per cent. on the latter amount, which was about 1½ or 1¼ on the original investment, and he would urge the Board to divide as much as possible of the revenue they derived from the renewal or reserve funds, which for all practical purposes amounted to the same thing.

Mr. GRIFFITH, referring to the statement of the last speaker that the stock of the Company had been very much written down, said that he was afraid that the Company had suffered greatly from the amalgamation with other companies at high prices. He was afraid that they must admit that the stock was considerably "watered," but on the other hand they had the good fortune to have accumulated a reserve fund of upwards of a million sterling, taking it at its market value. He was under the impression that in times past the Directors were willing to be content with a reserve fund reaching the large figure of a million sterling; and, considering how long-suffering and patient the Deferred shareholders had been, he hoped that the Directors would take a little pity upon them, and divide among them the interest on that very large fund. Referring to the French appeal case, he was glad, on looking at the "Stock Exchange Year Book," to find that the Court of Appeal decided in their favour, and that it was only the question of damages which was deferred. Perhaps the Chairman would give them some information as to how much they might expect in the way of damages.

Mr. NEWTON advocated what his friend Mr. Clark had done—that in future the interest on the renewal fund should be placed to the revenue account.

The CHAIRMAN said he was very glad to see so large an attendance of shareholders, a circumstance which he ascribed in a great measure to the action the Board had taken with regard to the renewal fund. It seemed to have had the effect of whetting the appetite of the shareholders. As to their French case, it was still in the hands of the judges. Mr. Clark had asked a question as to the outward and inward traffic, but it was not desirable or expedient that such information should be given as to the vacancies on the Board, the Directors would be glad to take Mr. Clark's hint whenever a vacancy did occur, to recommend a business man. He did not know whether Mr. Clark meant to suggest that the gentlemen on the Board now were not business men. When they had such men looking after their interests as Mr. Bevan, Sir James Anderson—who had a large connection with the telegraphic world—Mr. Samuel Barber, Mr. Charles Burt, Sir Albert Cappel—who had a large Indian connection—and Mr. W. S. Cunard, he hoped it might be considered that they were a fairly representative body of business men. As to the renewal fund the question resolved itself into this, what was to be the lowest figure at which they could allow the renewal fund to stand? The Directors had arrived at the conclusion, not to day nor yesterday (for many years the subject had been considered

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and threshed out), that they could not afford to do without one million sterling as their renewal fund. That was their deliberate judgment, which was really the crux of the whole question. Some gentleman had described it as a very large fund. It was by no means so, having regard to the fact that they had four cables, and that one of them was very old, and might at any time involve large expenditure on its renewal. The Direct United States Company had at least as large a fund in proportion to its capital. As to the responsibilities of Directors, in respect of investments, it was their duty to invest their money in the best possible securities, and he thought that if they did so properly, no other responsibility was likely to arise. Their stock had not been written down, as Sir John Swinburne seemed to think.

Mr. BURT said that Sir John Swinburne referred to the old Atlantic Telegraph Company's stock, which was taken over by the Anglo-American Company at a reduced figure.

The CHAIRMAN, continuing, remarked that from what he had said they would see that it was impossible for the Directors to give any pledge to invariably every year credit the revenue account with the interest on the renewal fund. All that they promised to do was what they had always promised, namely, that when the renewal fund exceeded one million pounds they would take into consideration the question of applying the excess to dividend.

The SECRETARY, in reply to Mr. Garner, said that the ordinary stock could be converted into Preferred and Deferred Stock at any moment during the three months, January, February, and March of each year, at the option of stockholders. He further added that the cash (£45,000) not yet invested, forming part of the Renewal Fund, was not at present available for investment, being employed in the general business. There were amounts owing by and to the Company which had to be settled, and which required an amount of floating cash.

The CHAIRMAN said that all the money which they had available for investment was at once invested.

The resolution was then put to the meeting, and carried unanimously.

The CHAIRMAN next moved :

"*That Sir James Anderson, who retires by rotation at this meeting, be, and he is hereby, re-elected a Director of this Company.*"

Mr. BEVAN seconded the motion, which was carried *nem. con.*

Sir JAMES ANDERSON having expressed his acknowledgment,

The CHAIRMAN moved :—

"*That Mr. W. S. Cunard, who retires by rotation at this meeting, be, and he is hereby, re-elected a Director of this Company.*"

Mr. BEVAN seconded the motion, which was carried unanimously.

Mr. JOHN NEWTON moved :

"*That Mr. Joshua Dean and Mr. John Gane, F.C.A., be, and they are hereby, re-appointed Auditors of the Company for the current year, and that their remuneration be £100 each.*"

Mr. GRIFFITH seconded the motion, which was carried unanimously.

Sir JOHN SWINBURNE proposed and Mr. GRIFFITH seconded a vote of thanks to the Chairman and Directors for their able conduct of the Company's business during the past year.

The CHAIRMAN having briefly returned thanks,

The proceedings terminated.

City and South London Railway Company.

The seventeenth half-yearly ordinary general meeting of this Company was held on Wednesday last at Winchester House, Old Broad-street, Mr. C. G. Mott presiding.

The SECRETARY (Mr. W. F. Knight) read the notice calling the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN : Gentlemen, it now becomes my duty to move :—

"*That the report of the Directors and accounts presented to the meeting be received and adopted.*"

Although we should have been glad if we had had a larger accession of traffic during the past half-year, and been able to pay a better dividend than we are able to do, still, on the whole, I think you will agree with me that our report shows a very decided and substantial progress, and that the condition of the line altogether is satisfactory. During the past half-year we have carried, including the season ticket holders, 600,000 more passengers over those of the same period last year, and we have carried since the opening of the line up to the present time more than 12,000,000 passengers, and I am thankful to say we have done so safely and without any accident of any consequence whatever. You know well that, during the early stages of this line, I had half-year after half-year to deplore that there should have been so many defects in our working, and that our traffic suffered in consequence. It is very satisfactory to think that during the last half-year we have had practically no stoppage of that kind whatever. I do not think that there is any railway that could give better results in point of working for punctuality, regularity, and convenience than this line ; and, considering that it is the first electric railway, and that we have had only two years' working, this augurs well for the future of similar undertakings. Beyond the fact that we have done, as I think, fairly well for the half-year, the Company has improved its position financially very considerably. A year ago we had a large amount of Lloyd's B bonds and a considerable amount of debts which pressed heavily on the minds of the Chairman and the Board, but I am happy to say that to-day these amounts, since the accounts were published, have been very largely reduced, and that we have been able to pay off every debt that we owed, and, furthermore, that we have funds in hand sufficient to pay off every one of the terminable debentures that become due within the next nine months. Therefore, our position financially is an exceedingly strong one. Turning to capital account you will see that during the past half-year we have issued preference shares to the amount of £18,500, and we have expended on capital account out of that £4,436 ; we have paid off £6,000 of debentures, and we have reduced our debts by £8,000, which accounts for the £18,000 raised. Since these accounts were made up, we have issued a further amount of preference stock, and as far as the Board is concerned we have issued all that we intend to issue at present. As regards the question of the debentures, in order to give our existing debenture holders every reasonable opportunity of improving their position we offered to them that, if they would convert their present debentures into the permanent Four per Cent. Stock they would be allowed to do so at par ; or if they preferred it they would receive in exchange our Five per Cent. Preference Stock, also at par. About one-fourth of our debenture debt has been so converted, the other three-fourths have not been, and will have to be paid off or dealt with as circumstances may suggest. Those who took advantage of the offer we made were very wise I think. Our debenture capital has risen to a considerable premium, and I have no doubt it will go very much higher than it at present stands at, because it is as secure a stock as you could possibly have. Inasmuch as we shall be able to issue debenture stock from time to time at a premium, we shall be able so far to reduce the amount of our debenture interest, and I anticipate that in future we shall be able to make each half-year a considerable saving in interest. Coming to the revenue, which is the most interesting part of an undertaking of this kind, our receipts from passengers during the half-year have been £21,462, against £19,550 in the corresponding period of 1891. Season tickets have brought us in £540, against £249 in 1891, and our parcels and other small receipts have brought in £15, against £5 in the same year. Our parcel traffic is slowly augmenting, and we have under consideration whether we cannot considerably develop it. Our transfer fees are £9, against £4 last year, while our rents are £562 against £435, whilst our sundry receipts are £400 against nothing last year, making a total of £22,652, or an increase of £2,409 for the half-year. You know that in most railways an increased traffic does not mean a net increase in profit, because it is absorbed in working expenses. I am happy to say that it is not so with us. Our maintenance has been decreased £101 ; our locomotive expenditure has increased £148, and our carriage repairs have increased £51. Our traffic expenses have decreased £317, our general expenses have risen £110, our law charges £8, our rates and taxes remain the same as before. The result is that there is a net decrease of £127 against that of the corresponding period last year. The result of the half-year's working is that we have made a profit of £7,262, against £4,727 in the corresponding period of 1891. This added to the balance brought forward makes a balance of £8,304, of which the debenture interest absorbs £4,259, leaving £4,045 available for dividend. This will pay 5 per cent. on the preference shares, and $\frac{5}{8}$ per cent. on the ordinary, carrying forward a balance of £822 to the next account, which is the same as we carried forward last year. I am happy to say that, so far as our experience of the present half-year is concerned, we have shown a very satisfactory increase of traffic. It has averaged an advance of £150 a week since January 1st, and if this continues I hope that at the next meeting we shall have a much more satisfactory return than we have at present. You may be interested in seeing how far this electric traction promises to be successfully and economically worked. We have had four complete half-years in which to form a comparison. In the first half-year all the expenses which are commonly comprised under the head of locomotive charges in a steam railway were 9d. per train mile ; in the next half-year these were reduced to 7·9d. ; in the following six months to 7·7d. ; and in this half-year to 7·1d. In order to compare favourably with the expenses of large railways, such as the Midland, Great Western, and the London and North-Western, you must recollect that in their case they take the price of coal at the pit's mouth, charging no carriage upon it, whereas we have to pay carriage from the mine to London, besides a heavy charge for conveying the coal into our depôt ; so that if we reduced our price of coal to what is paid for it at the pit's mouth, our expense would be only 5¾d. per train mile. That I think is a satisfortory thing, seeing that in an ordinary steam railway it is very rarely below 9d. We have run during the half-year about 70,000 trains, and including our season ticket holders we have averaged 48 passengers in each train. The first half-year we averaged 45, the second 46, and the last 48 passengers per train. The total percentage for working expenses during the first half-year was 79 per cent. of the receipts, for the second 76 per cent., for the third 70 per cent., and for this half-year 67·9 per cent., so that the expenditure is coming down very steadily and satisfactorily. If you make comparisons in this connection with other railways, you must take out of our expenses what we have to pay for lifts, and if you deduct that item you will find that the working expenses are only 59¼ per cent. of the receipts ; and I hope as our traffic increases that you will see a diminution of that figure. During the past half-year, during our busy time we have been running an additional train service, which has involved us in an extra 1,000 miles a week. Therefore, our mileage has gone up considerably. Of course you will see that we have been giving more accommodation during the busy times of the day, and the result has been that our receipts per train mile have been only 2s. 0½d., against 2s. 1d. during the previous half-year, or ½d. less. Our expenses per train mile, on the other hand, were in the first half-year 1s. 9½d., then 1s. 6¼d. ; in the second half-year they were 1s. 7¼d., and last half-year they were 1s. 5¼d., so that they are coming down very satisfactorily. You gave us authority some time since to convert our ordinary share capital into stock. We have availed ourselves of those powers, and have converted the 60,000 shares which existed into £600,000 of Consolidated Stock. The conversion has been largely carried out already. There remains, however, some 3,000 shares, and we propose to call a special meeting to convert these also into Consolidated Stock, so that the whole of the share capital will in

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future come under that denomination. I want now to call your attention to the position of our Parliamentary business. You will remember that the Bill of last Session, in consequence of the dissolution of Parliament, could not be gone on with by the Committee, and it was carried over with several other special Bills to the present Parliament, and it will be taken up at the point at which it was left last Session, and I hope and trust that we shall be able to get it carried through as we desire. As to our Clapham extension, we propose to carry that out so as to give us relief in the way of sidings, &c., but it would have been a useless and fruitless expenditure to have completed that line by the present time. Therefore we thought it better to leave the Bill in abeyance, and postpone any action in the matter, and we have lodged a small Bill to give us an extension of time in order that we may have ample opportunity to consider matters. The sidings at Stockwell are very much wanted, and we have contracted for carrying them out; but, unfortunately, we have been met with a good deal of opposition at the hands of the Vestry in the neighbourhood. We have chosen the very best position for them, but the Vestry have not shown any desire to encourage us or their own constituents. We are willing to give them the accommodation, and I think we ought to receive every encouragement from them. However, we have the authority of an Act of Parliament and we must exercise it, and we propose to commence those works.

Mr. HANBURY seconded the resolution.

Mr. DRAKE congratulated the Directors and shareholders upon the favourable position of the Company as disclosed by the data given by the Chairman. He had previously criticised the Board severely, but he had done so in ignorance of the real facts. Theirs was the pioneer electric railway in London, and he was sure that if things went on as they had done for the last twelve months that they had a prosperous future before them. He wished to compliment the staff for the able way in which they had performed their various duties during the past six months.

Mr. MIDDLETON said that he was glad to see that since the report was issued there had been an increase of traffic on the Company's line. He must point out that whilst they had increased their train mileage they had decreased their train mileage receipts. Last year they were 2s. 2½d. per train mile, while this half-year they were 2s. 1½d. This meant £1,700 which they gave to the public. Before reducing the fares, some consideration should be shown for the ordinary shareholders. Their railway had been worked for the last year without any appreciable delay or inconvenience, and he thought that it was only right that those who were in charge of their machinery at their depôts should receive their meed of praise for the efficient manner in which they had carried out their duties. He thought, however, that there was room for economy all round. The cost of administration was out of proportion to the capital; and he would like to ask the Directors to forego part of their fees until the dividend reached 2 or 3 per cent. The whole of the energies of the Board and staff ought to be directed to the perfecting of their line as it at present existed, and not to the extending of their wings to Islington or anywhere else.

The CHAIRMAN thanked Mr. Drake for his encouraging remarks, and said that in the matter of economy it had been the object of the Directors to keep down expenses as much as possible. The compliment paid to their manager and engineer by Mr. Middleton was thoroughly deserved. They had been endeavouring to encourage their mid-day traffic, from which they hoped to derive considerable benefit. Their short distance traffic—mostly penny fares—had resulted in a considerably increased income, but the average return per passenger was slightly reduced. As regarded the fees of the Directors, he could only say that if they were not worthy of their remuneration, they would be glad to retire in favour of others who would do their work for less. He objected, however, in the interests of the shareholders to any reduction of the Directors' fees.

The resolution was then put to the meeting and carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. HEWETT, dividends at the rate of 5 per cent. on the preference shares, and of § per cent. on the Consolidated Ordinary Stock, were declared.

The CHAIRMAN proposed and a SHAREHOLDER seconded, the re-election of Mr. C. S. Grenfell and E. Tate to their seats at the Board.

The motion was carried *nem. con.*

On the motion of Mr. MIDDLETON, seconded by a SHAREHOLDER, the auditor—Mr. Henry Bishop, of the firm of Messrs. Turquand, Youngs, Weise, Bishop, and Clarke—was unanimously re-appointed.

At an extraordinary meeting held subsequently, a resolution for the conversion into Consolidated Ordinary Stock of the remaining 3,000 ordinary shares already issued was passed unanimously.

Mr. DRAKE proposed a vote of thanks to the Chairman and Directors, which ended the proceedings.

General Electric Power and Traction Company (Limited).

The ordinary general meeting of the shareholders of this Company was held on Tuesday at Winchester House. Mr. James Pender presided.

The SECRETARY (Mr. J. Payne) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the proceedings of our meeting to-day will only be of a formal character. As you will have seen from the circular which we issued on the 27th inst., this meeting will, we propose, be adjourned to February 14th, owing to the illness of our chairman, Lord Albemarle, and also to the illness of Lord Egerton of Tatton. I am told by the Secretary that the report and balance-sheet will be sent out next Friday night. I now beg to move that this meeting be adjourned to the date mentioned.

Mr. ENGLISH: I will second that resolution with pleasure.

A SHAREHOLDER expressed the hope that the balance-sheet and profit and loss account, when received by the shareholders, would be found to be set out a little more fully than they were last year. It was, he said so summarised then, especially the items in the profit and loss account that many of the shareholders were dissatisfied with it.

The CHAIRMAN: The accounts have been thoroughly gone into by the auditors. As you will readily understand, the auditors have had a great deal of trouble and difficulty in the compilation of the accounts. As you know, we lost our first managing director; then our first secretary was unfortunately drowned, whilst his successor went out of his mind. Altogether we have had a series of difficulties to contend with. The auditors have made out a very full balance-sheet.

The SECRETARY: The auditors, in addition to their report, will send out a very elaborate statement, which will be of very great interest to the shareholders.

A SHAREHOLDER: If the chairman is still ill on February 14th will the meeting again be adjourned?

The CHAIRMAN: I really do not know. I do not think so; but I consider it would be very much better to have the chairman present at the general meeting.

Another SHAREHOLDER asked the reason why Mr. Paxman left the Board?

The CHAIRMAN: I really cannot give you any idea, but I think the days on which the Board meetings were held were very inconvenient to him. He is a very busy man.

The SHAREHOLDER: Does he still hold any shares in the Company?

The CHAIRMAN: I cannot tell you.

The SECRETARY: He still holds the same amount in the Company as he did last year.

The CHAIRMAN: Mr. Paxman never told me the reason for his leaving, except on one occasion he said that he found it extremely difficult to attend the Board meetings.

The resolution for the adjournment of the meeting was then put and carried unanimously, and the proceedings terminated.

Giant's Causeway and Portrush Electric Tramway Company.

The half-yearly general meeting of this Company was held on Saturday last at the offices of the Company, Portrush. Dr. Anthony Traill, J.P., F.T.C.D., presided.

The CHAIRMAN, in moving that the Directors' report be adopted, said that the shareholders had all received a copy of the report, and therefore there was little left for him to say except to regret, on the one hand, the diminution in the receipts for the past year which the report disclosed; and, on the other, to congratulate the shareholders upon the fact that, notwithstanding this reduction in their receipts, there was still an increase in the total balance. This had been chiefly brought about by considerable reduction on the expenditure side of the account. He regretted being unable to announce a dividend on this occasion.

Mr. J. STEWART MOORE was re-elected Director of the Company, and a vote of thanks to the Chairman and Directors brought the meeting to a close.

The report of the Directors states that there has been a diminution in the receipts under every head during the past year, as compared with those of the year 1891, though the total is still in excess of that of the year 1890. In passenger traffic there has been a falling off in the number to the extent of 1,591 first-class and 5,137 third-class passengers, making a total of 84,970, compared with 91,698 in 1891 and 82,802 in 1890. The receipts have consequently fallen to £2,663. 0s. 5d., as compared with £2,830. 4s. 2d. in 1891 and £2,579. 19s. 5d. in 1890. The goods and mineral traffic fell to 136 tons from 181 tons in 1891, and 316 tons in 1890 while the receipts under this head have fallen from £29. 1s. 5d. to £17. 7s. during the year. As this traffic was a serious cause of loss in past years, this diminution is not to be regretted. The miscellaneous receipts and those for parcels have diminished from £31. 9s. to £24. 8s. 6d., so that the total recipts from revenue account have been £2,704. 15s. 11d., as against £2,895. 14s. 7d. in 1891, and £2,698. 15s. 4d. in 1890. On the other hand, there has been a considerable reduction on the expenditure side of the account, which shows a total of £1,720. 18s. 10d., as against £1,945. 6s. 6d. in 1891, and £1,687 12s. in 1890. There is consequently a credit balance on the result of the year's working of £983. 17s. 1d., as against £950. 8s. 1d. in 1891, and £1,011. 3s. 4d. in 1890. The past year has therefore fully maintained the successful turn in the state of the finances of the Company which took place in 1890 and 1891, the corresponding credit in 1889 having been only £381. 18s. 7d. The net result of the year has, on the whole been satisfactory, though no dividend can yet be announced.

Elmore's French Patent Copper Depositing Company (Limited).

An extraordinary general meeting of this Company was held on Wednesday at the Cannon-street Hotel, E.C., for the purpose of submitting a resolution giving the Directors power to borrow, for carrying on the Company's business, a total amount not exceeding at any time the issued capital of the Company.

Major CHARLES JONES presided, and in the course of his remarks said that at the general meeting held in April last it was decided, on the recommendation of the Board, to increase the nominal capital of the Company by the creation of 100,000 preference shares of £2 each, and power was taken to issue 60,000 of these shares so as to raise £120,000 additional working capital, which was considered necessary to meet the liabilities of the Company, and to enable the management to push on the manu-

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facture on the large scale for which the works at Dives have been erected. Had that capital been fully subscribed they would have proved months ago, not only that the Elmore process is a commercial success, but also that it is a financial success. Unfortunately through the delay of the English Elmore Company at Leeds to make their business a financial success, confidence in the Elmore affairs has been shaken, and consequently their Preference issue was not responded to sufficiently to enable them to carry out their programme. They had, however, been able to carry on the work at Dives for some months past, regularly and satisfactorily turning out a considerable amount of goods. And further, they had substantiated every statement that M. Secrétan had ever made as to the quality of the products, the cost of manufacture, and the selling prices that can be realised. In a recent circular to the shareholders, the Directors informed them that they had sold the pan license, which they had done and had received the money, and also that they had made a contract with substantial persons for placing the £50,000 First Mortgage Debentures then proposed to be issued. Unfortunately they were misled, and these persons had failed to carry out their agreement, thus placing the Company in a position of great difficulty. Their only remedy was an action at law for specific damages. Therefore they must either raise more capital by some such scheme as they were going to lay before the shareholders; they must sell the Company outright; or they must reconstruct. They had received from business men in France, through M. Secrétan, a proposal for the purchase of the Company, for cash, shares, and debentures, by a new company to be registered in France, and the raising of £60,000 additional working capital. He need not go into the details of this offer, as it was not accepted. M. Secrétan says that if he is given a sum of £30,000 he will, in six weeks' time, be producing and selling 20 tons per week of tubes. This output is sufficient to show a considerable profit. To raise this money, and to provide for accrued liabilities in England, a scheme has been proposed by which Six per Cent. First Mortgage Debenture Stock to the amount of £100,000, redeemable in five years at £105, would be issued. The holders of the existing £50,000 First Mortgage Debenture Stock would exchange their stock either for Preference shares or new Debenture Stock. Their English creditors would be asked to take preference shares in payment of their debts, and the remainder of the new debentures would be taken up by the present shareholders for cash, thus providing the additional capital we require. It was only by some sacrifice on the part of all concerned that they could hope to save the ship. A large part of the present Debenture Stock holders had already consented to exchange their stock for preference shares. The security was good and ample. He then moved:

"*That the Directors be empowered to borrow for the purposes of the Company's business a total amount not exceeding at any time the subscribed capital of the Company.*"

Sir JAS. MACKENZIE seconded the resolution.

M. SECRÉTAN went into figures regarding the immense profits to follow some day, but our readers will be able to gather the purport of these calculations from a perusal of previous reports.

Mr. BODDINGTON (the legal adviser of the Company in Paris) followed with a flowery description of what the Company were doing and were likely to do.

In reply to Dr. Hedley, Mr. F. L. RAWSON said he had spent considerable time in going into the statements made by the French Company, and he found that there had been no mis-statements of any material character. One or two anticipations had not been carried out, but that was because they had not had sufficient working capital.

Mr. SAUNDERS inquired what probability there was of obtaining money at 6 per cent., seeing that the proposal to raise money at 10 per cent. had not been successful?

The CHAIRMAN pointed out that they were now offering Debentures with the security of all the Company's assets, whereas the other issue was only Preferred shares.

Mr. GLADSTONE asked whether the process sold by the Elmore Company was complete?

M. SECRÉTAN replied that the process, as handed over to him, was capable of making, and did make, tubes. He, however, had modified it and added to it, so as to make the product such as no other manufacture could compare with.

Mr. SIMPSON (a member of the committee of shareholders recently appointed) quoted figures to show that the whole of the capital already supplied to the Dire tors had been legitimately spent.

Ultimately the resolution was carried unanimously.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1892, pages 308-322, *&c., &c.*]

BAILY, GRUNDY AND BARRETT (LIMITED).—This Company was registered on January 18, 1893, with a capital of £10,000 in £5 shares. The objects are to take over the business carried on by Robert M. Baily, at No. 2, St. Mary's-passage and Magdalen-street, Cambridge, as electricians, mechanical engineers, and manufacturers, workers, and dealers in electricity, motive power, and light, and manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the generation, supply, accumulation, distribution, and employment of electricity, and to acquire the right to use or manufacture and put up telephones, telegraphs, and other electrical apparatus. The subscribers are—

	Shares.
Arthur Barrett, St. Mary's-passage, Cambridge, electrical engineer ...	240
Edwin Barrett, 30, Market-place, Cambridge	80
William E. Lilley, 12, Market-street, Cambridge.....	160
John L Smith, 19, Parkside, Cambridge	60
Samuel R. Ginn, Cambridge	60
William J. Crampton, St. Mary's-passage, Cambridge, electrical engineer	1
George A. Matthew, Cambridge, electrical engineer	1

DYNEVOR SPELTER COMPANY (LIMITED).—Capital, £20,000, in £50 shares. Objects: To manufacture and deal in spelter, lead chloride of zinc, zinc oxide, zinc galvanising, copper, &c.

EGGLESCLIFFE IRON COMPANY (LIMITED).—This Company was registered on January 24, 1893, with a capital of £27,000, in £10 shares, to carry on the business of mechanical and electrical engineers, electricians, &c., at the Egglescliffe Foundry, near Stockton-on-Tees.

ELECTRIC CONSTRUCTION CORPORATION (LIMITED).—The annual return of this Corporation, made up to December 30, 1892, has been filed. The nominal share capital now consists of £750,000, divided into 100 founders' shares of £10 each, 62,400 ordinary shares of £10 each, and 12,500 preference shares of £10 each. Of these, 100 founders, 49,900 ordinary, and 2,926 preference shares have been taken up, of which 4,900 ordinary shares have been issued as fully paid. Upon the 100 founders', 45,000 ordinary, and 2,926 preference shares the full amounts have been called. The calls paid have realised £465,849. 14s. 11d., while a sum of £10,501. 5s. 1d. is yet in arrears.

GENERAL METALLURGICAL COMPANY (LIMITED).—Capital £5,000, in £1 shares. Objects: To acquire and turn to account certain secret processes for manipulating and blending metals.

ALLCHIN, LINNELL, AND CO. (LIMITED).—Notice is given that a first and final dividend in this liquidation of 1½d. in the pound is payable at the Official Liquidator's office, 33, Carey-street, London, W.C., any day except Saturday.

ART WORKSHOPS (LIMITED).—A winding-up order was made in the Royal Courts of Justice on January 21st.

MACMAHON'S PATENT ELECTRIC CHECK SYSTEM (LIMITED).—A meeting of this Company is to be held at the Salisbury Hotel, Salisbury-square, London, E.C., on March 3rd, at 3 p.m., to receive an account of the winding up.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY (LIMITED.)—The statutory return of this Company, made up to Jan. 19, 1893, has been filed. Only seven shares of a total capital of £50,000, in £5 shares, have been taken up. The full amounts have been called, and all calls (£35) paid.

S. Z. DE FERRANTI (LIMITED).—The annual return of this Company, made up to December 24, 1892, has been filed. The Company has a capital of £100,000, divided into 2,000 £7 per cent. preference, and 8,000 ordinary shares of £10 each, and was registered on June 26, 1890, to carry on the business of electrical and general engineers carried on by Sebastian Z. de Ferranti, Francis Ince, and Charles P. Sparks. The Company acquired the business for £99,930, which was fully satisfied by the allotment of 1,993 fully-paid preference shares of £10 each, and by the allotment of the 8,000 fully-paid ordinary shares of £10 each. At the time of making up all the shares had been taken up, of which seven preference shares have had the full amount called and paid on them, the remainder having been issued as fully paid in accordance with the above agreement.

WOODHOUSE AND RAWSON UNITED (LIMITED).—The annual return of this Company, made up to January 5, 1893, has been filed. Out of a total share capital of £550,000, divided into 60,000 ordinary shares of £5 each, and 50,000 preference shares of £5 each; 55,197 ordinary and 41,008 preference shares have been taken up. Of these shares, 8,564 ordinary and 9,936 preference shares, of a nominal value of £92,500, have been issued as fully paid. Upon 31,072 preference and 9,119 ordinary the full amount has been called, and upon the remaining 37,514 ordinary shares calls amounting to £3. 15s. per share have been made, resulting in the payment of £8334,351. 12s. 6d. (which includes a sum of £180 paid on 60 shares forfeited), and leaving £7,280. 17s. 6d. as yet in arrear.

CITY NOTES, &c.

BUDAPEST.—Messrs. Ganz and Co. are reported to be forming a limited liability company, with a capital of £300,000, to carry on the electric lighting of the town of Budapest, Hungary.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended January 29nd were £976, as against £823 for the corresponding period of last year, being an increase of £153 The total receipts for half-year amount to £3,954, against £3,328 in the corresponding period of 1892, being an increase of £626.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of January amounted to £60,516 and to £63,436 in the corresponding period of 1892

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the

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month of January, 1893, amounted to £40,040, and to £42,805 in the corresponding period of 1892, or an increase of £235.

FRENCH ELECTRICAL POWER STORAGE COMPANY (LIMITED).—The creditors of this Company (which has been for some years in liquidation) are notified that a first and final dividend of 0·28f. per cent. is now payable at the office of M. Roucher, 1 bis, Rue Hautefeuille, Paris.

HOPE-JONES ELECTRIC ORGAN COMPANY (LIMITED).—This Company are inviting subscriptions for the balance of their Preference shares.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended January 27, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,648.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 25.	Price Wednesday, Feb. 2.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 2. Highest	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	54½ 55½	53½ 54½	4 11 9	Jan., Apr., July, Oct.	55½	54
£2,876,140	Stock	25/0	Do. Preferred	97 98	95½ 96½	5 8 10	,, ,,	97¼	96
£2,876,140	Stock	5/0	Do. Deferred	13½ 14	12½ 13	..	,, ,,	13 1/16	12¾
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11 11½	11¼ 11½	5 10 8	Mar., June, Oct., Dec.	11⅞	11¼
£68,200	£100	5%	Do. 5 per Cent. Bonds xd	101 104	99 102	4 18 0	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	104 108	104 108	4 12 7	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175 180	175 180	3 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12 13	12 13	6 3 1	February and August	..	..
6,000	10	10%	Do. Preference 10%	17½ 18½	18 19	5 5 3	,, ,,	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2 3	2 3	5 6 8	April and October..	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	,, ,,	..	..
60,710	20	3/6	Direct United States xd	11⅜ 12	11⅝ 11⅞	5 19 2	Jan., Apr., July, Oct.	11⅜	11⅜
400,000	10	2/6	Eastern	14¾ 15	14⅜ 15	4 6 8	,, ,,	15	14¾
70,000	10	6%	Do. 6 per Cent. Preference	16 17	16 17	3 10 7	,, ,,	16 3/16	16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	111 114	111 114	3 10 2	May and November	113	112
£105,900	100	5%	Do. 5 per Cent. Debentures 1899 xd	108 111	106 109	4 11 9	February & August	109	..
250,000	10	2/6	Eastern Extension	14⅞ 15⅛	14⅞ 15⅛	4 12 7	Jan., Apr., July, Oct.	15⅛	15
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	111 114	109 112	3 11 5	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102 105	103 106	4 14 4	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor Deb. 1900	102 105	102 105	4 15 3	,, ,,	104½	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.) xd	103 106	101 104	3 16 11	February & August	..	..
180,227	10	1/3	Globe Telegraph and Trust	9⅜ 10	9⅜ 10	4 15 0	Jan., Apr., July, Oct.	9 1/16	9 1/16
180,042	10	6%	Do. 6 per Cent. Preference	15 15½	15 15½	3 18 8	,, ,,	15 1/16	15
150,000	10	5/0	Great Northern	18¾ 19½	18¾ 19¼	4 8 4	Jan., April, and July	18¾	18¾
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	105 108	4 12 7	March & September	106	..
17,000	25	12/6	Indo-European	44 46	43 45	5 11 1	May and November	44½	43½
88,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	,, ,,	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108 111	108 111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October..	..	..
3,381	£100 Cert.	30,0	Submarine Cables Trust 6%	120 125	120 125	4 16 2	,, ,,	124	120½
15,609	10	5/0	West African Telegraph	6¾ 7½	6½ 7½	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	101 104	102 105	4 15 3	March & September	104	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	101 105	101 105	7 12 5	June and December	...	..
88,321	10	6d.	West India and Panama	1½ 1¾	1½ 1¾	..	,, ,,	1 1/16	1 1/16
84,563	10	6%	Do. 6 per Cent. 1st Preference	10½ 11	10½ 11	5 9 1	May and November	11	10¾
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½ 9⅓	8½ 9½	6 6 4	.. ..	..	..
£30,000	100	5%	Do. 5 per Cent. Debentures, 1917	105 108	105 108	4 12 7	June and December	..	..
64,242	15	3/0	Western and Brazilian	7⅜ 8¼	7⅜ 8½	5 9 1	,, ,,	8 1/16	8
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5¾ 6¼	5¾ 6¼	6 0 1	,, ,,	6¼	6
33,129	7½	4/6	Do. 5 per Cent. Deferred	1⅜ 2¼	1⅜ 2¼	..	,, ,,	2 1/16	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910 xd	106 109	104 107	5 12 2	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910 xd	106 109	104 107	5 12 2	,, ,,	109	106¾
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	103 106	103 106	5 13 2	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
224,880	14/0	1½d.	Consolidated Telephone Const. & Maintenance	1 3/16 1 5/16	1 3/16 1 5/16	7 16 5	May and November	..	..
220,000	£1	4½d.	Oriental (11s. paid)	⅜ ½	⅜ ½	7 18 2	Yearly	..	..
454,747	5	2/6	National	4⅜ 5⅛	5⅛ 5⅜	5 11 7	June and December	5 7/16	4 15/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14 15	14½ 15½	3 17 6	,, ,,	14 15/16	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13⅜ 14½	13⅜ 14½	4 4 3	,, ,,	14⅜	14
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	4½ 4⅝	4½ 4⅝	..	..	..	..
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112 115	112 115	3 18 3	January and July ..	114½	113½
48,000	£10	..	New Telephone, Limited (£4 paid)	.. ..	.. ..	..	.. ..	..	..
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	,, ,,	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	11½ 12	11⅜ 14¼	..	..	12¼	11⅞
20,000	£10	..	Do. 6 per Cent. Preference	7¾ 8¼	7¾ 8¼	2 18 2	..	8⅛	8
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	.. ..	.. ..	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	.. ..	.. ..	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	.. ..	.. ..	..	January and July ..	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	4 4¼	4 4¼	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5¾ 6	5¾ 6	..	March	..	..
111,000	5	..	London Electric Supply	⅝ ¾	⅝ ¾	..	..	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6¾ 7¼	6½ 7	..	..	6 7/8	6⅝
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5 6	5½ 6½	..	..	..	..
18,680	£5	9½%	St. James' and Pall Mall xd	7¾ 8¼	7¾ 8¼	..	..	8⅛	7 13/16
7,900	£5	7%	Do. 7% Preference xd	8¼ 8¾	8 8½	4 2 4	..	8 5/16	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5¾ 6¼	5¾ 6¼	2 8 0	..	6	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/9⅜	Brush Electrical Engineering	3½ 3⅝	3½ 3⅝	..	..	3⅝	3½
69,996	2	6%	Do. 6 per Cent. Preference	2⅝ 2⅞	2⅝ 2⅝	4 11 5	..	2⅞	2⅝
£125,000	Stock	..	Do. 4½ per Cent. Debentures	102 104	103 105	..	..	104⅝	103½
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July ..	5⅝	5 1/16
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	.. ..	.. ..	..	..	..	..
45,000	10	12/0	Electric Construction	2¼ 2⅜	2¼ 2⅜	..	..	2¼	..
70,000	2	10/0	Elmore's Patent Copper Depositing	⅛ ¼	⅛ ¼	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	22 23	22½ 23½	5 6 4	February & August	23½	22¼
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	103 105	4 5 9	March & September	103½	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	4/0 6/0	4/0 6/0	..	..	..	..
78,949	5	4/2⅝	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	..	..
87,350	12	12/0	Telegraph Construction and Maintenance	45 47	45 47	5 2 2	March and July.....	46½	..
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July ..	..	..
..	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	..	..	..	..
..	£5	8%	Do. Preference (fully paid)	.. ..	.. ..	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	.. ..	.. ..	..	..	..	..
600,000	Stock	½%	Do. Stock	35 38	37 39	1 5 7	May and November	..	..

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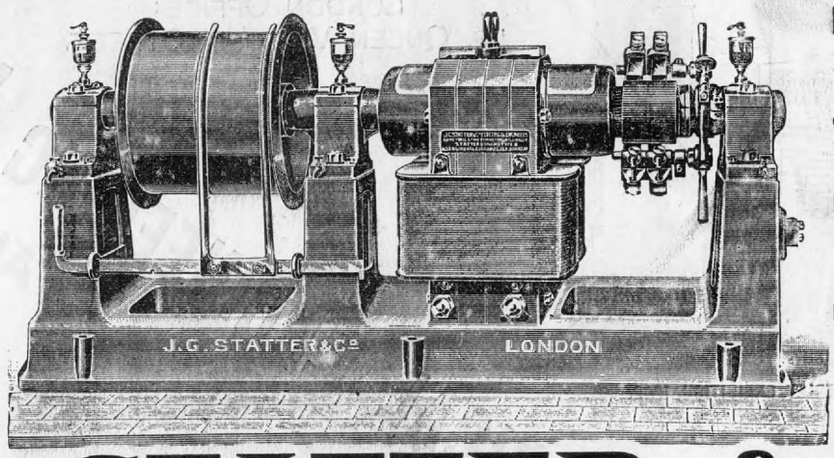

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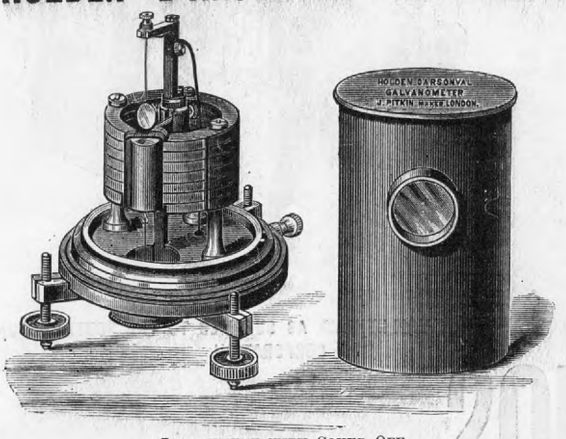

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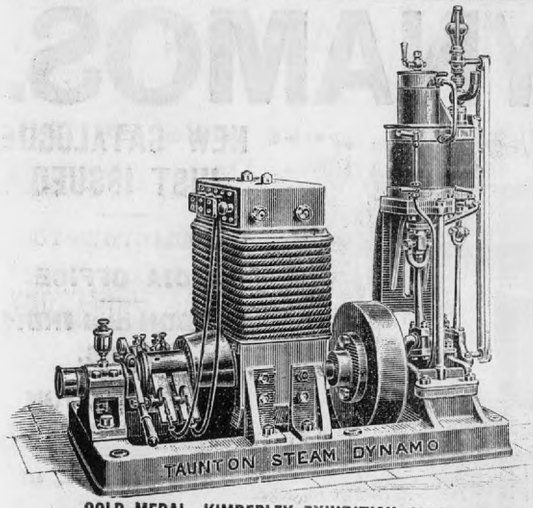

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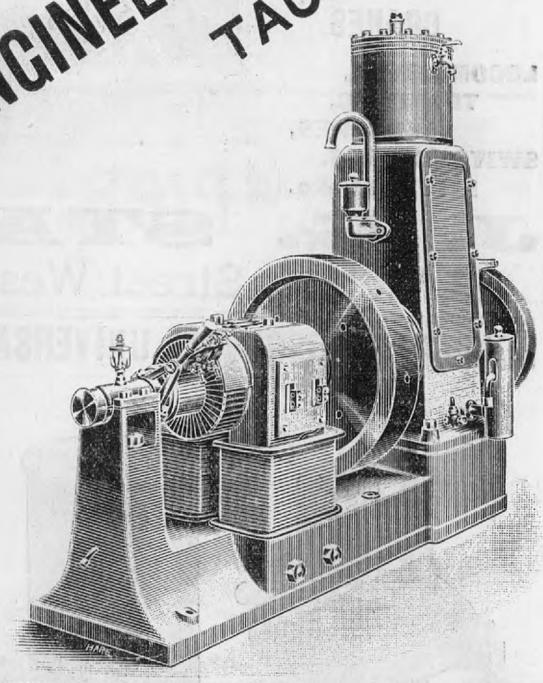

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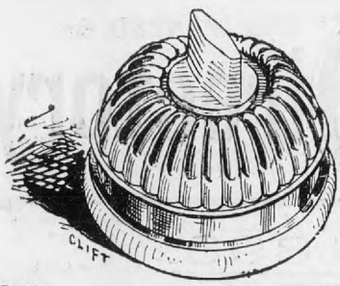

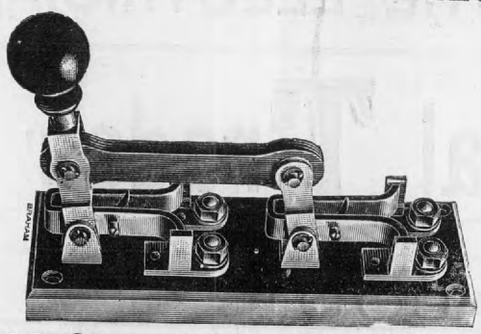

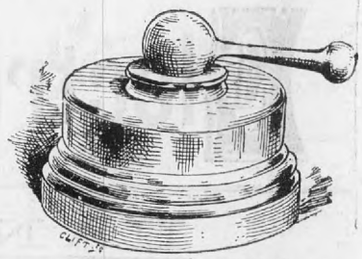

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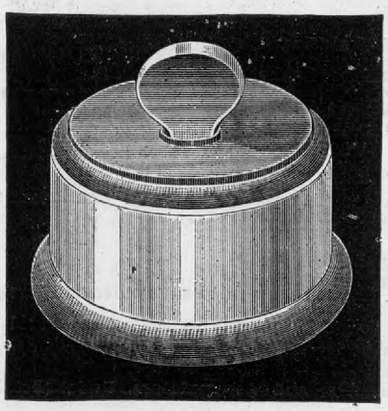

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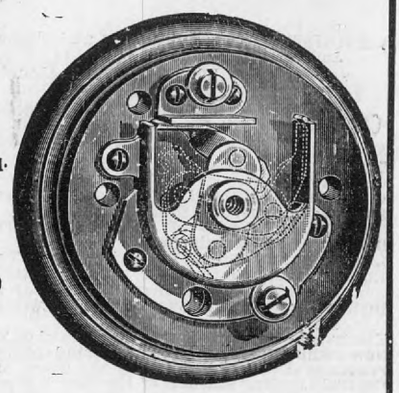

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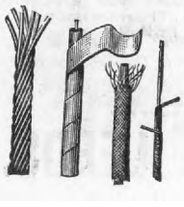

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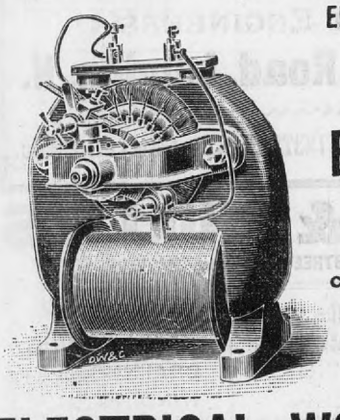

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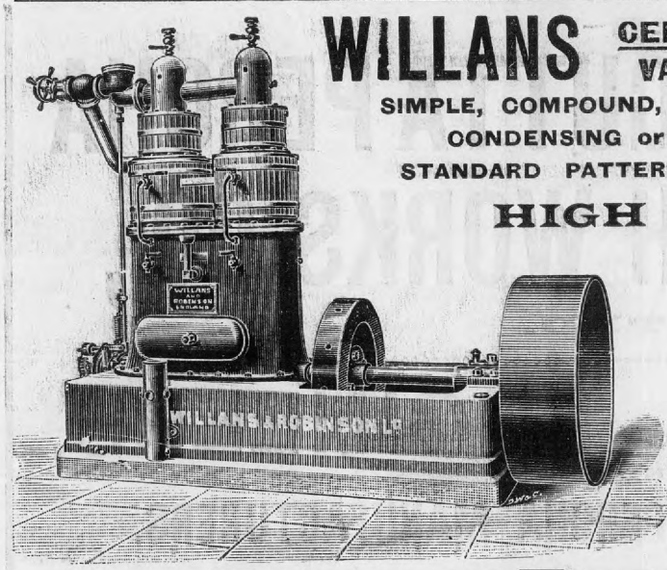

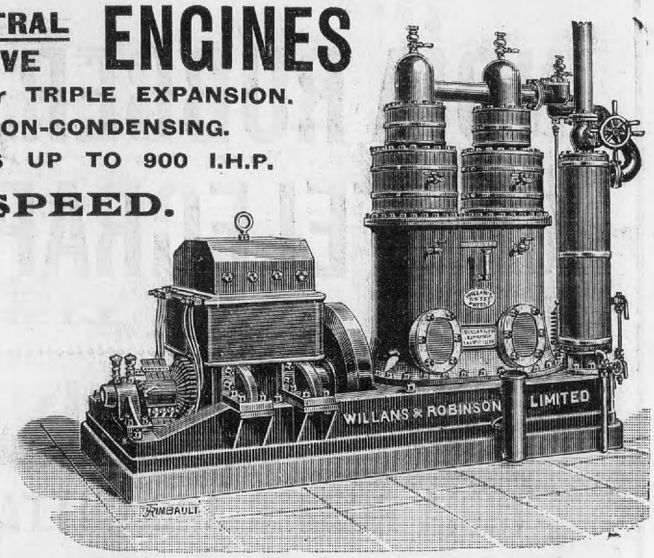

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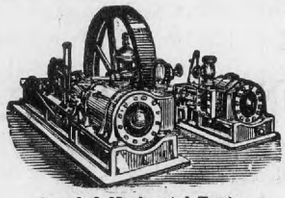

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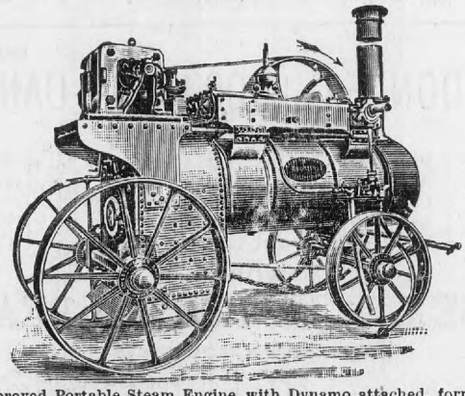

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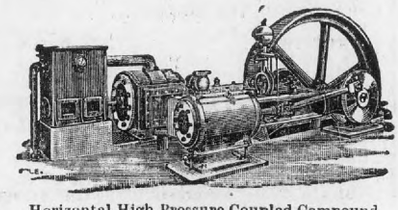

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 769.—Vol. XXX. FRIDAY, FEBRUARY 10, 1893. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

A brief account of the Liverpool Overhead Railway will be found in another column, together with a few illustrations which, although engraved some time ago, we have, by special request, refrained from publishing until after the opening ceremony. Many columns might be filled with a description of the construction of the line, but this is outside our province. The electrical arrangements, as far as locomotion is concerned, appear to be admirably simple. The use of motors on each carriage, instead of on a separate locomotive, is undoubtedly the ideal method, and the supposed need for concentrating otherwise useless weight on the driving wheels to give the necessary adhesion will, we hope, disappear as completely as the ancient idea that racks were necessary for this purpose in ordinary railway work. It may be that a separate motor will be wanted for each wheel in some cases.

Mr. A. Wright has lost no time in putting into practice the method of charging for electrical supply which he described in our Correspondence Columns some six weeks ago, and the Brighton Corporation are now charging only half-price, or 3½d. per supply unit for all consumption in excess of two hours per day for each 8-c.p. lamp fixed. A recording instrument is placed by the Corporation on the consumers' premises. The readings of this instrument are to be averaged in the three darkest months of each half-year, and this average will be taken as indicating the number of 8-c.p. lamps demanded, also the number of units to be consumed in each half-year before half-price begins to be charged. The total number of hours between sunset and 8 p.m. throughout the year may be reckoned up laboriously from an almanack, but it is evident that in any part of the world the average time of sunset is 6 o'clock, and there must be an average of two hours between sunset and 8 p.m., making about 730 hours in the year. A 32 watt lamp for 730 hours at 7d. comes to 13s. 8½d., and this average must be attained before the price begins to fall below 7d. The average revenue per lamp of the St. James's and Pall Mall Company for the last half-year was 13s. 11d., and this figure will doubtless stand near the top of the list when the accounts of the companies are published. In order to reduce the price to 6d. per unit, each lamp must be burned from sunset till 8.45 p.m., and to reach 5d. it must not be extinguished until 10.40 p.m.

Torn by tar distillers, coaxed by coke merchants, and devoured by dealers in ammonia, the Gaslight and Coke Company find that they are unable to reduce the price of gas to the old figure; and instead, as had been expected, of being able to add some £30,000 or £40,000 to the reserve, they have only been able to make both ends meet, and to carry forward £500. They are evidently just beginning to feel the competition of electric lighting; it is very trifling at present, but just enough to give a bitter flavour to that part of Colonel Makins's speech, at the recent meeting of this Company, which dealt with electrical matters. It was, perhaps, as well that the St. James' and Pall Mall Company had not at that time declared a voluntary reduction of over 14 per cent. in their price, viz., from 7d. to 6d., with a sliding scale discount for large consumers, bringing it down to 5d. in some cases. But this would have been so easily explained, because everybody knows that this is a favoured district, and the members of Clubs in Pall Mall may be found "huddled together in the smoking-room, cursing the electric light for its want of warmth, and bemoaning the departure of gas."

The determination of insulation resistance and of faults during the working of electrical supply is a problem which has forced itself on the notice of every station manager, but is one which has often baffled him. Dr. O. Froelich has sent us, in English, a valuable article on this subject, but we have been unable until now to present the first instalment of it to our readers. The subject is readily handled by the mathematician or the arm-chair engineer, but Dr. Froelich clearly recognises the practical considerations of the problem, and the rather elaborate formulæ which will appear in our next issue should not cause needless alarm; the testing of submarine cables, as the author observes at the conclusion of the articles, was at one time regarded as "scientific humbug."

Prof. G. Forbes' suggestion that other correspondents should add to his list of useful formulæ has resulted in several communications, some new and some old. That such formulæ should be useful, in the sense implied by Prof. Forbes, they ought to be in an easily remembered form. Mr. Kingdon's rule, for example, contains a rather long row of 0's, and when the sectional area of a wire has to be measured in square inches, the application of this formula will be accompanied by a rather bewildering number of insignificant but important cyphers. A modification of this rule is that a wire of a sectional area of one-thousandth of a square inch runs 12½ feet to the ohm. Accurately, 12·66, or, at 95 per cent. conductivity, 12. In connection with this, a rule for the area

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of a circle may be useful, since, if we have to look up the area of a wire in a table, we may as well look up the resistance. To find the area of a circle approximately, square the diameter and subtract one-fifth. For example—diameter 5, the square is 25, the square less one-fifth is 20; the true area being 19·6349, or 1·8 per cent. less. For greater exactness, therefore, subtract also 2 per cent.

Cable Interruptions and Repairs—

	Interrupted.	Repaired.
Senegal-Pernambuco	Dec. 26, 1892	Feb. 9, 1893.
Cayenne-Vizeu	Sept 24, 1892	—

The Engineering Exchange.—On Monday, the 30th ult., the Lord Mayor formally opened the Engineering Exchange in Billiter-street.

Lancaster.—The Town Council has resolved to apply for power to borrow £25,000 for the purpose of carrying out an electric lighting scheme.

Personal.—Mr. Emile Garcke, having accepted the appointment of managing director to the Electric Construction Corporation, has resigned his seat on the Board of the Brush Electrical Engineering Company.

Electricity on the Stage.—At the Comédie-Française a new drop-curtain, raised and lowered by electric motors, has been installed by the Edison Company, the current being derived from the Palais Royal Station.

St. Pancras.—At the last meeting of the St. Pancras Vestry, Mr. Sweet, Chairman of the Electricity Committee moved the adoption of the accounts for the year ended December 31st last. The motion was adopted unanimously.

Liquid Oxygen.—At the general monthly meeting of the members of the Royal Institution, held on Monday last, special thanks were returned for several donations, amounting in all to £110, for carrying on investigations on liquid oxygen.

Newcastle-upon-Tyne Electric Supply Company.—For the year ended December 31st last the units metered by this Company's meters were as follows:—Private consumers, 330,838; public lamps, 4,303; used at works, 11,687; total, 346,828.

Woolrich's Magneto-Electric Machine.—The Birmingham Corporation have granted, through the United States Commission, the loan of the historic Woolrich Magneto-Electric Machine to Messrs. J. E. Hartley and Son, of Birmingham, who will exhibit it at Chicago.

Cyclone Dust Collector.—We understand that Prof. V. Boys is not the inventor of the cyclone dust collector, as suggested in our last issue, but was engaged on the recent patent case in connection with the allegation that the Boys and Cunynghame steam trap was an anticipation of the above invention.

The St. Pancras Arc Light Pillars.—People in the Euston-road were alarmed one evening recently by an explosion. Some gas is stated to have accumulated in one of the arc lamp columns, and having ignited explosively, blew out the door to the switch chamber at the base. The light itself, however, was not affected.

Trans-Mediterranean Cable.—The steamer "Calabria," having on board the cable to be laid for the French Government between Marseilles and Tunis, arrived at Bizerta yesterday, having successfully accomplished the first part of the operation. Between Bizerta and Tunis, the junction will probably be effected in two days.

Westminster Electric Supply Corporation, Limited.—This Corporation give notice that, from March 31st next, the standard charge for electric energy will be reduced to 6d. per Board of Trade unit, with a sliding scale of rebate to clubs and other large consumers. For current supply for lifts and other motor power the charge is 5d. per unit.

Firth College, Sheffield.—A *conversazione* has just been held at this college to celebrate the completion of the additional building. The addition comprises new physical and biological laboratories, workshop, and class-rooms, and considerably increases the accommodation available for teaching purposes. The cost, £5,500, has been wholly defrayed by local subscriptions.

Patents in 1892.—The record of applications for patents in the United Kingdom during the past year shows that the increase noted annually since 1883 still continues. The number of applications in 1892 was 24,166, a total far exceeding that of any previous year, and greater by 1,278 than that of 1891. In the United States the annual number of applications for patents is about 40,000.

The Tudor Accumulator.—In the latest type of Tudor cell, the negative plate is a lead sheet, scored vertically, and the positive plate is composed of horizontal triangular strips, arranged in a series of vertical columns. Each plate rests on a glass block running across the cell underneath it, and secured at either end in a groove, the glass supports themselves resting on a strip of rubber running down each side of the cell.

The Adams Prize.—The Adams Prize, offered biennially and open to the competition of all persons who have at any time been admitted to a degree in the University of Cambridge, has been adjudged to Prof. J. H. Poynting, D.Sc., late Fellow of Trinity College. The subject of the essay is, "The Methods of Determining the Absolute and Relative Value of Gravitation and the Mean Density of the Earth." The prize was last awarded in 1883.

Bewdley.—At the last meeting of the Town Council a report was brought up from the Electric Lighting and Water Committee relative to the possibility of utilising the water of the Severn for the purpose of pumping water for the supply of the Borough, and for providing the electric light. Power was asked to incur a small expense for making further inquiries. There was considerable discussion on the subject, and ultimately the report of the Committee was adopted.

Ships' Electric Side Lights.—A memorandum having been received by the Admiralty from the Board of Trade stating that the tint of green in ships' side lights is affected when the lamps are lighted by electricity, the Portsmouth officers have ordered that, with a view of ascertaining whether the tint of green used in the naval service is suitable for navigating purposes, a report is to be forwarded through him to the Admiralty from each ship fitted with electric lanterns.

Electrical Bills in Parliament.—On Monday evening last private Bills, the progress of which was interrupted by the general election, were brought in and read a first and second time in accordance with the relief order of February 15th last. The Bills included the Baker-street and Waterloo Railway, City and South London Railway, Hampstead, St. Pancras, and Charing-cross Railway, London County Council (Subways), National Telephone Company, and Waterloo and City Railway.

The Distribution of Electric Energy.—In a recent issue we called attention, in the course of some remarks on a County Court decision, to the fact that no statutory "electric lighting" company bound itself to do more than supply "electric energy," a fact which, by itself, invalidated the argument that consumers' lamps were part of a company's plant. *L'Industrie Electrique* puts the matter very pithily. "The distribution of light," says our contemporary, "is, in the present state of our knowledge, theoretically possible, experimentally realisable, but commercially absurd."

Windsor.—The Windsor and Eton Electric Light Company are now supplying current to a few business premises. The mains are laid upon a system devised by Mr. T. Tomlinson, late chief engineer to Messrs. Gordon and Co., and described in our issue of December 2, 1892. The conductors are copper tubes, having a sectional area of 0·1 square inch, and they rest on porcelain insulators laid in a concrete trench, the trench being filled up with an asphalte composition. Over this strips of calico are placed to exclude dust or dirt, and then the whole is sealed in with concrete filled in up to the pavement.

The West End Street Railway (Boston).—The United States have been suffering from an unusually severe visitation

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of snow lately, and the technical journals contain numerous reports of the manner in which the "electric cars" overcame all obstacles. In Boston the service of the West End Street Railway is said to have been maintained admirably. They had out 80 snow-ploughs and sweepers, each run by two 25 H.P. motors. About 160 miles of track had to be cleared. They were sent out the moment snow came on, with the result that not a single trip was lost.

The Hodgkins Fund.—On the subject of the Hodgkins Fund the following resolution has been passed by the managers of the Royal Institution:—"Having regard to the fact that the work of the Institution is devoted to the attainment of truth, and thereby constitutes in itself an investigation of the relations and co-relations existing between man and his Creator, resolved, that the income of the fund be devoted to that work, and that once in seven years a sum not exceeding 100 guineas be paid to some person, to be selected by the managers, for writing an essay showing how the work of this Institution has during the preceding period of seven years furthered the objects of the trust."

Obituary.—The death is announced of Mr. Alfred Carpmael, a member of the well-known firm of Wilson, Bristows and Carpmael, who act as honorary solicitors to the Institution of Electrical Engineers.——The death is also announced of Mr. George Mathews Whipple, superintendent of the Kew Observatory. Mr. Whipple was fifty years of age. He entered the Kew Observatory in 1858, and in 1862 became magnetic assistant. He was appointed superintendent of Kew Observatory in 1876, and for the past sixteen years he has contributed the results of his investigations to the Royal Meteorological Society. The magnetic part of the report of the committee of the Royal Society which met to discuss the Krakatoa eruption and the subsequent phenomena was written by him.

Derry.—At the last meeting of the Lighting Committee of the Corporation the following resolution was carried unanimously:—"That the sanction of the Local Government Board having been given to the application of the Corporation for a loan of £15,000 at 3½ per cent. interest, the principal repayable by equal instalments in twenty-five years, for the public lighting by electricity of the city, including the Waterside, it is resolved that such loan be accepted, and, in order to ascertain accurately the cost of the proposed scheme, that tenders be invited for the carrying out of the works in such form that contractors can tender for the whole or any part or parts of same, the erection of the buildings for the generating station to be confined to local contractors."

The Cable Ship "Amber."—A *Times* telegram, dated Zante, February 8th, says:—"The cable ship 'Amber,' belonging to the Eastern Telegraph Company, has arrived here, having been ordered hither from Egypt as soon as the news of the disastrous earthquakes in the island became known. Her officers and crew are now energetically assisting in alleviating the existing distress. A quantity of stores most needed by the inhabitants have already been landed from the vessel. Captain Greey, of the 'Amber,' has been received by King George, who expressed to him his gratitude to Sir John Pender, Sir James Anderson, and the other Directors of the Eastern Telegraph Company, for the help given in the hour of trial. His Majesty declared that he would never forget the energy which the English had shown in providing prompt relief for the distressed."

Electric Traction in Brussels.—A proposal is well advanced for providing Brussels with an underground electric railway similar to the South London line. The railway will be arranged similar to the Inner Circle railway, having eleven stations at the most important points of the City. No locomotives will be employed, but each train will consist of only one first and second-class composite bogie carriage, to carry forty passengers, with a compartment in front in which the electric traction gear will be arranged. It is proposed to run eleven such cars in each direction, and to work the traffic by the automatic electric block system, as adopted on the Liverpool electric railway. The lifts at each station will be operated by electric power. Messrs. Alexander Penney and Co. are the agents for the syndicate, and Mr. J. H. Greathead has been appointed engineer.

The First Swan Lamp.—On Wednesday morning last, at a quarter to 6, the premises of the Literary and Philosophical Society of Newcastle-on-Tyne were discovered to be in flames. The outbreak was first noticed by a telegraph clerk, who communicated by telephone with the fire brigade. The Society was founded in 1793, and the foundation stone of the present building, which cost £14,500, was laid by the Duke of Sussex in 1822. On Tuesday evening the centenary of the Society was celebrated by a *conversazione*. Half of the library of 35,000 volumes was completely destroyed, and the flames scorched all the books and the furniture which were not destroyed. The building was heated by hot-water pipes and lighted by electricity. The cause of the fire is not known. It was in this Society's rooms that on February 3, 1879, Mr. Swan showed to an audience of 600 to 800 persons the first carbon glow lamp running off a dynamo.

Fatal Electric Light Accident.—A dynamo tender named George Gifford, an *employé* of the Brighton and Hove Electric Light Company, met his death late on Sunday night last. It appears that the deceased went to the assistance of the electrician in charge, Mr. E. R. Maples, engaged in switching the load over to one dynamo, and that the deceased inadvertently put both his hands behind the base of one of the switch plugs, and was killed. At the inquest evidence was given to the effect that the deceased had been warned of the danger of doing what he did, and that he was a steady, competent, experienced man. Amongst the witnesses called was Mr. George Joseph Philpott, chief engineer to the Company, and Mr. William Lowrie. After deliberation, the jury returned a verdict of "Accidental death," and added a rider to the effect that the instruments ought to be more efficiently protected, the foreman remarking that it ought to be done, and done at once.

The London County Council and Technical Education.—The Report of the Technical Education of the London County Council, which was discussed by us in a leading article on January 27th, came up for adoption at the meeting of the Council on Tuesday last. The following addition to resolution No. 1, recommending the Council to exercise its powers under the Technical Instruction Acts, 1889-91 was carried:—"Provided that the City Livery Companies be invited to contribute for the same purpose a sum of not less than one-tenth of their corporate income as distinguished from their trust property." Resolution No. 2, recommending the formation of a composite body, to be called the Technical Education Board, to administer the funds, was agreed to by a large majority, notwithstanding that Mr. Tillett objected to such delegation of authority as being "antagonistic to democratic principles." The discussion was adjourned after acceptance of the third recommendation, that the Board should be appointed for a term of three years.

The Drehstrom at Dresden.—The administration of the Royal Saxon State Railways has decided on the construction of an electric central station to supply all the Dresden railway stations with light and power. From the various schemes submitted, that of Messrs. Siemens and Halske, slightly altered by Mr. Ulbricht, of Dresden, was adopted. This scheme proposed the use of the "drehstrom." On completion of the station, the output is to be 1,300 H.P. The installation will consist of five boilers, four engines, and the same number of "drehstrom" machines of 330 H.P., each running at a speed of 100 revolutions per minute. The station pressure of 120 volts is raised by transformers to 3,000 volts, and reduced again for use at the lamps and motors. The network stretches to places four miles distant, and feeds 600 arc lamps and over 3,000 glow lamps. The work has been divided between Messrs. Siemens and Halske and the Helios Company of Cologne, the former firm being responsible for the station, the motors, and the station transformers, while the latter company provide the mains and the lighting arrangements. This station will be the largest in existence working on the "drehstrom" principle.

The Telephone Tubes in the City.—At the last meeting of the Commissioners of Sewers the clerk read a letter from Mr.

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H. S. Foster, M.P., pointing out that the City of London Electric Lighting Company would ask permission to break ground for the purpose of laying down tubes for telephonic purposes, the right of which he stated had been sold to the Pioneer Company, and then transferred to the new Telephone Company, and finally transferred to the National Telephone Company. Much serious dissatisfaction existed in the City in respect to the present charges for the use of the telephone, and it was intended therefore to establish a new company which would introduce a better and cheaper system. Mr. Foster also reminded the Commissioners that if they gave their permission to the application they would be giving also a monopoly to the National Telephone Company, and he hoped permission would be postponed. Mr. Morton, in moving that the subject should be referred to the Finance and Improvement Committee and the Streets Committee, said the citizens needed protection in the matter. This motion having been seconded, it was carried, the Remembrancer was instructed to oppose the National Telephone Company's Bill on the second reading.

Electric Smelting Patent Litigation in America.—The suit between the Pittsburg Reduction Company, of Pittsburg, Pa., and the Cowles Electric Smelting and Aluminium Company, of Lockport, N.Y. and Cleveland, Ohio, for infringement, was, says the *Electrical Engineer* of New York, decided in favour of the plaintiffs, on January 11th, by the United States Circuit Court for the Northern District of Ohio. The decision, says our New York contemporary, was a sweeping one, inasmuch as the Hall patent for the reduction of pure aluminium by electrolysis was sustained on every point. Mr. Hall's invention consists in the reduction of alumina by dissolving it in a fused mass of fluoride of aluminium, together with a fluoride of some other metal more electro-positive than aluminium, and precipitating the metallic aluminium from the dissolved alumina by means of electrolysis. The dissolving fluoride bath remains practically constant, and the process is a continuous one, for the reason that the ore is simply dumped into the bath, when the precipitation immediately begins, and the metal is either tapped out, or ladled out without any interruption whatever. In 1866, Mr. Hall had an interference suit with M. Heroult, owner of the large aluminium works, near Schaffhausen, on the Rhine. The suit lasted a year, and Mr. Hall was adjudged the prior inventor. The point then at issue was one of those raised in the present suit.

Exports of Telegraphic Apparatus.—The Board of Trade Returns, just published, enable a comparison to be made of our exports of telegraphic wires and apparatus connected therewith for the whole of last year in comparison with the two previous years. The figures are disappointing both for the month of December and for the twelve months. It will be seen from the table given below that the total value of our exports under this head for 1892 were less than £1,000,000, as compared with nearly £1,500,000 in 1891, and as compared with considerably over £1,500,000 in 1890. The percentage decrease last year was 36 as compared with 1891, and 43 as compared with 1890:—

—	1890.	1891.	1892.
First quarter	£324,670	£653,081	£96,079
Second quarter.....	397,042	331,449	579,756
Third quarter	210,280	342,106	124,605
Nine months.....	£931,992	£1,326,636	£800,440
October	£335,064	£38,167	31,198
November	246,378	25,143	39,993
December	88,829	44,927	38,439
Year	£1,602,205	£1,434,020	£910,070

It will be seen that the aggregate figures do not quite tally with the total monthly returns. This is owing to the fact of previous returns having been adjusted since their issue.

Belfast.—There seems to be a possible opening for electric traction in Belfast. The option of purchase by the Corporation of the whole tramway system matures in August next, and the new agreement which it is proposed to enter into appears to be exciting no little opposition in the town. The gist of the agreement which the tramway company, with the approval and assistance of the Corporation, are promoting in the form of a Bill is that the Corporation grants the Company a further lease of the streets of Belfast for fourteen years at a rent of £4,000 a year for the first seven years, and £5.000 a year for the second seven years of the term. Beyond that, says the *Northern Whig*, there seems to be no guarantee either for cheap fares, good service, or modern improvements. The traffic returns for the years 1887 and 1891 respectively show that totals were 7,638,191, and 16,393,426 — more than 100 per cent. increase—although the additional extent of lines opened during these four years was only $3\frac{3}{4}$ miles. The mileage of the system was $19\frac{1}{4}$ in 1891, as against $15\frac{1}{2}$ in 1887. Belfast, with $19\frac{1}{4}$ miles of tramway, carried nearly as many passengers in 1891 as did the Dublin United system with 33 miles. The Act promoted by the Company is not yet passed, says the *Northern Whig*, and as the result of the growing spirit of discontent, a combination of ratepayers has been formed to oppose it in Parliament. A considerable sum of money has already been subscribed to meet the costs of such a proceeding, and it is anticipated that there will be trouble before the contract becomes law. As the ratepayers appear to be interesting themselves in the subject, our Belfast contemporary proposes to publish a series of articles giving some of the results of inquiries and personal investigation.

The Forthcoming International Electrical Congress.—A meeting of the Advisory Council of the Chicago World's Congress of Electricians was held at the rooms of the American Institute of Electrical Engineers, New York, on January 17th. The following were present:—Dr. Elisha Gray (Chairman), Prof. William A. Anthony, Prof. Charles R. Cross, Dr. Louis Duncan, Dr. William Geyer, Mr. Carl Hering, Mr. George A. Hamilton, Prof. F. B. Crocker, Mr. A. E. Kennelly, Mr. T. D. Lockwood, Mr. T. C. Martin, Mr. George M. Phelps, Dr. M. I. Pupin, Mr. R. W. Pope, Prof. H. A. Rowland, and Mr. Herbert Laws Webb. It was resolved that the Electrical Congress should consist of two Chambers, of which the Legislative Chamber should decide on units, names of units, and standards, and consist solely of delegates named by their respective Governments. The following apportionment of delegates was made by a Committee whose report was adopted by the meeting. Great Britain 5, France 5, Germany 5, Austria-Hungary 5, United States 5, Belgium 3, Italy 3, Switzerland 3, Holland 2, Denmark 2, Norway and Sweden 2, Russia 2, Spain 2, Portugal 1, British North America 1, Australian Colonies 1, India 1, Japan 1, China 1, Mexico 1, Brazil 1, Chili 1, Peru 1, Argentine Republic 1, making a total of 55 official delegates. It was resolved to appoint a Committee on Invitations to consist of five members who are to select and recommend to the chairman the names of electricians, electrical engineers and others who shall be members of the Electrical Congress, the Committee to co-operate with the Foreign Committees. It was further resolved that in addition to invitations to deliberating and voting members of the Congress, a general intimation should be made through the journals or otherwise that the meetings will open to the public, for attending the proceedings, but not for taking part therein. A Committee on Programme and Papers was decided upon, whose duty it will be to invite, receive and consider Papers and other documents relating to the work to be done by the Congress. It was further resolved that it was to be the duty of this Committee to formulate a programme for the Congress. It was resolved that the reports of the English and American sub-committees which were received at the meeting should be referred to the Committee on Programme and Papers, and that the Committee should confer with the English Committee as fully as possible and with such other Foreign Committees as may be formed. It was resolved that the Electrical Congress of 1893 should last one week, beginning on August 21st. Finally it was resolved that the question of charging a fee for membership of the Congress, and fixing the amount of such fee should be referred to the Executive Committee.

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THE DIFFUSION OF LIGHT.

BY W. E. SUMPNER, D.SC.

(*Continued from page 382.*)

Before describing the experiments by means of which the reflecting qualities of the various substances just referred to were measured, it may be well to give an exact meaning to certain terms which are often used in a somewhat vague way. By the *illumination* of a surface is meant the quantity of light incident on it per unit area of the surface. The *reflecting power* of a diffusing surface is the ratio of the amount of light reflected by it to the total amount of light incident upon it. The *candle-power* of a source of light in a particular direction is the intensity with which it radiates light in that direction, and in most cases varies with the path considered. The intensity of the light given off by a standard candle in the horizontal direction is taken as the unit of candle-power, and the illumination due to the horizontal rays of a candle at the distance of one foot may be taken as the unit illumination, and called a *candle-foot* The illumination due to a source of K candle-power at a distance of F feet is K/F^2 candle-feet. The *quantity of light* received by an area of A square feet placed perpendicular to the rays of light, and at a distance of F feet from the source of K candle-power is equal to the area multiplied by the illumination, and is, therefore,

$$K\frac{A}{F^2}$$

units of light. The ratio A/F^2 is called the solid angle subtended by the area A at the light, so that the quantity of light given out by a lamp of K candle-power within a solid angle Ω is $K\,\Omega$. If the lamp radiates light equally well in all directions, so that its candle-power is independent of the direction of the rays, the total quantity of light given out is $4\pi K$, since the solid angle subtended by a sphere at its centre is 4π, or 12·6. A light of 1 c.p. thus gives out 12·6 units of light, a fact which has been called "absurd" by some writers, who seem unable to distinguish between the ideas represented by the words "candle-power" and "quantity of light." There is, however, nothing more absurd about this statement than about the equivalent one that the area of a sphere of radius one foot is 4π square feet, and not simply one square foot. It might be for some reasons convenient to take as the unit quantity of light the total light given out by a source of 1 c.p. But the simplification so introduced would be apparent and not real; and it would be as undesirable to adopt this definition for the unit amount of light as it would be to use the area of a sphere of unit radius as the unit of area.

Besides candle-power, illumination, and quantity of light, there is one other term which it is necessary to use when considering the subject of diffusion. This term is the word *brightness*. A luminous surface may be said to have a brightness of one candle per square foot, when an area of one square foot of the surface acts like a lamp of 1 c.p. in the direction normal to the surface. If B is the brightness of a surface of area A the illumination produced by it at a distance, F, in the direction perpendicular to the surface is $B\,A/F^2$ or $B\,\Omega$ where Ω is the solid angle subtended by the area at the point at which the illumination is measured. The candle-power of a bright surface in directions inclined to the normal is found to vary as the cosine of the inclination of the ray to the normal, and from this fact it can be shown mathematically that the total quantity of light given off per unit area of a surface of brightness B is equal to πB.

It is this fact that renders it possible to measure the reflecting power of a diffusing surface. No instruments exist by means of which light can be measured as a quantity. But candle-power can be measured with a photometer, and the brightness, B, of a diffusing surface can be found by dividing its candle-power, measured in the normal direction, by the area of the surface. When B is once obtained, the total light reflected by the surface can be calculated from the formula $\pi B A$, where A is the area of the surface. To connect this with the reflecting power r of the surface we have the equation

$$\pi B = r I,$$

where I is the calculated illumination of the surface. This equation must hold, because I is by definition the amount of light incident upon the surface per unit area, and consequently $r I$ must be the amount reflected—that is, πB.

It is of some interest to compare the values of B for white paper under various conditions, such as frequently occur. Referring to some measurements made by Prof. L. Weber [*The Electrician*, Vol. XXV, p. 404], we find that when exposed to a summer sky the brightness of white paper is over 30 c.p. per square *inch*, or B = 4,300 c.p. per square foot. When illuminated by ordinary diffused daylight within a room, the value of B is much less, and may be obtained from the relation $\pi B = r I$. The value of I for ordinary daylight within interiors probably does not much exceed 20 candle feet; also r for white paper may be taken as 0·8. It follows that B is only $16/\pi$, or 5·1 candles per square foot. At night time a room is considered well lit if the illumination I is as much as 1 candle-foot, and in this case B is only 0·25. The illumination due to moonlight is about 0·025, and it follows that a piece of white paper exposed to the rays of the moon has a brightness of only 0·006 candle per square foot. The ratio of 4,300 to 0·006 is over 700,000, yet this large number represents the relative brightness of a piece of white paper when successively exposed to the rays of the sun and moon. What has been stated with reference to white paper applies, of course, equally to all diffusing surfaces, the brightness being simply proportional to the reflective power of the surface. Since this reflective power for most substances ranges between 20 and 80 per cent, it follows that the brightness of the walls of rooms (in candles per square foot) varies, as a rule, from 1 to 5 during the day, and during the night from 0·05 to 0·25. Even the blackest surfaces we know of are capable of reflecting a great deal of light. It appears from the results already referred to that black velvet, which is probably the worst of reflectors, is capable of shining with a brightness of over 6 c.p. per square foot when exposed to the summer sky at noon, and therefore can give off as much light as the same area of white paper when illuminated with diffused daylight such as ordinarily occurs within interiors.

The dazzling effect of a large white surface is well known, and Alpine climbers, and others who traverse fields of ice or snow, always protect their eyes from snow-blindness by using dark spectacles. The necessity for taking such precautions becomes evident on calculating the amout of light received by the eye from the snow-field. If B is the brightness of the field, and Ω the solid angle it subtends at the eye, the illumination at the surface of the eye due to the snow-field is $B\,\Omega$, and it will frequently happen that Ω is as much as a half a hemisphere, or π. But

$$\pi B = r I$$

where r is the reflecting power of the snow, and I is the illumination of the snow due to the sun's rays. The value of r for fresh snow is certainly over 80 per cent., and is more probably 90 per cent.; so that the illumination at the surface of the eye due to the snow is practically the same as if the eye were directed straight at the sun. The eye receives as much light in one case as in the other, and, indeed, it probably receives more light from the snow than it would from the sun, since in the latter case the eye would close up owing to the great brightness of the image of the sun on the surface of the retina. After an hour's exposure to a snow-field the eye has therefore received more light than if it had been looking at the sun for an equal time.

Measurements of Reflecting Power.

The following is a convenient method of measuring the reflective power of a diffusing surface, and was the one adopted in making most of the measurements recorded in Table I. The surface, whose reflecting power was required, was attached to a large screen of black velvet, O R, placed at one end O of a 3-metre photometer-bench O L (*see* Fig. 1), so as to be perpendicular to its length. Two lights were used, one being a Methven two-candle gas standard, placed at L; and the other a glow lamp K of about 20 c.p., placed at P. This second light was placed on the same slider as a Lummer-Brodhun photometer,* and just behind it. The photometer slider was

* For a description of this photometer see *The Electrician*, Vol. XXVI. p. 666.

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moved along the bench till the illumination due to reflection from the surface O R was equalised by that caused by the direct rays of the Methven standard at L. In some cases both O P and O L were varied to get the adjustment.

If the distances O P and P L be equal to x and y respectively; if K and L respectively denote the candle-powers of the glow lamp and the Methven standard; and, finally, if A be the area of the diffusing surface on the screen O R, it can be shown that the reflecting power r is given by the equation

$$r = \frac{L}{K}\frac{x^2}{y^2}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\}.$$

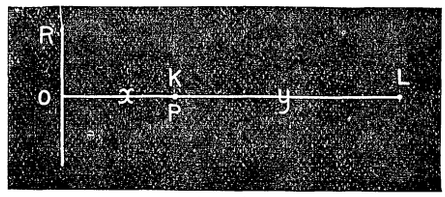

FIG. 1.

The area A should not be much longer in one direction than in the other. It should preferably be round, or nearly square, with its centre placed at O on the line of centres of the bench. The above formula is only true for surfaces which are purely diffusive. Some surfaces, such, for instance, as white enamelled iron, shine under the action of light, and reflect to some extent in accordance with the law of regular reflection. With such surfaces the value of r calculated from the above formula is found to vary with the value of x, and is too high. If r_1 is the proportion of the incident light which is diffused, and r_2 the proportion which is reflected according to the regular law of reflection, it can be shown that

$$\frac{L}{K}\frac{x^2}{y^2}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\} = r_1 + \tfrac{1}{4}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\} r_2.$$

The true reflecting power r is given by the equation

$$r = r_1 + r_2,$$

and, in order to obtain it, it is necessary to make experiments

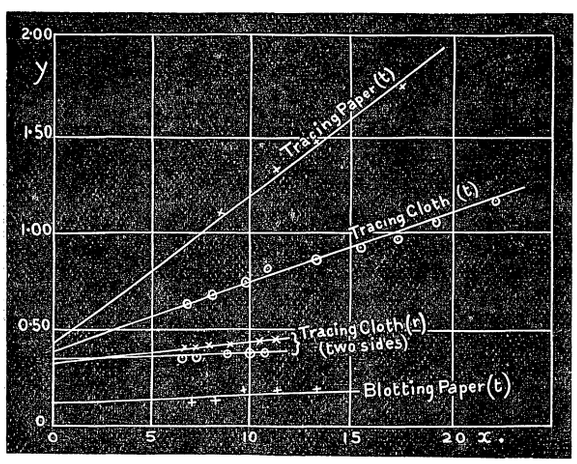

FIG. 2.—Value of $x = \frac{\pi x^2}{A} + 1{\cdot}75$.

Value of $y = \frac{L}{K}\frac{x^2}{y^2}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\}$.

with various values of x, and to plot from the results a curve having for abscissæ the values of

$$X = \frac{\pi x^2}{A} + 1{\cdot}75,$$

and for ordinates the values of

$$Y = \frac{L}{K}\frac{x^2}{y^2}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\}.$$

The equation between X and Y is that of a straight line

$$Y = r_1 + r_2\, X/4,$$

from which the values of r_1 and r_2 can be obtained. The value of $r = r_1 + r_2$ can be found by simply observing the value of Y, for which $X = 4$.

The observations referring to the reflecting power of tracing cloth, and plotted in Fig. 2, form an example of this method, and the observed values of the different quantities are given in Table II. This substance is the ordinary material used in drawing offices. It shines more on one side than on the other, but each side reflects a certain amount of light in accordance with the law of regular reflection. The values of x and y given in the table were the quantities actually observed. The values of X and $Y_{obs.}$ are calculated from x and y by means of the formulæ given above, and values of $Y_{calc.}$ are those given by the straight line

$$Y_{calc.} = 30{\cdot}9 + 4{\cdot}8\, X/4,$$

which most nearly goes through all the observed points.

Table II.—*Reflecting-Power of Tracing-Cloth (shiny side).*

A = 1,300. K = 12. L = 2. $r = 35{\cdot}7$. $Y_{calc.} = 30{\cdot}9 + 4{\cdot}8\, X/4$.

x	50	55	62·3	59·8	47·5	44·5
y	90	104·4	127·7	120·2	82·5	75·5
X	7·82	9·10	11·13	10·45	7·22	6·55
$Y_{obs.}$	40·4	41·8	44·1	43·2	39·6	38·6
$Y_{calc.}$	40·3	41·8	44·2	43·4	39·6	38·7

The four substances mentioned at the head of Table I. are common specimens of white diffusers. The first two—viz., blotting paper and cartridge paper—reflect a great deal of light and transmit very little. The two latter—tracing cloth and tracing paper—on the other hand, transmit a large portion of the light incident upon them, and reflect comparatively little. These surfaces were accordingly selected for the most careful measurements, and the results of the reflection tests are summarised in Table III.

Table III.—*Percentage Reflective Power.*

	Diffused r_1.	Regular r_2.	Total r.
Blotting paper	82	0	82
Cartridge paper	80	0	80
Tracing cloth (shiny side)	30·9	4·3	35·7
,, ,, (rough side)	31·6	2·7	34·3
Tracing paper	19·8	2·7	22

(To be continued.)

ON THE DETERMINATION OF THE INSULATION RESISTANCE AND OF FAULTS IN ELECTRICAL PLANTS DURING THE WORKING.

BY DR. O. FROELICH.

At the present time the measurement of the insulation resistance and the detection of faults in electrical plants during working consists in taking the absolute potential of different points of the circuit, especially of the conductors in central stations, by means of incandescent lamps or galvanometers. Better methods are only given, to my knowledge, by Frisch (*Zeitschrift für Elektrotechnik*, 1889, p. 218) and by Dr. Hiecke (*Elektrotechnische Zeitschrift*, 1892, p. 534); the former gives a method of measuring the insulation, the latter shows how to find a heavy fault by measurements from the station. I describe here an almost complete set of measurements partly necessary, partly useful, taken during the working of continuous-current plants of every kind, a system which has been worked out and tried at the Berlin works of Messrs. Siemens and Halske.

Tests.—The problems to be solved are the following:—(1), Determination of the insulation; (2), Determination of situation and resistance of one fault in a simple circuit, the other existing faults being of higher order; (3), Determination of the resistances of several faults existing together, situations

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of which are known (conductors of a central station); (4), Determination of the situation of a heavy fault in a complicated circuit (central station). All these tests have to be carried out during working without interfering with it. It will be shown that they can be carried out in quite a practical way. If one point of the circuit is connected to earth, as in telegraph circuits and in central stations, where the middle conductor is not insulated, it is impossible to determine insulation and faults in other parts of the circuit during working.

Properties of Faults.—If a circuit had absolutely perfect insulation—which none ever have, and cannot possibly have—the absolute potential of any point in it would be indefinite because the laws relative to potential refer only to differences of potential, not to absolute potential; in such a circuit very high or very low potentials could, therefore, occur. But if in one point of the circuit the potential is determined by any condition, all other potentials in the circuit are also determined.

If the circuit has only one fault at one point, viz., a communication to earth of any resistance, this point must assume the potential of the earth, that is to say, the zero potential. For, if it were not so, some electricity would flow to earth; but then there would be a continuous loss of electricity without return, which is impossible. If the circuit has two faults at different points, the same current goes from one point by earth to the other point; consequently, the potential of one point must be positive, that of the other negative, and the (absolute) potentials of the points are inversely as the resistances of the faults. If there are many small faults and one heavy one, the current in the latter is equal to the algebraic sum of the currents in the other ones; but the direction of the currents in the small faults can be different. If we determine the situation of the fault, supposing that there is only one fault, the calculated situation of the resultant fault will be near the heavy fault. If there are many small faults of about the same

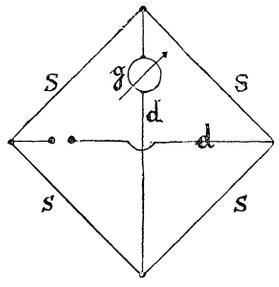

Diagram A.

order over the whole circuit, the position of the resultant fault will be near the middle of the circuit; in this case we only consider the sum of all faults or the insulation.

In theoretical deductions about faults it is often of advantage to introduce the conductivity, K, of the fault, instead of the resistance, F, of the fault; the conductivity is the reciprocal of the resistance: $k = 1/f$. The conductivity (K) of all the faults is the sum of the conductivities of the separate faults, and is equal to the reciprocal of F, the insulation resistance.

$$K = \Sigma k = \Sigma\, 1/f = 1/F.$$

Methods of Measurement.—The two methods chiefly employed are the interposing of galvanometers between points of the circuit and earth, and bridge measurements in various combinations. The first method presents two features. If the resistance of the galvanometer is great, the potentials in the circuit are scarcely altered by the interposition of the galvanometer; the deflection of the latter gives then the absolute potential of the point of the circuit in question. If the resistance of the galvanamoter is small, the insertion of the galvanometer is like the addition of a new fault of known resistance, effect of which upon the potentials in the circuit can be made use of for the measurement.

The bridge measurements are based on the Wheatstone Bridge generalised by the writer (*see Elek. Zeit.*, 1886, p. 483, and 1888, p. 137), the principle of which is that the known proportion existing between the sides s of the parallelogram (Diagram A) in case of equilibrium is still true if there are electromotive forces in all branches; but the equilibrium must be arranged so that by opening or closing or changing the resistance of one diagonal branch d, the current in the other diagonal branch d remains the same; not disappears, as in the common arrangement.

In the use of this method the following practical hints may be given:—The diagonal branches can ever be interchanged. Instead of the battery hitherto in use in one diagonal branch, we can also put any resistance. If the current in the galvanometer, caused by the electromotive forces in the other branches, is so strong that the needle goes hard over it is not necessary to neutralise this current by some battery, but it is easier to use magnets, viz., a strong one brought near in a direction perpendicular to the axis of the magnet until the needle goes over in the other direction, and a feeble one turning on a vertical axis above or below the needle, by which the needle is made to swing freely. Then the sensibility of the instrument is about the same as if no current went through it. If a telephone can be used instead of a galvanometer, the opening and closing of the other diagonal branch must be made in regular repetition by a contact wheel turned by hand, or by an electric motor; then a distinct sound is heard in the telephone, which is easily distinguished from any other sound, such as the note given out by the dynamo; for equilibrium the first sound must disappear on opening or closing the other diagonal branch.

In some bridge measurements given below, the arrangement of the circuits is not wholly that of the Wheatstone Bridge, but a more complicated one, and we only give the final formula used in the practical measurement.

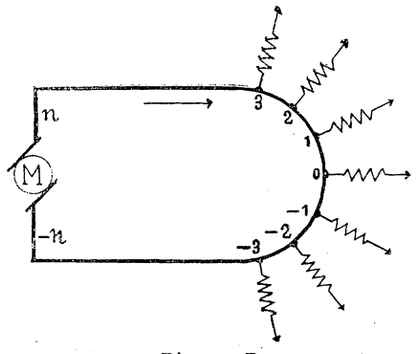

Diagram B.

Measurement of the Insulation.

Let us begin with a theoretical consideration. In the simple circuit (Diagram B), the external circuit between the poles of the machine be divided into $2n$ parts of equal resistance, with a fault between each two contiguous parts. Let us suppose that the difference of potential between the ends of each part be δ; to fulfil this supposition, the resistances of the faults cannot be very small, but in practice the supposition is almost always fulfilled. Let the middle point be 0; let the points between 0 and the positive pole be 1, 2, 3 . . . n, and the other points be $-1, -2, -3$ . . . $-n$. The resistance of the fault attached to the point m may be denoted by f_m, the conductivity of this fault by $k_m = 1/f_m$; the conductivity of all faults is

$$K = \sum_{+n}^{+n} k_m = \sum_{-n}^{-n} 1/f_m.$$

The currents of the faults we take positive in the direction to earth, and denote them by: $i_0, i_1, i_2 \ldots, i_{-1}, i_{-2} \ldots$ The potentials at the starting points by: $P_0, P_1, P_2 \ldots, P_{-1}, P_{-2} \ldots$

We have the equations

$$\sum_{-n}^{+n} i_m = 0$$

$$-i_0 f_0 + i_1 f_1 = \delta \qquad -i_0 f_0 + i_{-1} f_{-1} = -\delta$$
$$-i_1 f_1 + i_2 f_2 = \delta \qquad -i_{-1} f_{-1} + i_{-2} f_{-2} = -\delta,$$
$$\&c. \qquad\qquad \&c.$$

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Resolving these equations we find

$$P_0 = \delta/K \{ -k_1 - 2k_2 - \ldots - nk_n + k_{-1} + 2k_{-2} + \ldots + nk_n \},$$

or $P_0 = \delta\, h/K$, where

$$h = -k_1 - 2k_2 - \ldots - nk_n + k_{-1} + 2k_{-2} + \ldots + nk_{-n}.$$

The other potentials are deduced from P_0 by

$$P_1 = P_0 + \delta_1,\ P_2 = P_0 + 2\,\delta, \text{ \&c.}$$
$$P_{-1} = P_0 - \delta_1,\ P_{-2} = P_0 - 2\delta, \text{ \&c.}$$

If we put a galvanometer of resistance g between the point m and earth, the resistance between m and earth is diminished, and instead of $1/f_m$ we must put $1/f_m + 1/g$. Then the potential at the point 0 will be

$$P'_0 = \delta\,(h - m/g)/(K + 1/g),$$

and all potentials are augmented by $P'_0 - P_0$.

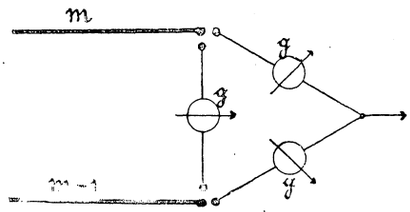


FIG. 1.

It follows that the potential of the middle point in the external circuit of any electrical plant is zero, if the sum $k_1 + 2k_2 + \ldots + nk_n$ on the positive side is equal to the like sum on the negative side, and that the effect of a fault of a certain resistance on the potential of the middie point is the greater, the longer the distance between the place of the fault and the middle point.

From the formulæ given the measurements of the insulation, which we give below, can be easily understood.

Method 1. (Fig. 1. Frisch).—Herr Frisch inserts a galvanometer first between one main conductor of a central station and earth, then between a neighbouring main conductor and earth, finally between the two conductors; by the three deflections so obtained the resistance of the insulation can be determined.

If the galvanometer lies between m and earth, its deflection in volts will be

$$P'_m = \delta\,(h - m/g)/(K + 1/g) + m\,\delta;$$

if the galvanometer lies between $m - 1$ and earth,

$$P'_{m-1} = \delta\,(h - (m-1)/g)/(K + 1/g) + (m-1)\,\delta;$$

if it lies between the two conductors, it gives δ.

Thence, it follows that

$$\left.\begin{aligned} K &= 1/g\,[P'_m - P'_{m-1}]/[\delta - (P'_m - P'_{m-1})] \\ F = 1/K &= -g + g\,\delta/(P'_m - P'_{m-1}) \end{aligned}\right\} \quad . \quad (1)$$

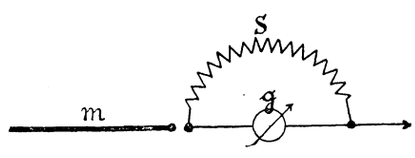


FIG. 2.

Method 2. (Fig. 2. Shunt Method.)—The insulation can also be measured by putting the galvanometer between one main conductor [point m] and earth, and varying the resistance of the galvanometer, viz., by measuring with and without the shunt s. Then we need only to take two deflections; and, if we vary the resistance of the shunt so that the second deflections is a certain definite part of the first one, we need only the resistance of the shunt. If the instrument is inserted between the point m and earth, the potential of the middle point will be

$$P'_0 = \delta\,(h - m/g)/(K + 1/g);$$

If we add the shunt s, the potential of 0 will be

$$P''_0 = \delta\,(h - m/g - m/s)/(K + 1/g + 1/s).$$

Thence we deduce

$$K = -1/g + 1/s(P''_0 + m\delta)/(P'_0 - P''_0)$$
$$= -1/g + 1/s(P''_m)/(P'_m - P''_m) \quad . \quad (2)$$

where P'_m and P''_m are the two observed deflections.

If the shunt can be varied, we arrange it so, that the second deflection is half of the first or $P''_m = 1/2P'_m$; then we have

$$K = 1/F = -1/g + 1/s \quad . \quad . \quad . \quad . \quad (2a)$$

where F is the resistance of the insulation.

If the galvanometer is very sensitive, we must add resistances to it to get a suitable deflection; the resistance g will be great and $1/g$ can be neglected. If, then, the second deflection is one-half of the first one, we have simply

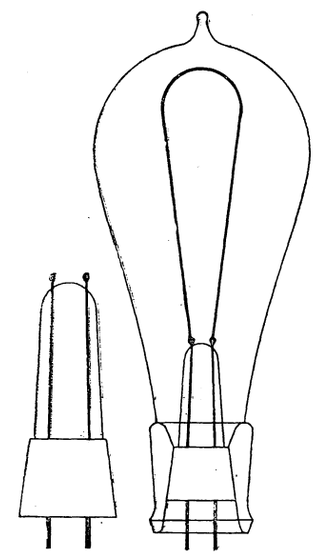
$$K = 1/s \text{ and } F = s \quad . \quad . \quad . \quad . \quad (2b)$$

viz., the resistance of the insulation is equal to that of the shunt. We see that by this method we need no calculation, but only a reading of the resistance inserted in a box.

(To be continued.)

THE NEW WESTINGHOUSE LAMP.

The new Westinghouse lamp, concerning which there has been so much speculation, has at length been exhibited to a chosen few at Pittsburg. The accompanying illustration from the New York *Electrical World*, represents the "preferred" form, and presumably the one which is about to be put upon the market.



The Westinghouse Separable Lamp and Stopper.

It was hinted some time ago that the filament, instead of being "sealed in" the glass globe by fusion in the usual way, was mounted on a glass stopper ground to fit the neck of the globe, into which it was secured by a cement. From the description now given, and by reference to the illustration, we are able to see how this is carried out. The neck of the globe is thickened both on the outside and inside, so that there is a considerable mass of glass at that end. The opening is conical in shape, and ground to receive the stopper, which is shown separately in the illustration. The stopper is a solid piece of glass, cast around the leading-in wires, and is ground to fit the neck of the globe. The leading-in wires are iron—not platinum. When the filament has been attached to the leading-in wires, the stopper is covered on its bearing surface with a varnish or cement, and is tightly pushed into its seat in the neck of the lamp. The lamp is exhausted at its upper end as usual. During exhaustion nitrogen gas is from time to time introduced and withdrawn again, for the purpose of entirely removing the least traces of atmospheric

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oxygen. The exhaustion is, however, believed to be as perfect as it can be made.

The makers of the lamp say that it does not infringe the Edison patents. It has, in fact, been specially designed with that object. Whether that end has been achieved or not will probably be a matter for the American Law Courts to decide. It is difficult to see wherein the necessary difference lies. It surely cannot be that the filament is not enclosed in a receiver made entirely of glass. The globe is entirely composed of glass, and so is the stopper, though, to be sure there is a thin partition of varnish between the two. The first reports about the lamp stated that there was to be no vacuum, or at all events only a partial one. This, however, appears to be a mistake, for although nitrogen is said to be introduced into the lamp while pumping, it is all pumped out again as far as possible. The only other difference is in the use of iron wires instead of platinum. With all its differences then, the new lamp is still a combination of a carbon filament within a receiver of glass from which the air has been exhausted.

Now, apart from patents, there are several points in connection with the manufacture of such a lamp which call for attention. In the first place, can it be made for the same price as an ordinary lamp? It would certainly seem that it would cost considerable more. There is a great deal more glass in the globe. It is probably much thicker all over than in ordinary lamps, and there appears to be some difficulty in sealing it to the thick neck. Then there is the stopper to be made. The inside of the neck must be ground, the stopper must be ground, and then the two must be ground together. All this has to be done as against the usual simple process of sealing in with the blow-pipe. It may be claimed that there is a gain in the use of iron leading-in wires instead of platinum. This part of the invention was probably made at the time when platinum stood at a high price. The amount of extra labour required in the new lamp must, however, more than swamp the gain here. The amount of platinum really required in a lamp is very small, as may be seen in the ordinary Edison-Swan lamps. It takes very little labour to cost as much as this with platinum at its present price. Again, the introduction of nitrogen into the lamp during exhaustion must add to the cost, not only by the cost of the nitrogen and applying it, but in the time taken to exhaust the lamp. If, as is stated, nitrogen is introduced several times during exhaustion, the exhaustion is of course thrown back each time, and has to begin again. What the advantage of this process is, is not very apparent. It is said to be in order that the residual gas shall be nitrogen instead of atmospheric air. It is, however, open to doubt whether in an ordinary lamp the residual vacuum contains any uncombined oxygen. It is probably chiefly composed of gases given off by the filament when under current. It is certain that some particular gas is often present and may be detected by its smell when a lamp is opened.

One advantage claimed for the new lamp is that the bulb and stopper can be used again and again, and a considerable sum will be allowed by the makers for returned used-up lamps. This in itself is no doubt an advantage; but whether it will work in practice is another matter. It is said that the stopper can be easily removed. To do this the lamp is warmed, and the cement softens, the stopper can then be drawn out after the air has first been let in at the other end. If the cement softens by warming, is there not therefore a danger of its softening by the heat of the lamp itself and so losing the vacuum? Even if this is all satisfactory and the stopper can be removed at will, the inside of the bulb has to be cleaned. This is a troublesome process. Before the stopper can be drawn, the air must be let in by cutting off the tip of the nipple at the top of the lamp. For re-pumping the lamp a glass tube must be fused on to this end. This is not always a successful operation, as the globe is apt to crack at the place where the former tube was joined on. The danger of cracking will be greater each time the operation is performed.

It also remains to be proved whether the iron wire is satisfactory for the purpose of leading-in wires. Iron has a greater coefficient of expansion than glass. The glass in a molten state is cast around the iron wires, and it may be in close and air-tight contact with the wires at the temperature of solidification. But as it cools the wires will contract more than the glass, and will tend to shrink away from it. Consequently, it is highly probably that air may slowly leak into the lamp between the wires and the glass. Whether it actually does so or not trial only will show.

One thing is not mentioned in the description, namely, the method of joining the filament to the wires. Probably this joint is made with a carbon paste. It is difficult, if not impossible, to make the ordinary deposited carbon joint upon iron, because iron will not stand the temperature to which it must be heated in order to obtain a good deposit. There is another point to be considered. In order to obtain a good vacuum it is necessary that the lamps be strongly heated while being pumped. Now this appears to be impracticable in the case of this lamp for two reasons. Firstly, owing to the thickness of the glass at the stopper end, it would be liable to crack, especially round the sharp shoulder shown in the illustration. Secondly, the stopper cement melts if heated. It is probably on this account that it has been found necessary to use nitrogen. As the vacuum cannot be made nearly so perfect as in lamps heated during exhaustion, it is thought better that the residual gas should be nitrogen. This is a point which would tell somewhat against the lamp, because with such a vacuum the glass will get very hot.

All things considered, it appears highly improbable that this lamp will be able to compete with lamps made in the ordinary way.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 10th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting. After which the following Papers will be read: (1) "Recent Determinations of Molecular Refraction and Dispersion," by Dr. J. H. Gladstone, F.R.S.; (2) "The Separation and Striation of Gases," by E. C. C. Baly.

INSTITUTION OF CIVIL ENGINEERS.

7 30 p.m. Students' Meeting. Paper to be read: "Long Shoot Dredgers—their Design and Mode of Working," by H. Calder Löbnitz, Stud.Inst.C.E

SOCIETY OF ARTS.

8 p.m. Howard Lecture (5): "The Development and Transmission of Power from Central Stations," by Prof. W. Cawthorne Unwin, F.R.S.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "The Application of Small-power Electric-motors," by Douglas Heap and Arthur Heap.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Some Associated Organisms," by Prof. Charles Stewart, Pres.L.S.

MONDAY, February 13th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture (3): "The Practical Measurement of Alternating Electric Currents," by Dr. J. A. Fleming, F.R.S.

TUESDAY, February 14th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion: "Electrical Railways," by Dr. Edward Hopkinson, M.A.

WEDNESDAY, February 15th.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting at the Institution of Civil Engineers. Papers to be read: (1) "Report on the Phenological Observations for 1892," by Edward Mawley, F.R.Met.Soc.; (2) "Relation between the Duration of Sunshine, the Amount of Cloud, and the Height of the Barometer," by William Ellis, F.R.A.S.; (3) "Winter Temperatures on Mountain Summits," by W. Piffe Brown.

OLD STUDENTS' ASSOCIATION.

7.30 p.m. Meeting at Finsbury Technical College. Paper to be read and discussed: "The Series Method of Teaching Foreign Languages, and its Application to the Technical Professions," by Howard Swan.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in Air," by Prof. Frank Clowes, D.Sc.

FRIDAY, February 17th

INSTITUTION OF ELECTRICAL ENGINEERS

8 p.m. Students' Meeting. Paper to be read: "Cost of Private Installations," by W. L. Bayley.

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THE LEEDS ELECTRIC TRAMWAY CASE.

The judgment given by Mr. JUSTICE KEKEWICH in the action brought by the National Telephone Company against Mr. GRAFF BAKER for disturbing their Leeds telephone service by the working of his electric cars is a satisfactory termination to the first skirmish between telephony and electric traction. To criticise Mr. JUSTICE KEKEWICH'S law is beyond our province and beyond our competence; from a lawyer's point of view it may not, perhaps, be unexceptional.

In delivering judgment, the learned judge skilfully concealed his final decision until he had thoroughly imbued the defeated side with the idea that they were the victors. Then, in a single sentence, the tables were turned. A marked contrast to Mr. JUSTICE ROMER'S mode of procedure in his three-wire judgment, in which the suspense of the audience was terminated in less than a minute. There was, said Mr. JUSTICE KEKEWICH, no question but that each party to the action was lawfully exercising undoubted rights. There was, moreover, no question but that the working of the Roundhay Park cars interfered to a very serious degree with the neighbouring telephone circuits; indeed, so serious was the telephonic disturbance that the remedy would have been by injunction rather than by damages—had any legal remedy existed. The real and only issue, however, was whether the nuisance was actionable. Referring then to the American cases, Mr. JUSTICE KEKEWICH said he had studied them with deep interest, especially the decision in the case of "Cumberland Telephone and Telegraph Company *v.* United Electric Railway," and he would not have hesitated to allow his own conclusion to have been guided by the powerful arguments there set forth, but for the fact that the principle of "Fletcher *v.* Rylands" was not fully recognised in America, whilst, in his opinion, the principle *was* applicable to the action in hand. The principle of "Fletcher *v.* Rylands" epitomised appears to amount to this: That where the owner of land, without wilfulness or negligence, uses his land in the ordinary manner of its use, he is not liable, should mischief thereby be occasioned, to his neighbour, but if he brings upon his land anything which would not

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naturally come upon it, and which is in itself dangerous and may become mischievous if not kept under proper control, he will be liable in damages for any mischief thereby occasioned, even though he may act without personal wilfulness or negligence. It may be remarked that in this action the Plaintiffs practically abandoned the question of disturbance by conduction, their case being that the trouble arose from induction. The defences raised in the present action were numerous, but the principle arguments were :—First, that owing to the extraordinary delicacy and sensitiveness of telephonic instruments, and to the fact that the use of the earth return furnished imperfect and unsatisfactory results, such use was not an ordinary or *reasonable* use of property, and that therefore any interference with it did not amount to a nuisance. Secondly, it was argued that the National Company could obviate all disturbances by the adoption of metallic circuits; and thirdly, it was contended that Mr. Graff Baker was engaged in the lawful exercise of statutory powers, and must, therefore, be held free from blame for the injury done to the plaintiffs' property. As to the first plea, Mr. Justice Kekewich decided that all he had to consider was whether the use was a *lawful* use, and that if any distinction was to be taken between electrical currents and other forces, that distinction must be made by a higher tribunal. On the second plea, the Court held that the National Telephone Company could not be obliged to double its wires, nor, for matter of that, could Mr. Graff Baker be forced to keep his system constantly up to date by continually adopting "the last inventions of ever changing, ever advancing scientific discovery," the single wire overhead trolley method of traction being, in the judge's opinion, "on the whole, the best which practical science has yet discovered." On the other hand, the third contention of the defendants was considered good law, and judgment was therefore given in favour of Mr. Graff Baker, the licensee of the Leeds Corporation.

At first glance the principle upon which this decision is based appears to be of general application, and the judgment consequently one of the most momentous in the history of the electrical industry. Are not all tramways worked under an Act of Parliament, and before electricity can be employed must not a definite clause to that effect exist? It has, however, to be remembered that for several years past the telephone interest has succeeded in getting a most objectionable paragraph, known as the Birkenhead clause, inserted in most Acts having reference to electric lighting or traction. Since this clause was adopted at the time as a standard one to be made use of in all similar cases, it may not be amiss to quote it in full as it was accepted in July, 1890, by a Select Committee of the House of Commons, presided over by Mr. Stansfield :—"The Undertakers shall construct their mains and other works of all descriptions and shall work their undertakings in all respects so as not injuriously to affect the working of any existing electric circuits from time to time used or intended to be used for the purpose of telegraphic, telephonic or electric signalling communication, or the currents in such circuits, and shall use every reasonable means in the construction of their mains and other works of all descriptions in the working of their undertaking to prevent injurious affection, whether by induction or otherwise, to any electric circuits used or intended to be used for the purpose aforesaid, *whether existing at the time of the construction of such mains or other works or not.*" With a protecting proviso of this sweeping character snugly ensconced in numerous Tramway Acts—and likely, unless nipped in the bud, to continue to blossom forth in the same soil, season after season—the National Telephone Company can afford to regard its recent rebuff in a Court of First Instance with comparative equanimity. It has the power of the purse, and who can tell what may happen on Appeal or in the Lords?

On closer inspection, therefore, it would seem as if the victory of the tractionists in Chancery Court IV. were a Pyrrhic victory after all, and that so far as the Leeds cars are concerned it would be well to avoid further legal conflicts by a timely compromise, not prejudicing future action in other cases. The place to give effective battle is not in the Law Courts, but in the Legislature. The one-sided clause quoted above should be fought in Committee until it is mended or ended. By all means give the telephones a reasonable measure of protection. We have no desire to see careless work anywhere. The protection, however, should be reciprocal. It is an axiom in strategy that much may be done with a small force against a larger one by beating the scattered army corps in detail. In the present instance the telephone interest is not only the stronger, but it is better organised. The electric traction industry is being attacked in detail, and will inevitably be beaten unless an assault on any one of its members is deemed a menace to the industry as a whole. In other words, victory will ultimately be with the National Telephone Company unless their opponents combine together, no longer allowing a single concern to bear the burden and heat of the day, in the hope that those who stand aside may reap the reward properly due only to those who do the fighting and pay the piper. If an association were formed, a permanent guard could be kept upon the *fons et origo malorum*, the Legislature, and it might then be good tactics to continue the struggle in the Law Courts as well. What is the Traction and Telephone Committee of the Electrial Trade Section of the London Chamber of Commerce doing? This clause has been brought before them more than once, and they have been warned of its inevitable results on more than one occasion. The spirit of compromise is altogether admirable—within limits. Give and take is the very life of negotiation. There need be no fear that the telephone interest will refrain from taking; the danger is that the traction interest may leave itself with nothing to give. Action too long delayed loses the name of action.

OBITUARY.

JAMES EDWARD HENRY GORDON.

We regret to announce the death of Mr. J. E. H. Gordon. On Friday last he was riding near Thornton Heath, when the horse bolted, and, in turning a corner, threw him on to an asphalte pavement. He died an hour after his admission to the Croydon Hospital from extensive fracture of the skull. He was particularly fond of riding, and was considered to be an experienced and daring horseman.

Although prominent of late as an energetic contractor for the erection of electric supply stations in England and Ireland, Mr. Gordon's earlier work was perhaps the more important, and of this, the building of his large dynamos was one of the most remarkable examples, judged, of course, with reference to the time, and not compared with the practice of to-day. Mr. Gordon was born in 1852, and was educated at Eton and Cambridge, with a short interval at King's College, London. He took his degree in mathematics in 1875, and studied for a year or two at the Cavendish Laboratory under Clerk Maxwell. He afterwards set up a laboratory at Pixholme, near Dorking, at the house of his father, the late Dr. J. A. Gordon, F.R.S., Physician to the London Hospital. Here he conducted researches which were the development of his work at Cambridge, and which were published in the *Philosophical Transactions* of the Royal Society in 1877 and 1879. Amongst these were an investigation of the electro-magnetic rotation of

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polarised light carried out under Clerk Maxwell's direction. The abstract of this Paper was published in *Proc.* Roy. Soc., June, 1875, rather more than a year before M. Henri Becquerel's memoir on the same subject. In 1878, Mr. Spottiswoode's year of presidency, Mr. Gordon became assistant secretary to the British Association, a post which he held for two years. At the Dublin meeting of this Association he gave an account of his investigation of sparking distances in air at different pressures. The experiment is described in *Phil. Mag.*, September, 1878. An elaborate research on the specific inductive capacity of solid and liquid dielectrics was published in *Phil. Trans.*, 1879. The apparatus, which was of considerable complexity, included a high-speed contact breaker, the invention of Mr. Gordon; it consisted of a toothed wheel, turned by an electric motor at 100 revolutions per second, and interrupting the current 6,000 times a second. His first series of experiments on dielectrics was made in 1877. In 1879 Mr. Gordon delivered four lectures at the Royal Institution on "Electrostatic Induction." These were published as a small book.

In 1880 he published a "A Physical Treatise on Electricity and Magnetism," a work which is now in its third edition and which has been published also in America and France. This book contains excellent accounts of the works of Boltzmann and others on specific inductive capacity, of terrestial magnetism and the instruments used for measuring it, of the B.A. determination of the ohm in 1863, Prof. Adams' work on equipotential lines and lines of flow, the researches of Spottiswoode, Moulton and De la Rue on discharges in vacua, and, besides other digests of Papers which otherwise are difficult of access, and his work contains five chapters on electro-optics. In 1879 and 1880 he was busily employed in experimenting on a platinum-iridium lamp, and on hearing that a discovery of iridium had been made in America, he is said to have called for a quotation for a supply of a ton of this metal. He had three patents for iridium amps.

In 1881 he was appointed one of the thirty-one English delegates to the Electrical Exhibition in Paris, and in the following year he built his first large alternate current dynamo at the Greenwich works of the Telegraph Construction and Maintenance Company. This machine was described in *The Electrician*, Vol. IX., p. 365. It was undoubtedly before its time, and cannot be said to have been a success, but it is of interest as being the first example of a large slow-speed dynamo. The 32-field magnets were mounted on a rotating wheel, 8ft. 9in. in diameter, and the stationary armature coils were coupled for any desired voltage; transformers were not in existence at that time. In 1884 he published his "Practical Treatise on Electric Lighting," in which a good account of the early manufacture of glow lamps is given. An instrument for measuring the strength of magnetic fields is described; this consisted of a coil which could be rotated through a right angle and caused to fly back suddenly by means of a spring; a modification for measuring the field between the magnet and the armature of a dynamo is also described. He predicted in this work that meters would probably be constructed with a snail cam, and an arm actuated by clockwork at intervals would strike the cam, and record the total length of all its journeys. Some four or five meters have since been constructed on this principle by other inventors. In this book the following curious chapter occurs:—

CHAPTER XIX.

Central Station Lighting.

I had intended to write a long chapter with the above heading, but, for various reasons, I am not yet prepared to do so. I have, however, left in the heading for the convenience of inserting such a chapter in a future edition of this book, should one ever be required.

With his varied experience of different systems, Mr. Gordon, if he had lived, could have written, not only a long chapter, but a most interesting book on this subject.

Nothing further besides a few experiments was done with his dynamo, which was protected by two patents, until 1884, when he designed the then largest central station, for lighting Paddington Station, offices, hotel, &c. The three dynamos, each weighing 45 tons, and having magnet wheels of 9ft. 8in. in diameter, while not large compared with modern machines (the two large Ferranti dynamos at Deptford having armatures 13ft. in diameter), attracted great attention at the time, as, indeed, did the many ingenious devices which were employed at this station. The Paddington plant was started on April 21, 1886.

In less than a year Mr. Gordon had turned his attention to continuous currents with secondary batteries for use at a station in Whitehall; and in the course of the discussion in February, 1888, on Mr. Kapp's Paper on "Alternate-current Transformers" at the Society of Telegraph Engineers and Electricians, he said that he had lately, even at the expense of abandoning every patent that he held, been so far convinced of the superiority of the method of distribution given by storage batteries that he felt compelled to abandon what had been identified as his own system. But with the impetuosity which was so marked a trait in his character, he proposed to run dynamos at full load for 12 hours, or for "24 hours, which may, in some circumstances, be advisable." It was not long before he had found out that batteries did not afford the storage for which he had hoped. It was at the close of this speech that, after alluding to different methods of distribution, he deprecated the then prevalent "system of distributing electricity from house to house by means of circulars in halfpenny wrappers."

The Whitehall Station becoming the nucleus of the present Metropolitan Electric Supply Company, Mr. Gordon became associated with the design of several new stations, being one of the original Directors of as well as Engineer to this Company. About a year later, in the autumn of 1889, he severed part of his connection with the Metropolitan Company and commenced business as a consulting engineer, and in the summer of 1890 taking Mr. W. J. Rivington into partnership, his restless activity found ample scope in the tempting occupation of erecting complete central stations and distributing systems at Carlow, Larne, Bray, Sydenham and Windsor, and his sad death occurred just at the time when, owing to the large expenditure of capital involved in such work, his business was embarrassed; and his career was cut short just when his energies were needed to pull through the difficulties which surrounded it.

F. VAN RYSSELBERGHE.

It is with deep regret that we record the death of the eminent Belgian electrician, M. Van Rysselberghe.

M. Van Rysselberghe was born at Ghent on August 25, 1846, and at the time of his decease was Consulting Engineer to the Telegraph Department of the Belgian Government; Professor of Electrotechnics at the University of Ghent; Chevalier of the Legion of Honour and of the Order of Leopold. Having mainly completed his education by his own exertions, M. Van Rysselberghe was, in 1865, appointed Professor of Nautical Astronomy at Ostend, where he invented the Maréeographe, for recording the rise and fall of the tide, and the Météorographe, for registering atmospheric changes. Having acted as hydrographical engineer, charged with preparing a chart of the Scheldt, he was in 1887 attached, as meteorologist, to the Royal Observatory at Brussels, and entrusted with editing the *Bulletin* of the Observatory. It was at this period of his career that the young *savant* invented his registering Telemétéorograph, which was made by Schubert, of Ghent, and was awarded a gold medal at the International Electrical Exhibition of Paris in 1881. Taking part in the Congress of Electricians in the same year, he was made Chevalier of the Legion of Honour. In 1880 M. Van Rysselberghe began the experiments in simultaneous telephony and telegraphy, with which his name is identified, on the wire running between the Brussels Observatory and the Meteorological Station at Ostend. In 1884, on giving the Belgian Government free use of his invention, M. Van Rysselberghe was appointed consulting engineer to the Telegraph Department of the Belgian Government, and was also made Chevalier of the Order of Leopold. Subsequently, in conjunction with M. Charles Mourlon, he was occupied in pushing his system of simultaneous telephony and telegraphy, and in devising an hydro-electric scheme for the town of Antwerp.

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REVIEWS.

Electric Light Cables. By STUART A. RUSSELL. (London: Whittaker and Co., 1891.)

While an enormous number of popular and of elementary books have been written on electric lighting there are not half-a-dozen really first-class works on the market, if purely scientific treatises be excepted. Nothing has been written on dynamos which can be compared with the best books on the steam-engine; few authors have attempted to cover any one branch of the important subjects into which electrical engineering may be divided, and those who have succeeded best have confined themselves to special applications. The book before us may certainly rank with the half-dozen first-class books, and, so far from specialising, as might be imagined from its title, it covers the whole ground of the construction and use of conductors for the supply of electrical energy. A more thorough book could not have been written. With a minimum of theory, calculations when they are necessary are fully worked out, and with a maximum of practice the author has crammed every chapter with details.

One of the very few criticisms we have to make are upon the contents of some of the earliest pages. In discussing the Thomson law of maximum economy in conductors, and the various modifications which are necessary, he argues that, while the cost of a unit should include cost of fuel, &c., plus management and depreciation, the waste of energy in the conductors is a matter of fuel only; and since it is desired to get at the actual increase of expenditure on account of the energy wasted in conductors, so that it may be balanced against the annual charges for interest and depreciation on them, "it seems right in most cases to put on one side all the expenses connected with management, supervision, labour, and depreciation of buildings and fittings, and to include in the cost of unit only the extra expenditure on fuel, water, oil, petty stores, and the depreciation on the generating plant." We do not take exception to this argument, since it is saved by the proviso "in most cases"; but it is necessary to add that these cases include only those in which fuel is of importance, and in which the loss of energy is small. In cases where there is no fuel, as for example, where water is used, and where, at the same time, the loss in the conductors may be large, the position is very different. As soon, in fact, as the loss becomes appreciable, an appreciable part of the value of the buildings and plant must be allocated to it. The fallacy of writing 0 for the cost of fuel, but continuing to use the arguments which are fairly correct when coal is used, underlies nine-tenths of suggested schemes for using water-power or tidal-power. Mr. Russell makes, and probably would make, no such mistake, but careless readers might apply his arguments wrongly if not warned.

While containing more information than is to be found elsewhere on the manufacture and use of cables, no book that we have yet seen contains such valuable descriptions and comments upon the distribution, or, as the French say, "*canalisation*," of electrical energy. At the end of the second chapter in which the laws of economy, current density, and the size of conductors are discussed, a paragraph only is devoted to the considerations which demand that such theoretical conclusions must be modified by common sense. So much mathematical nonsense has been written about placing central stations at the centre of gravity of the system of lamps, and about the quantity of copper in imaginary networks, that the importance of these considerations might with great advantage have been amplified. The use of added resistance to short conductors, *versus* conductors of small section is sometimes necessary and is sometimes absurd. The author, with his extremely lucid working out of examples, might have given a case or two to elucidate this.

The effects of rise of temperature in wires under different conditions and fall of volts are fully discussed, and lead to a very good account of the various systems of distribution not only by different arrangements of conductors, but with reference to accumulators, transformers, and dynamotors. There is a little ambiguity about the effect of the magnetising current of Hedgehog transformers, which might lead the reader to imagine that they entail "the use of a conductor having 40 per cent. more area" than if continuous currents were employed. Mr. Mordey's table of virtual resistances is given, together with diagrams and fully worked out numerical examples of different systems of distribution. The author cannot help giving some conclusions which may, perhaps, be regarded as of less value than the details from which they are deduced. One of these is that "in a general way it is economical to use a high pressure alternating current with transformers whenever the average distance between the station and the lamps exceeds 1,000 or 1,200 yards.

Joint-making, various methods of insulating, leakage, and shocks are discussed, and the book contains very useful chapters on internal wiring, overhead wires, culvert and other underground systems, and concludes with methods of testing. The account of india-rubber cables is, as might be expected, very complete, but the author deals with rival insulators such as bitite, oil, Ferranti's system, and with air insulation in a very impartial and generous manner. It is, we regret, seldom that we can confidently and unreservedly recommend a book on electrical engineering; but we have no hesitation in saying that everyone engaged in electric light or heavy electrical work, if he has not already got it, should provide himself with a copy of this work.

Lessons in Heat and Light. By D. E. JONES, B.Sc. (London: Macmillan and Co.)

The best of all elementary physics laboratories is the world of every-day life. We are glad to find that Prof. Jones has introduced so many illustrations from that laboratory into his text-book, and that he has made so successful an attempt to elucidate the principles of physics by homely examples of their operation. It is, moreover, a pleasure to discover a work in which the evident object, an object which has been steadily kept in view throughout the treatise, is to *teach* and not to cram for examination. This book is divided into two parts. The first, on Heat, consists of fourteen well-illustrated chapters dealing with thermometry, calorimetry, thermal expansion of matter, and the modes of transmission of heat. Each chapter concludes with a number of numerical examples, the answers to which are given in an appendix. The second part consists of nine chapters on Light, each of which is concluded with numerical examples. The chapter on Photometry does not contain any reference to modern instruments for light measurement, nor is mention made of any other standard of light than the candle. There is no reason why elementary books should perpetuate old-fashioned instruments and methods, and ignore what has been done in recent years. In the chapter on the Velocity of Light we can find no mention of the medium in which the propagation takes place. The ether is ignored from the beginning to the end of the book, notwithstanding that in several places the wave-lengths of different rays are referred to. The phenomenon of aberration of light also is ignored; and nothing is said about the electro-magnetic theory. We are well aware that it is not quite orthodox to treat of these things in an elementary text-book; yet we are at a loss to understand why these conclusions of modern science are not to be described to the beginner as well as to the more advanced student. There is no necessity whatever to introduce complicated mathematics; it is quite possible to give a simple, intelligible account of the electro-magnetic theory without the use of a single equation or symbol. It is quite time that the text-books took a step forward and incorporated some of the researches of later years. The remaining chapters of the second part are devoted to the reflection and refraction of light, optical instruments, dispersion and colour; and are clearly and accurately written. We think every elementary student of physics should possess a copy of this work.

Electrical Experiments. By G. E. BONNEY. (London: Whittaker and Co.)

The author has been informed that "a large number of idle hours hang wearily on the hands of youths during the long winter evenings in country villages which could be spent in profitable amusement if they only knew how to use easily-

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made electrical apparatus." He goes on to enumerate some eight of his own books, with prices. In these books the youths, who may form themselves into clubs for the purpose, are to find instructions for making the apparatus, and the present work tells them how to play with them. It is true that the author "hopes that the members of such clubs will not be content to merely find amusement. . . . but will go on from this to something higher."

Recreative science was all very well in the days of Guyot and Hutton, and may be said to have come to an end under Prof. Pepper. It may linger yet in the *conversazione*, and in the scientific toy; but whirling vacuum tubes, magnetic fish, electric pop-guns, and lead trees are very poor fun in themselves, apart from the science of which they are the fringe. It is doubtful whether any other subject has been thus trifled with. A banjo strummer need only develop his amusement and he may become a musician, the kodaker may become a photographic artist, the butterfly-catcher an entomologist.

With the exception of polarised light experiments in optics, which have real beauty, we cannot see any justification for wasting time in scientific pastimes. There is a wide gulf between this and Prof. Perry's top spinning and Prof. Boys' soap bubbles, even if it were only on account of the manual dexterity involved. The money value of a Gassiot's cascade, with the necessary accessories, would provide enough games of spillikins for 500 village clubs, and the recreative and technical value of the latter would be incomparably greater.

The Engineering Telegraph Code. By A. H. Blackburn and J. Stevens. (London.)

The object of this code may be illustrated by the following example which appears in the preface:—"Buy and ship as soon as possible portable steam crane, complete, with engines and boiler, mounted on wrought iron carriage. To lift 4 tons. Radius 16 feet. Gauge 4 feet 8½ inches. Send the same type as on page 10 in Jones' catalogue."—"*Lapade, Muehlseil, Larcenous, Prœluceam, Jones.*" Why telegraph companies should be bothered to send so cumbersome a word as "*prœluceam*" for "10" is best understood by the compilers. *Apropos* of "Jones' catalogue," the compilers seem to have approached one or two well-known firms, whose names appear very prominently in connection with apparatus which they do not pretend to manufacture. We do not, however, find any code words for "National Telephone Company's tram cars," or for "E.P.S. alternate current transformers," or for "The Elmore Wire Manufacturing Company's wire."

THEORY AND PRACTICE IN ELECTRICAL SCIENCE.*

BY ALEXANDER SIEMENS.

In his opening remarks the lecturer drew the attention of his hearers to the excellent exemplification of the advantage of the intimate association of science and practice afforded by the comparatively recent development with giant strides of electrical engineering as a branch of applied science. He laid great stress on the immense assistance which it had been to the practical electrical engineer to find so great a body of scientific material ready to his hand. The fact that the science of electricity had already been brought to an advanced stage of development had saved the practical electrical engineer from wasting years of valuable time and large sums of money in the fruitless experiments and groping in darkness which would otherwise have been inevitable. The engineers had shown how fully they recognised this indebtedness by naming the practical units which they employed in electrical measurement after the great discoverers who had developed the science of electricity. He pointed out, moreover, the manner in which the requirements of practical work had stimulated the further progress of purely scientific investigation. He specially mentioned, as an illustration of the assistance which electrical engineers had derived from scientific investigation, the discovery, communicated by Dr. John Hopkinson to the Institution of Civil Engineers, that alternators could be run in parallel. Dr. Hopkinson had been led to this result by mathematical theory. Dr. Hopkinson had subsequently discovered that he had been anticipated in this by Mr. Wilde, and had communicated this fact to the Institution.

The lecturer then passed on to the consideration of the numerous practical applications of electricity to the requirements of every-day life. Referring to the question of heating by electricity, he did not believe it could be commercially successful in such a place as London, for example, where the electrical energy corresponding to the energy in a farthing's worth of coal cost about 1s. 10d., but it was quite another question where water-power was abundant. This was the case in Norway, and in that country electrical heating was now extensively used in nail making. The process of making a coiled spring out of a thick steel rod by means of an electrical furnace was then exhibited, showing how perfectly the temperature was under control. This was a point of great importance in this particular case, as it enabled the workman to produce a spring of extremely even temper throughout. The current used in this experiment was obtained from the Deptford supply mains at a pressure of 2,400 volts, transformed down to 15 volts.

The lecturer considered it absurd to ascribe the origin of the electrical transmission of power to an accidental discovery of the reversibility of the Gramme dynamo at the Vienna Exhibition of 1873, and pointed out that Jacobi had employed an electric launch as early as 1839. He informed his audience that Sir William Siemens had told him that his brother Werner Siemens had inferred the reversibility of the dynamo from the known reversibility of the magneto machine. As an illustration of the advantages of employing electromotors for driving machinery even in large factories he pointed out that at his own works at Woolwich the employment of electromotors had enabled them to concentrate the 1,200 H.P. engines required in the factory within a ground space only 32ft. by 25ft. They found that a great saving was effected by replacing the numerous small engines previously employed by a small number of large engines. The reason of this was chiefly owing to the well known fact that it is possible to make large steam engines much more efficient than small ones, and to the reduction in the wages bill owing to the smaller number of engine drivers required. The electrical distribution of power was also much more economical when only part of the machinery was in use than the older method of employing belts and shafting. Another great advantage was the facility of altering the speed of any one machine independently of that of the others. This cheapening of power was a matter of great importance, as cheapening power meant cheapening production. Moreover, when a supply of electrical power from a central station was available it was of special advantage to the owners of small factories, both on account of the diminution of capital expenditure and on account of its enabling them to dispense with the small, and consequently comparatively inefficient, engines which would otherwise be required.

Referring to the Lauffen electrical transmission of power at high pressure, the lecturer considered the result, an efficiency of 75 per cent. over a distance of 110 miles, extremely satisfactory from a scientific point of view. The practical difficulty, and consequent expense, however, of effectively insulating conductors carrying currents at such a high pressure, prevented this method of transmission from being of practical use.

A number of very brilliant experiments, illustrating the difficulty of insulating conductors for very high pressure, were then shown. These included the passage of the current under a pressure of from 30,000 to 50,000 volts through a log of wood and slabs of marble and slate, also the breaking of a large sheet of glass. These experiments were considerably more brilliant than those which had been shown at the Crystal Palace, owing to the much higher capacity of the mains. This large capacity was partly due to the current being taken from the Deptford mains, and was further increased by passing the current through about 300 yards of twin cable, which was employed with the object of obtaining as high a capacity as possible.

* Abstract of Friday evening Discourse delivered at the Royal Institution, February 3rd.

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THE LIVERPOOL OVERHEAD RAILWAY.

On Saturday last the Marquis of Salisbury formally opened the Overhead Railway in Liverpool, which has been in process of construction for the last three years; the line is carried overhead upon a structure built up almost entirely of steel, at an average height of 16ft. clear above the ground, with the exception of about 270 yards, where it runs over an embankment and passes underneath an existing line belonging to the Lancashire and Yorkshire Railway. Many novel features have been introduced into the design of the structure and the method of erection employed; in the length of the line there are three tilt and a swing bridge, which are opened to allow of traffic passing underneath, the swing bridge being over the entrance to the Stanley Dock. The construction of the line and its equipment have been carried out under the direction of Sir Douglas Fox and Mr. J. H. Greathead, the engineers to the Overhead Railway Company. After careful consideration electricity was adopted as the means to be used for working the trains, signals, and lighting the stations. The contract for the whole of the plant was placed in the hands of the Electric Construction Corporation (Limited), Wolverhampton, and has been carried out by them under the personal superintendence of Mr. Thomas Parker, their chief engineer.

The railway is six miles in length, with a double line of rails 4ft. 8½in. gauge; the gradients throughout are easy, only in one case there being a dip of 1 in 40. The quickest curve has a radius of six chains. Fourteen stations give the necessary facilities for taking up and setting down passengers, the maximum distance between any two stations is 1,200 yards, and the minimum 300 yards, the latter being in the City at the centre of the line. It is intended that the line shall eventually be extended for a distance of one and a half miles at each end, thus bringing up the total length when completed to nine miles. The six mile journey from one end of the line to the other will be completed in thirty minutes, this including a stop at each station. The generating plant is at the Bramley Moore Dock, adjoining the railway and about the centre of its length. The station building (*see* Fig. 1) has been formed by building up some of the arches under an existing overhead railway belonging to the Lancashire and Yorkshire Railway Company, and used for bringing coal to vessels in the dock. Steam is generated by six Lancashire boilers, 8ft. diameter, 30ft. in length, the outer shell being $\frac{21}{32}$in. thick, and the flues $\frac{1}{2}$in. thick plates; the working pressure is 120lb. per square inch. The boilers are

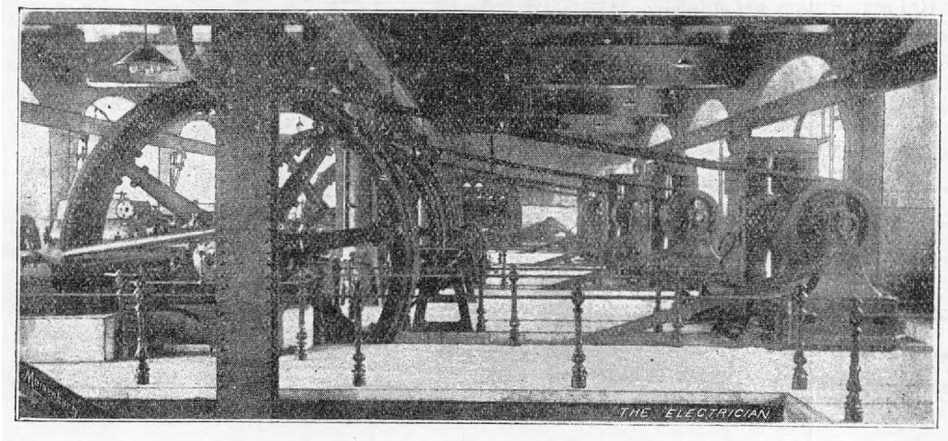

FIG. 1.—Generating Station of the Liverpool Overhead Railway.

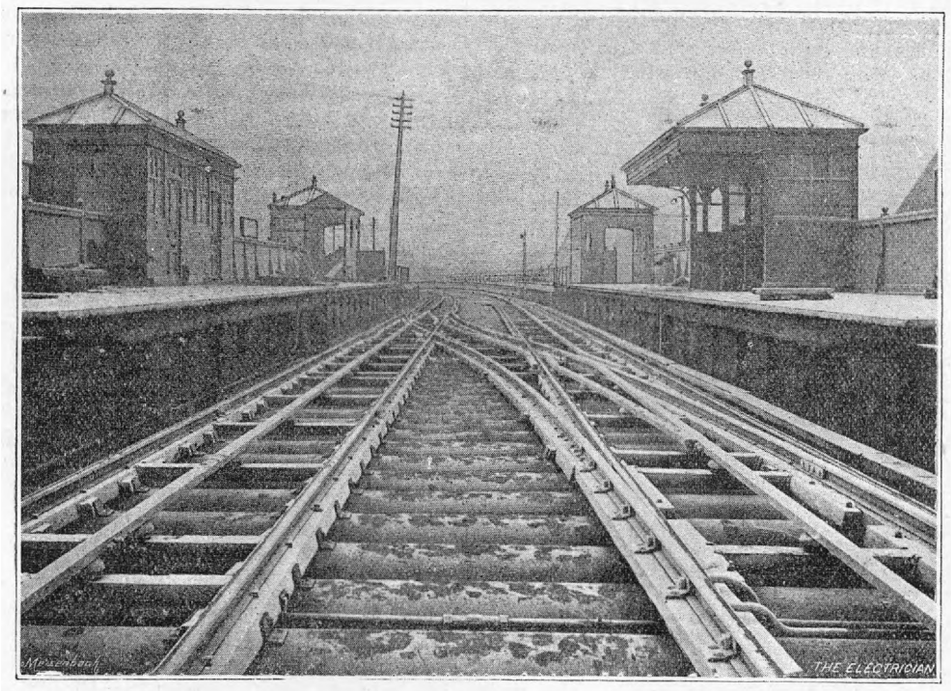

FIG. 2.—Single Cross-over Road at Intermediate Station

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fired by Vicars' mechanical stokers, these being supplied with coal by a conveyor from the large hoppers fixed in the roof of the boiler house and into which the trucks bringing the coal on the overhead line are directly discharged. An economiser in the main flue utilises the waste heat for raising the temperature of the feed water.

There are four main engines of the horizontal coupled compound type, each capable of indicating 400 H.P., with 120lb. steam pressure, at 100 revolutions per minute. The cylinders are 15½in. and 31in. diameter, 36in. stroke, both fitted with Corliss' valve gear. The heavy flywheels, 14ft. diameter, are each grooved for 19 1¼in. diameter ropes. A barring engine, with countershaft and gearing, is provided for turning round or starting the engines. The exhaust steam is taken to a separate surface condensing plant, which has been erected in duplicate, each set being capable of dealing with the steam from three of the main engines when working up to full load. The circulating water is obtained from the dock adjoining. Auxiliary engines are provided for driving the air and circulating (centrifugal) pumps of the condensers, boiler feed pumps, stokers, conveyor, and economiser scrapers. All the steam and feed pipes are arranged to give a duplicate service between the boilers, engines, and pumps.

Each of the main engines drives by means of cotton ropes an Elwell-Parker shunt-wound two-pole dynamo, giving an output of 500 volts, 475 amperes, at 400 revolutions per minute; the magnets are of the double horse-shoe type fixed vertically, and divided on the horizontal centre line, so that the top half can be readily taken off to allow of the examination or removal of the armature. The pulley is carried between two bearings, and a coupling being inserted between the pulley and armature shafts allows the latter to be taken out without dismounting the pulley, taking off the ropes, or interfering with the set of the bearings. The switchboard is of a very simple description, as all the dynamos couple in parallel on to omnibus bars, from which the current passes out to the line; each machine is provided with a multiple contact-switch and set of resistance coils for regulating the E.M.F., a voltmeter, an ammeter, and a double-pole Elwell-Parker patent automatic magnetic cut-out, which also acts as the switch. Between the omnibus bars and the line is a main automatic magnetic cut-out carrying the whole current going out from the station.

The current is carried along the line for supplying the motors by means of a steel conductor laid in between both up and down lines. This conductor, which is made of a special quality of steel, having a high conductivity, takes the form of a channel, having a sectional area of 4 square inches and weighing 40lb. per yard; the various lengths are jointed by copper fish plates arranged to allow for expansion and contraction. The conductor is carried upon pot insulators, a thin sheet lead cap being inserted between the channel and the insulator. As the ordinary rails are carried by longitudinal sleepers, special cross bearers have been fixed to carry the insulators. At each of the intermediate stations there is a cross-over road, and at each terminal station two cross-over roads; these are features which introduce difficulties in working to prevent short circuiting between the conductor and the ordinary rails which form the return circuit. Mr. Parker has overcome this by fixing the height of the centre conductor so that its surface is about 1in. higher than the top of the ordinary rails (Fig. 4), and the collectors being made very wide it bridges across from the conductor on one side to that on the other side of the ordinary rail. The arrangement can be better understood from the illustrations (Figs. 3 and 4) than by a description. The conductors on the up and down lines are electrically connected at each cross-over road, as are also the ordinary rails, thus making a network of conductors. The ordinary rails are electrically jointed across the fish plates.

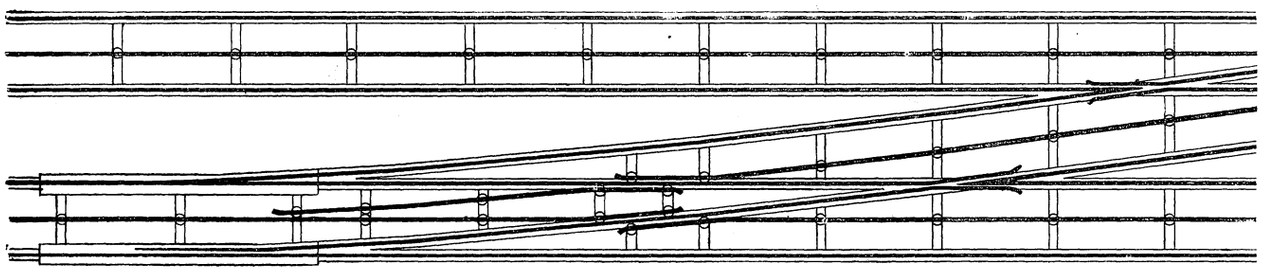

FIG. 3.—Plan of Points and Cross-over Road.

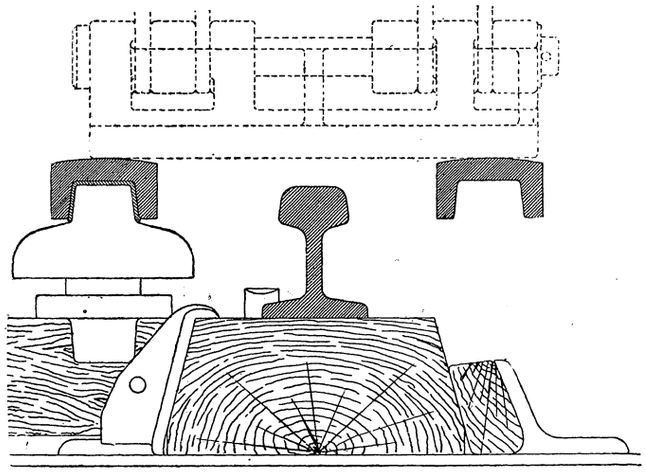

FIG. 4.—Section of Conductor Crossing.

The collectors (Fig. 5) consist of hinged cast-iron blocks carried by, but insulated from the bogie frame; one is fixed to each carriage. The carriages, 45ft. in length over the end pillars and 8ft. 6in. in width over the side pillars, are carried by two four-wheel bogies, having 32ft. centres and 7ft. wheel base, the wheels being 2ft. 9in. diameter. Each carriage has a seating capacity for 57 passengers—16 first and 41 second class. Two carriages form a train, which weighs approximately when complete with motors, switches, and full complement of passengers 40 tons. A driver's box is partitioned off at one end of each carriage, and fitted with the driving switches and brake gear; the box at the front of the train is occupied by the driver, and that at the rear by the guard, who is also trained to take charge of the driving in case of emergency, a gangway between the two cars giving a means of communication. Westinghouse brakes, which are fitted in addition to hand brakes, derive their supply of compressed air from receivers

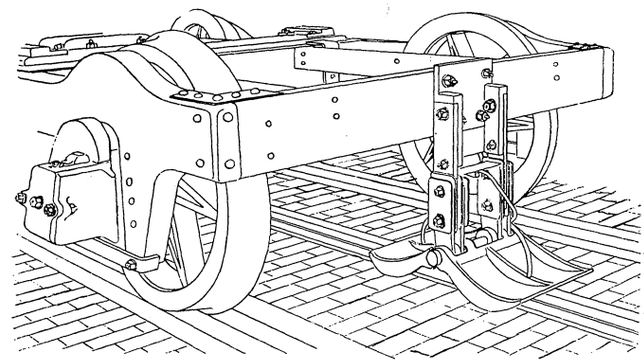

FIG. 5.—Slipper Collector fixed to Bogie Frame.

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carried under each carriage, these being charged at the north terminal station, where an air-compressing plant is erected. One bogie of each carriage carries a motor, the trains being made up so that there is a motor on the leading bogie of the first carriage and one on the trailing bogie of the second carriage. The motor armatures are mounted directly upon the axles, 10 revolutions of which are equivalent to a train speed of one mile per hour, and as a speed of 25 to 30 miles per hour is required to complete the journey in 30 minutes, this gives a speed to the motor armature of 250 to 300 revolutions per minute. The magnets are supported by two bearings on the axle, and, in addition, by a special arrangement of springs from the bogie frame.

The motor magnets are of the double horse-shoe type series-wound, the armature being of the "drum" type. The dimensions and winding were determined upon after careful experiments carried out by Mr. Parker, the object being to arrive at the most economical arrangement, having in view the fact that the greater part of the work which the motors are called upon to perform is that of starting and accelerating the trains; only for a very few minutes during each journey are they run up to full speed. Some tests taken at the Electric Construction Corporation's works showed that when the motor was stationary and a current of 30 amperes passed through it the torque effort on the rim of the wheel (2ft. 9in. diameter) was 170lb., with 50 amperes 450lb., and with 80 amperes 1,060lb.

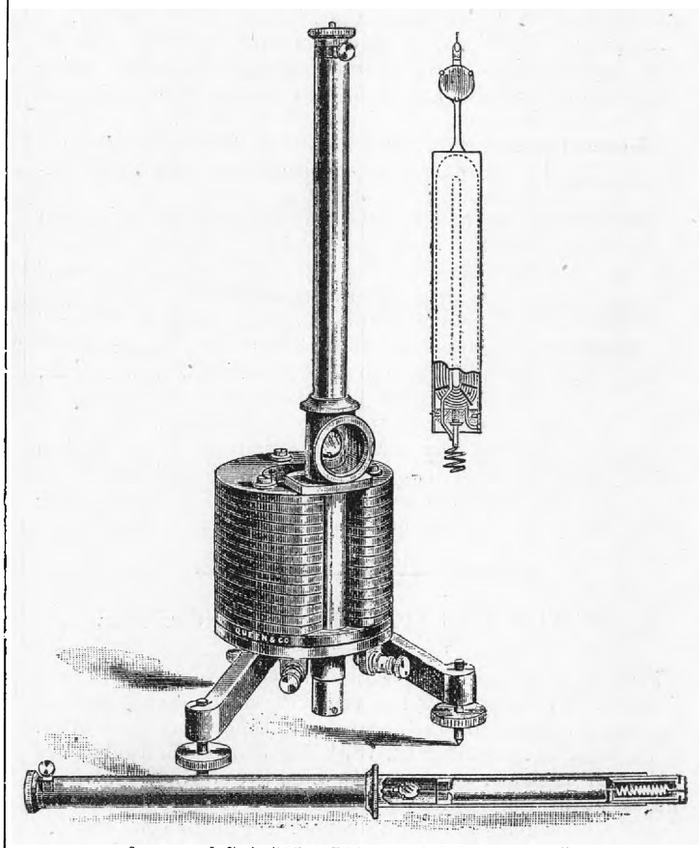
The carriages are lit with glow lamps supplied with current from the centre conductor. At each of the 14 stations along the line is an accumulator of 54 cells, forming two batteries each of 27 cells. One battery at each station to the south of the generating station are connected in series and charged off the 500-volt circuit, a second loop taking in the batteries at stations to the north of the generating station. These batteries furnish current for lighting the stations, and also for working the automatic signals. Home and starting signals are fixed on up and down line at each station, and connected up with the necessary making and breaking contacts, the latter being worked by a striking bar on the train when it passes over. Each train as it goes along automatically blocks the one section in the rear. Glow lamps in duplicate are used in the signal lanterns at night.

To carry out the work several firms have been engaged as sub-contractors — the boilers, engines, and other portions of the steam plant having been supplied by John Musgrave and Sons (Limited), Bolton; the carriages by Brown, Marshalls, and Co. (Limited), Birmingham; the steel channel by the Shelton Iron and Steel Company (Limited), Stoke-on-Trent; the signals by I. A. Timmis, London, &c. The whole of the electrical plant has been designed and manufactured at the Electric Construction Corporation's works at Wolverhampton, they also being responsible for all other portions of the plant.

ANOTHER "NEW" GALVANOMETER.

Closely following on the heels of the "New Standard Ballistic Galvanometer," described in our issue of December 16, 1892 (p. 187), an account of another "chestnut," the "New Queen d'Arsonval Galvanometer" appears in the Journal of the Franklin Institute. We are not prepared to accept the doings of a single firm as representative of a whole nation, or we should have to confess that at last some subject had been found in which Americans had no originality. This appropriation of the design of one of our latest English instruments is not quite so cool as the case of the ballistic galvanometer, since the Paper on "Recent Improvements in d'Arsonval Galvanometers," by Mr. N. H. Genung, not only acknowledges the existence of the Ayrton-Mather instrument and refers to our description of it (*The Electrician*, Vol. XXIX., p. 336), but quotes from the joint Paper of these authors with Dr. Sumpner (*The Electrician*, Vol. XXIV., p. 348), and Mr. Mather's Paper on "Shapes of Moveable Coils used in Electrical Measuring Instruments" (*The Electrician*, Vol. XXIV., p. 577).

When we learn, moreover, that an Ayrton-Mather galvanometer was exhibited at the reading of this Paper, we need only regard the "New Queen d'Arsonval Galvanometer" as an American edition of this instrument, and examine the modifications which have been thought necessary to adapt it for the American market. The puny height of 6in. was unworthy of the occasion, so another 10in. or more have been clapped on to it. The miserable little coil designed by Mr. Mather has, like the toad in the fable, swollen hugely, and has attained a bulk about eight times that of the original; while the magnet



Queen and Co.'s "New D'Arsonval Galvanometer."

is about four times as great. Most of the other changes have been in the direction of greater elaboration, one exception being the absence of a spirit level; it will be remembered that in their copy of the Nalder galvanometer the Queen Co. omitted the level as a needless refinement. If the detail drawings of the instrument given in the Journal of the Franklin Institute are to scale, it seems that the clearance between the coil-tube and the case-tube is so small that very careful levelling will be necessary to allow the coil to swing freely. The most sensible way of levelling is to use a level; of course, there are other ways, one of them being to fidget about with the screws until the coil swings. If this operation really suits American electricians, we may distinguish it as "leveling." The most noticeable alteration is the construction of the magnets from stampings of sheet steel and the rounding off of the corners, to concentrate the field and to avoid waste. This is very proper, but we learn that these magnets are "hardened glass-hard," and "after having been thoroughly magnetised, great care is exercised not to subject them to any rough usage." No amount of allowance for peculiarities of transatlantic requirements can convince us that such magnets would not be all the better for a little knocking about, with the deliberate intention of "ageing" them.

Coil Tube and Mirror of Ayrton-Mather-D'Arsonal Galvanometer.

The increase of size and possibly the additional strength of field has produced a distinct advance in the absolute sensitiveness, by which we mean the deflection produced by a given current, irrespective of the time of oscillation, for one volt

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gives one millimetre deflection at a metre scale-distance through 200 megohms. This sensitiveness, however, is gained at the expense of quickness, for an interval of about 55 seconds is required to deflect the coil to its steady position, the movement being aperiodic. As regards proportionality of deflection to current, this instrument leaves much to be desired, the discrepancy amounting to between 4 and 5 per cent. English instruments, from one of which this has been copied, have an error of less than one-tenth per cent. in this proportionality.

Accurate proportionality of deflection to current depends upon very delicate adjustment and shaping of the magnet poles relatively to the shape of the coil. If these are blindly imitated in Chinese fashion, fair proportionality may result, but if either poles or coil are altered, some intelligent knowledge and experience of the instrument or a considerable amount of tentative experiment would be needed to secure it.

The slipping out of the tube, the shape of the coil, and the flattened phosphor-bronze suspension are all too simple to bear any improvement. "To the top of the aluminium tube," says the Paper, "is attached the mirror, held in place by a three-armed aluminium clip, thus avoiding the use of wax." The three-armed clip referred to is clearly shown in the illustration which was published in *The Electrician*, Vol. XXIX., p. 336, and which was engraved from a drawing made from an instrument lent to us for the purpose by Mr. Paul. We shall watch with interest the Americanization of other English instruments, and trust that those which have the honour to be thus translated may be worthy of the selection by the appreciative instrument makers of Chestnut-street, Philadelphia.

THE ELECTRIC LIGHTING OF SINGAPORE.

For some time past the question of electric lighting has been discussed in Singapore, and a very interesting correspondence has been published in the local papers concerning the matter. So far back as November 18, 1891, Mr. James MacRitchie, the municipal engineer, wrote to Mr. Lindsay, of Glasgow, who is the agent in Europe for this Municipality, stating that the Municipal Commissioners of Singapore had under consideration a proposal to light the town, or a portion of it, with the electric light. Before, however, deciding upon any particular course they were anxious to obtain for their guidance particulars as to the systems adopted in other towns where electric lighting was used, as well as the success obtained, cost of installation, prices charged to customers, &c. With this letter was enclosed a schedule containing inquiries, which were to be forwarded to various towns and electric supply companies, with the view of obtaining answers which would assist the Commissioners in Singapore in settling the question. These circulars were sent out, and the replies were returned to Mr. MacRitchie, who furnished a report to the Municipal Commissioners, dated April 7, 1892. In this report he points out that before the list of questions was issued it was submitted to Prof. Jamieson in Glasgow, who made slight alterations, and out of the large number of circulars issued, only 11 replies were received, these being from Liverpool, Waterford, Norwich, Bradford, Dublin, Taunton, Exeter, Bristol, Chelmsford, Westminster, Notting Hill, St. James and Pall Mall. Of those sent to America not a single schedule was filled in. Besides the above data, the municipal engineer collected details of cost from periodicals, and obtained them direct from Hong Kong and Shanghai; he also obtained additional information from a firm in Calcutta.

It will be well before proceeding to give an abstract of this report to consider the amount of lighting which is required in Singapore. It appears that at present there are 883 gas lamps used for the public lighting, each lamp giving about 15 c.p., and the gas company of course supplies a considerable quantity of gas to private consumers. The Municipality pays at the rate of 6s. 5d. per lamp per month, while the charge to private customers is 9s., less 10 per cent., per thousand cubic feet. It may be well to remark that the amounts quoted in the report of the municipal engineer and also in the correspondence are given in dollars, and it appears that the rate of exchange is taken at 6·7 dollars to the pound by the municipal engineer, and at 6 dollars to the pound by Mr. Thomas, whose name will appear later. We have, however, transformed all the amounts into English money. The public lamps burn five cubic feet of gas per hour, and are lighted eleven hours per night, so that they use 1,650 cubic feet per month, which at the rate charged to the ordinary consumer would amount to 13s. 4d. per month, or rather more than double the amount charged for public lighting. The position of Singapore near the Equator renders the question of public lighting simpler than it is in other countries. The light is required regularly eleven hours per night, and this, of course, is a distinct advantage in favour of electric lighting, and would lead to a better load-factor than can be obtained in Great Britain. This fact has been brought very prominently forward by several gentlemen who took very different views of the matter from those put forward by the municipal engineer. Major MacCallum, of the Royal Engineers, who holds the position of colonial engineer, has shown great interest in the question, and is a strong advocate for electric lighting; feeling, however, that he is not an expert upon the question, he has availed himself of the assistance of Mr. Thomas, who is strongly in favour of using alternating currents and arc lamps.

Major MacCallum proposed to replace the 883 public lamps as follows:—To use 250 arc lamps of 1,200 c.p. each instead of 600 gas lamps, and to replace the remaining lamps by 283 oil lamps at 6s. per month each. The reason for proposing oil lamps was that these lights were very much scattered, and the arc lamps were to be used in the more densely populated part of the town. The proposal was that overhead wires should be used, and it was thought that these would not be objectionable, as there are at present a great number of overhead telephone wires. Major MacCallum's proposal did not contain any allowance for private lighting, and from the figures given to him by Mr. Thomas he considered that the total cost would work out to £25,000, and the annual cost per arc lamp was put down at £13. 13s. The municipal engineer states in his report that he has carefully gone into the proposals made by Major MacCallum and Mr. Thomas, and the main objection in his mind appears to be that if the gas company were not allowed to supply gas for the public lighting they would not be able to carry on their own business at a profit. It is hardly an argument against the introduction of public electric lighting that if it were undertaken the gas company would suffer. It must be distinctly borne in mind that in such a place as Singapore the hours of lighting are practically constant throughout the whole year, and as we have remarked previously amount to about 11 hours per night. In the case of an arc-light installation, therefore, the conditions of supply would be eminently favourable from a financial standpoint, and the figures which have been obtained by Mr. MacRitchie from central stations in Great Britain are of little use in such a case.

In his report the municipal engineer has made free use of the details which have appeared from time to time in the columns of *The Electrician*, and both he and Mr. Thomas acknowledge the great assistance which has been afforded to them by our yearly reports on the condition of the various supply companies, and from the tables published in "The Electrician" Electrical Trades' Directory and Handbook. Mr. MacRitchie, in his report, does not consider Major MacCallum's proposal as originally framed, but has taken it to be a scheme for arc-lighting in the public streets, and also for private supply as well. This gives an entirely different aspect to the question, and we think it is hardly a fair treatment for the proposal. From this voluminous report we have been able to gather little which cannot be obtained from our own columns. Mr. Thomas had supplied data of arc-lighting upon the Thomson-Houston system, of which he has had much experience, having been in charge of the Taunton Station for some time. He claims that the arc lights can be supplied in Singapore for the sum of £13. 13s. per annum, or at the rate of 22s. 9d. per light per month, and that in this way the town would obtain 30 times as much light as it is now getting from the gas lamps. Mr. MacRitchie gives details of the charges made by the electric lighting companies to the municipal bodies in Eastbourne, Taunton, Dublin, and various other towns, and upon

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these charges bases his estimate for the cost of arc lights in Singapore. His argument is that in the first place plant erected in Singapore would cost 25 per cent. more than similar plant erected in England, and that whereas the cost of coal at such a place as Taunton was only 13s. per ton, the price of coal in Singapore is £1. 10s. per ton. Mr. MacRitchie quotes the cost per arc lamp at Taunton at £22 per annum, and remarks that this is only for eight hours per night; he therefore concludes that the price at Singapore per light would be considerably more, and considers that Major MacCallum's estimate is too low. The whole of the municipal engineer's arguments appear to be based on a fallacy. He has considered the charges made by electric lighting companies to public bodies as though these were the actual costs of production. This, of course, is obviously absurd, and Mr. Thomas has very rightly drawn the attention of the public to the fact that the cost of running arc lamps in St. Pancras district is only £12 per annum. The gas lamps, as quoted by Mr. MacRitchie, are 75 yards apart, and there are 930 lighting some 40 miles of street; this number does not agree with the figures which we have given above, and which were supplied previousiy to Major MacCallum. It appears to us that 250 arc lamps of 1,200 c.p. each would give a very satisfactory improvement upon the lighting obtained from 600 gas lamps. We think Mr. Thomas's is a figure for which the work might be done considering the special conditions of such a town as Singapore, and in order to give the authorities an opportunity for seeing arc lamps in use, Mr. Thomas has proposed to run 18 Thomson-Houston arc lamps of 1,200 c.p. each for a month. These lamps would be placed on wooden poles at 100 to 150 yards apart in the public roads, and would be supplied with current from a Thomson-Houston machine, driven by an 8 H.P. portable steam engine. He is willing to run this installation for one calendar month for the sum of £158. In the event of the Municipality providing the necessary engine, boiler, and shed, a reduction would be made of £54. We can only say we trust that before long Singapore will be sufficiently enterprising to take up the question of electric lighting, although the rate of interest—6 per cent.—which the Municipality has to pay upon loans is somewhat excessive according to home ideas.

According to latest advices the Municipal Commissioners have refused Mr. Thomas' offer by five votes to four, the President stating that he expected every day to get an offer from the Gas Company with regard to the street lighting.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

BY PROF. W. CAWTHORNE UNWIN, F.R.S.

Systems of Hydraulic Transmission. Accumulator v. *Reservoir Storage.*

The lecturer said the introduction of the system of distributing energy by water pressure was due to Lord Armstrong. The high-pressure system of hydraulic transmission was almost exclusively an English system, and almost exclusively a system for working intermittent machines. For ordinary power purposes it was not so well adapted, and it was abroad, and at a later date, that hydraulic transmission had been carried out and adopted for the supply of power for all ordinary industrial purposes. The intermittent action of cranes and other similar machines led to the study of means of storing energy. Reservoir storage was not at first possible, and it occurred to Lord Armstrong that air pressure might be used. But there were practical difficulties. Air pressure varied with the variation of the quantity of water in store in the air-vessel; an air-pump must be used to replace the air absorbed by the water and to maintain the air-cushions in the air-reservoir. Subsequently, Lord Armstrong invented the accumulator, which answered the purpose of meeting momentary fluctuations of demand in hydraulic systems driving intermittent machinery. As early as 1840 Lord Armstrong had completely worked out the idea of a system of power distribution. The systems of hydraulic transmission might be divided into two groups. First, there were the systems with reservoir storage, which for convenience he would call low-pressure systems. In none of these cases did the pressure reach anything like the amount it did in the Armstrong system, but they were of very high pressure all the same, and he only called them low pressure for the sake of distinction. In these systems the pressure was fixed by local conditions, and usually was not equivalent to more than 400 to 600 feet head (170-260lb. per square inch. By low pressure systems they had power distributed for all ordinary industrial purposes, for continuous as well as for intermittent machines. In the second group were systems with accumulator storage, worked usually at very high pressure, 700 to 800lb. per square inch, or 1,600 to 1,800 feet of head. In these systems the energy was distributed almost exclusively for lifting purposes and for driving presses, or for other similar intermittent machinery.

* Howard Lecture IV., delivered before the Society, of Arts Friday, February 3rd.

Advantages and Limitations of Hydraulic Transmission.

He proposed first to glance at some of the mechanical advantages of hydraulic transmission. First, just consider the amount of power which could be transmitted in pipes by pressure water. The velocity in the pipes could not be made great without excessive frictional losses and without incurring danger from hydraulic shock. A velocity of 3ft. per second was commonly allowed, and perhaps this might be doubled without excessive frictional loss or excessive risk. With a speed of 3ft. per second, and a low pressure of 500ft. head (215lb. per square inch), such as that of Zürich, a 12in. main would transmit 133 H.P.; with a 24in. main about 533 H.P.; with a very high pressure of 750lb. per square inch, like that in London, or a 6in. main transmitted 116 H.P., and a 12in. main, if it could be used, which was not certain, would transit 463 H.P. The horse-power was gross horse-power, without any allowance for waste at the motors. It would be seen that neither on the high nor the low pressure system was the amount of power which could be transmitted by a single main a very large quantity. This at once marked out a characteristic limitation for hydraulic transmission. It was therefore best adapted for intermittent machines. If applied continously, it was best adapted to motors of comparatively small size used in industries not requiring great amounts of power. When they came to deal with thousands of horse-power, the hydraulic transmission system broke down from the excessive size of the mains to be used. That was the first point. The second point was the loss of pressure in the mains due to friction. At 3ft. per second the loss of pressure per mile was very small in amount, about 18lb. per square inch in a 6in. main, only 9lb. per square inch with a 12in. main, and 4½lb. with a 24in. main. These losses were quite insignificant on the high-pressure system, and not very important on the low-pressure system with ordinary distances of transmission—that was, distances of a mile or more; in fact, the question of loss in the mains might be put aside as perfectly insignificant in the cases to which hydraulic transmission was properly applicable. A third point was the considerations arising out of the strength of the pipes. In all hydraulic systems at high pressure in this country cast-iron pipes had been used, with a peculiar flanged joint introduced by Lord Armstrong. The jointing material was gutta-percha, but the form of the flanges had been modified by Mr. Ellington. Pipes subject to high pressures were usually jointed as shown in diagram (Fig. 1). [In Fig. 2. the new type of joint is shown.—Ed. *E.*] The working stress on these cast-iron pipes was 2,800lb. per square inch of metal, a very moderate limit of stress. Probably at this time welded steel pipes could be used for hydraulic transmission at high pressure, if a suitable joint for them could be devised. Such pipes were proposed to be used in the project submitted to the Niagara Commission by MM. Vigreux and Levy, but he (the lecturer) did not know of any system where they had been actually used. A stress of 15,000lb. per square inch might be used with such pipes, and this would, no doubt, greatly increase the applicability of high-pressure transmission. On low-pressure systems cast-iron socket pipes had.

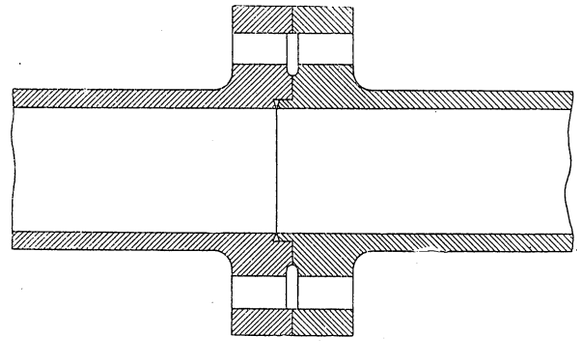

Fig. 1.—London Hydraulic Power Company's Joint (Old Pattern).

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been alone used, so far as he knew; but on such systems steel pipes might be advantageously used in many cases. Examination showed that, as far as strength was concerned on low-pressure systems cast-iron could be used in all cases, but for high-pressure systems it was doubtful whether cast iron could be used in mains more than 6in. in diameter. There came in a practical limitation to the amount of power which could be transmitted on high-pressure hydraulic systems. Then there came a further consideration arising out of the weight and cost of the pipes. For pipes of equal strength it appeared that the weight was simply proportional to the horse-power transmitted; hence, so far as cost of mains was concerned, the low-pressure system was as economical as the high-pressure system. That, of course, did not allow for such practical exigencies as perfect pipes being made of the thickness determined by conditions merely of strength. No doubt, the practical exigencies taken into account, a given amount of power might be somewhat more cheaply distributed in high pressure than in low-pressure systems. That, perhaps, cut across a popular impression, but he believed it was the case that if they could make their pipes always to suit the exact conditions required for strength, the low pressure would be as economical in distribution in most cases as high pressure.

Next came considerations arising from motors driven by the pressure water. On all very high-pressure systems the motors used were almost exclusively pressure engines. Such motors became extravagantly expensive, if driven by low pressure water; the greater the water pressure the more conveniently and cheaply the power was produced in machinery of that kind, and hence it had

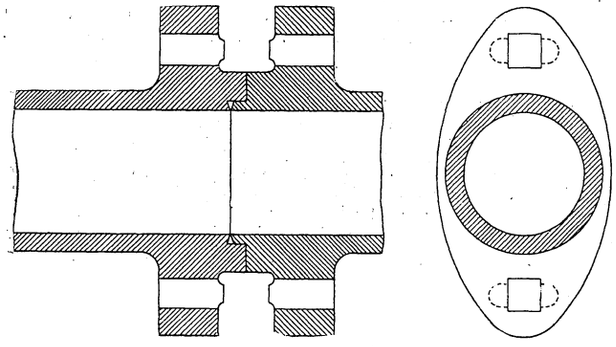

FIG. 2.—London Hydraulic Power Company's Joint (New Pattern).

come about that all the English systems of water-pressure distribution, which had been intended for working pressure engines, had been constructed for pressures of 700lb. to 800lb. per square inch. These systems were extremely convenient for actuating lifting machinery, for presses, and even for rotative motors of small power, but were not nearly so convenient when a considerable amount of power was required continuously for driving a factory. For that purpose turbines were more convenient, and for turbines the high-pressure English system of distribution was not convenient; the reservoir system in that case was very much better adapted.

Hydraulic Power Stations (Accumulator System), Hull, London, Birmingham, Manchester.

The earliest general system of high-pressure hydraulic transmission was one installed in the town of Hull. He believed that was the first system in which power was sent from one station to many consumers. It might be said that that was a purely local system, covering no great area of town, the longest main being but 1,500ft. in length. The efficiency of the whole system was said to be 76 per cent. The tariff adopted in Hull for working cranes was £52 for one crane in one warehouse, with a diminishing price for many cranes in one warehouse. The Hull charges were equivalent to from £104 to £83 per horse-power per annum.

Now he came to the London Hydraulic Power Company's system. An Act was obtained in 1871 for supplying hydraulic power in London on the Armstrong system. The power conferred by the Act remained dormant until resuscitated by Mr. Ellington in 1882. The present company was constituted in 1884. In 1887 twenty-five miles of pressure main had been laid in London streets, and at the present time there were 59 or 60 miles of pressure mains under the London streets. There were three principal pumping stations, one at Falcon Wharf, another at Millbank, and another at Wapping, whilst a fourth station is soon to be erected. The whole of the water was taken at the original station from the river, but it was filtered before it was used. The filtered water was pumped into the high pressure mains, then used by the consumers, and from the consumers flowed away into the sewers. The power was available night and day all the year round, and was largely used for lifting machinery. The charges were based on the power taken by both large and small consumers. The company claimed that it could be used for electric lighting of particular establishments, and it certainly could be used for extinguishing fires by the application of an ejector. The quantity of water used by each consumer was measured by a meter on the discharge main. Now, the London system was an exceedingly remarkable one, which had grown up comparatively rapidly but very silently until it had become a large institution.

He wanted them now to look at the charges for water-power on the London hydraulic system. A minimum charge of £5 per annum was made for quantities not exceeding 12,000 gallons per annum; the charges varied according to a sliding scale, and for 15,000 gallons the charge amounted to £8 per annum, or about 8s. per 1,000 gallons. For a consumption of a million and a quarter gallons the charge was £170, or little more than 3s. per 1,000 gallons, so the variation in the charge for water was considerable. With these charges the cost of power for the kind of work for which the system was best suited were often very small. It had been calculated that very often the charge for the water used for lift machinery amounted to less than ¼d. per ton lifted 50ft. On the other hand, in these lectures it was necessary to compare the cost of power on some common basis, and it was unavoidable to take as a basis the work of ordinary machines going continuously throughout the day. If they took the power supplied by the London Hydraulic Company, supposing it to be used for machines working 3,000 hours per year, then the cost would be very considerable. Allowing an efficiency of 80 per cent. in the motor, they would find they had to pay the Company £175 per horse-power per annum if they took a motor of the smallest size for which they supplied power, or £62 per horse-power per annum if they had a motor of the largest size. In either case the charge for continuously exerted power turned out to be a very large one.

Since the establishment of the London hydraulic system the same system had been extended to some other towns, and in connection with them he would just point out, first of all, that in some of them attempts had been made to use water from the town mains for power purposes. In Liverpool, for instance, pressure water on the street mains was used as early as 1847. From an interesting Paper by Mr. J. Parry, it seemed that the use of hydraulic pressure from the town mains made very slow progress for thirty years. In 1887 the number of machines supplied was 89, and at the present time 162 machines in Liverpool were worked by pressure from the mains, consuming about 125 million gallons of water per annum. In the Liverpool mains they had a very good pressure, about 70lb. per square inch, and he found that the whole of the power taken from the water mains in Liverpool amounted only to 82,000 H.P. hours in the year. Therefore the whole of the power taken from the town mains in Liverpool only amounted to 27 H.P. taken continuously from the mains during 3,000 hours in one year—a very small power, indeed.

In Birmingham lately they had been extending a system strictly on the lines of the London system—the high-pressure system. He referred to the Birmingham system mainly because, in the first place, it was a municipal system. In the next place, in Birmingham they were making an experiment by working their central pumping station with gas-engines. There were three triple hydraulic pumps, pumping at a pressure of 730lb. per square inch in the mains, driven by three Otto gas-engines of a total of 100 effective horse-power. There was one peculiarity in the system which was very interesting. The gas-engines used were moderately large engines, but there was used to start these gas-engines a small Brotherhood hydraulic engine, worked with water pressure from the accumulators. A system of this kind was about to be established in Manchester, but from the local conditions there, the necessity of working by presses which were already constructed, and which the owners did not like to alter, they were going to use the enormous pressure of 1,600lb. per square inch. There was another peculiarity about the Manchester system, which touched on a point to which he would have to allude in his last lecture. At Manchester they had come to the conclusion that it would be economical to have a high-pressure hydraulic system and an electric lighting station worked from the same generating station. It came to be a case of improvement of load-line. They hoped to realise an economy from working a power system and a lighting system in conjunction.

Hydraulic Power Stations (Reservoir Storage), Zürich, Geneva.

He now came to consider the hydraulic transmissions at low pressure, in which there was no accumulator storage, but a reservoir storage. In connection with these low-pressure systems he would be driven to speak of high pressure and low pressure; that was in the characteristic examples he was going to quote there were comparatively low pressure and comparatively high-pressure mains. But high pressure meant only one third of the pressure of the London system.

The first of these foreign hydraulic transmitting systems which he wanted to describe was the one at Zürich. That installation

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was a complex and very interesting one. It was the earliest system in Switzerland in which hydraulic power was used partly for the supply of potable water for town purposes, and partly for the supply of motive power from the same central station. It had grown gradually, and within the last three or four years had been very considerably extended. The system at Zürich now comprised a water supply for the town, the supply of motive power by wire rope to certain factories, the supply of motive power by low pressure water from the town mains, the supply of motive power by a special high-pressure system with about 500ft. head, and an electric lighting station. All these were under one management. Originally the water supply was obtained from a filter in the bed of the river Limmat, near its exit from the lake at Zürich. This water was pumped by turbines erected in the river a little further down. The quality of the water was found to be inferior; they had a bad outbreak of typhoid some years ago which led to an inquiry, and now the water for the supply of the town was obtained entirely from the lake itself, the main being extended a considerable distance into the lake, and the water from the old filter bed was now used entirely for motive power purposes. The pumping station had provision for 12 turbines, of which eight were Jonval turbines, of 80 H.P. each, and another of recent construction was of 175 H.P. The whole of the turbines worked on a horizontal shaft. The fall was 5ft. to 10½ft. The large double-acting pumps worked by gear from the shaft. There were two 300 H.P. compound steam-engines which were idle nearly all the year; they were held in reserve in case of some extraordinary low condition of the water when the power of the turbines would be insufficient. The electric lighting station was the next part of the central station. There were two alternating dynamos which could be driven in three ways. The normal way of driving them was by two impulse turbines of about 200 H.P. each, which were driven by water which had been pumped by the other turbines into reservoirs. The dynamos could also be driven off the horizontal shaft by the low-pressure turbines, or by the steam-engines. The power was obtained at Zürich, just as at Geneva, in this way: A weir was constructed across the river, and in the river was a longitudinal embankment. At the end of one of the two divisions of the river so formed by the embankment the turbine house was placed, and in the one division the water was kept up to a definite high level. The other half of the river was deepened by dredging and formed a means of discharging the surplus water and of taking the tail water from the turbines. At the head of the first division of the river there were moveable sluices by which in times when there was a great deal of water to be got rid of it could be got rid of down the arm of the river without interfering with the turbines or increasing the high level in the length. The power obtained from the turbines was distributed somewhat in this way: for pumping the town supply of water 240 E.H.P.; for the supply of motive power on the low-pressure system, about 130 H.P.; for the supply of motive power by rope transmission, about 230 H.P.; and for supplying motive power on the special high system, power which was chiefly used at present in the lighting station, 450 H.P. In connection with the pumping station they had at Zürich four reservoirs to which they could pump water at different elevations, varying from 154ft. above the pumping station to 530ft., the reservoir at 530ft. being the one which stored the water for the high-pressure hydraulic transmission system. For a horse-power for a year of 3,000 working hours they charged at Zürich from £7. 10s. to £16. The Zürich system had been working, with the exception of one part of it, for fifteen years or more.

Quite recently there had been established, very much on the pattern of the Zürich system, a still more important station at Geneva, where there was now in continuous daily operation one of the largest and most remarkable hydraulic power stations in the world. The water of the Rhone was employed to drive a series of large low-pressure turbines, and giving a total effective power of 4,500 horses. These turbines pumped water into two systems of mains; one, the older of the two, was termed the low-pressure system, the pressure being about 160ft. to 200ft. of head, 70-90lb. pressure, This was a development of a previously existing system, and was still chiefly intended to supply water for domestic and municipal purposes. The other system of mains was termed the high-pressure system, and had a pressure of 460ft. (200lb. pressure) of head at the pumping station. This system was partly intended to supply potable water in the higher parts of the town, which could not be reached by the low-pressure system; but it was specially intended for motive power purposes. Reservoirs had been constructed at Bessinges to supply this high-pressure system, and to store water pumped by the turbines at night and at times when other demands on the apparatus were scanty. The water pumped up to Bessinges, 460ft. above the pumping station, represented part of the water power of the Rhone, which without this storage reservoir would be wasted.

The Geneva system, it would be seen, was a complex one, which had been developed under special local conditions. In spite of natural and political isolation, manufacturing industries had for centuries flourished at Geneva. That they did so was partly owing to the fact that water power was easily obtained from the Rhone. The industrial quarter gathered along the two banks of the river, and factories at one time were built even in the stream itself. In 1871 Colonel Turrettini, the engineer under whose direction the present works had been constructed, had applied to the Town Council to place small-pressure engines on the mains of the then existing water supply. The plan of obtaining motive power in this way proved so successful and convenient that in 1880, before the new works were commenced, there were 111 small motors at work in Geneva, using 34 million cubic feet of water annually, and paying a yearly rental to the town of £2,000. The cost of the power at that time to consumers was at the rate of from £36 to £48 per horse-power per year of 3,000 working hours. Finally, in 1883, a contract was given to construct the works. The turbine house was constructed on the basis of the supply of nearly 4,500 H.P., and at present 3,500 H.P. was being developed. As in the case of Zürich, they proceeded by dividing the river into two parts. Partly by utilising the islands in the river, and partly by constructing a longitudinal embankment, they had divided the river into a head race to the turbines and a race for the discharge of the surplus water (*see* Fig. 3). The works altogether had cost £283,000. This included outside items, and the cost of utilising the forces of the Rhone was only £200,000. The turbine and pump-house placed at the end of the head race was originally intended to contain 20 turbines of 210 H.P. each. At present there were only 18 Jonval turbines, some of which were of more than 200 H.P. They worked on a vertical shaft, and a crank drove two double-acting pumps placed at right angles. The head varied from 5½ft. to 12ft. Great power, therefore, was obtained out of a very moderate fall. There was a special arrangement in the turbines by which variation of fall produced very little variation in the speed of the turbines. The original motors used were Schmidt pressure engines. These were still used for the smaller powers. They were very convenient, and very cheap, and could be run at any speed required by the machine to be driven. They acted as perfect meters of the amount of water used. In Geneva, for all except very small motors, impulse or partial admission turbines were used. The maximum efficiency of these was from 65 per cent. to 75 per cent., and not much less with light loads. They were cheap, occupied little space, and the speed was easily and perfectly regulated by a governor. In Geneva, the question of speed regulation was found to be a very important one. Industries connected.

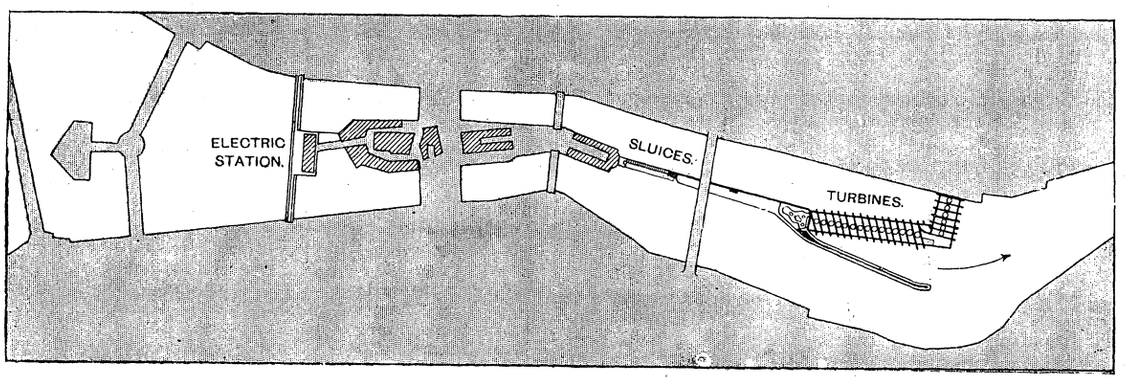

FIG. 3.—Geneva Hydraulic Works. Plan.

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with watchmaking required motors with very great speed-regularity. To meet these conditions, MM. Faesch and Piccard had invented the relay governors, described in a previous lecture, and he might mention that a short time ago he found about 100 turbines in Geneva fitted with them. In Geneva there was hardly any intermittent machinery worked from the power system; the pressure water was almost entirely used for continuous working machines. The largest single amount of power which was used was that which was used in the electric station. There was one rather beautiful contrivance on the high-pressure transmission in Geneva, a contrivance so novel that he thought it might be interesting to describe it. The pipe-main from the town of Bessinges, four kilometres off, sometimes took water up to the reservoir and sometimes brought water back from the reservoir. There would be variations of pressure-head in the town, according as the water was being pumped up to the reservoir or being brought back from it. This would not be very serious if all the water applied for power purposes had been measured by ordinary meters. But in the case of some of the motors they charged for the pressure-water supply in this way: they had an orifice of a fixed size on the main, and they could take all the water they could get out of it during certain hours. On the power supplied in this way there would be a variation of 20 per cent. due to the variation of pressure. To obviate the variation of head there had been devised a centrifugal pump relay, which went into action and increased the pressure-head whenever necessary. The relay was placed one kilometre out of Geneva. There was first an impulse turbine, which drove the centrifugal pump; the whole of the water either going up to or coming back from the reservoir passed through this centrifugal pump, except in case of accident, when it could be carried straight through without going through the relay-house. When the water was going up to the reservoir the pump was stationary. The moment the water began to flow back from the reservoir, and a friction of 3 or 3½ kilometres of main arose, an automatic arrangement put the pump into action, and it acquired a speed proportional to the loss of pressure in the main, and it added to the pressure-head very nearly the equivalent of the loss. The whole arrangement was absolutely automatic.

In 1887 the City Council of Geneva entered into an arrangement with the Company for supplying electricity for lighting. It was part of this arrangement that the Company should use motive power supplied by the town for all its installations. Power was supplied to the Electric Lighting Company at the rate of £3 per effective horse-power per annum, and they now took from the Municipality turbines a maximum of 625 E.H.P. They had three 300 H.P. turbines and one 25 H.P. The £3 just paid the town for the cost of pumping the water, and the town had the right, first of all, to certain additional profits of the Company over a certain percentage, and secondly a right to buy the Company up after a certain number of years. At first sight that looked a very singular arrangement of having an electric light station worked by pumped water. At Geneva it was absolutely rational. The power taken in that way was power which was obtained from the Rhone by those primary turbines chiefly in the night time, when the power could not be otherwise used and would be wasted. The Electric Lighting Company there probably got the cheapest supply of power of any electric lighting company in the globe. He (the lecturer) was in that lighting station a year ago, and he never was in a station so quiet; there was nothing in the whole station you could hear, and nothing you could see moving excepting the governor balls of the turbines. The turbines were started instantly by the opening of the sluices, and once open the governor took care of them, and they wanted very little more attention. Of course, if the electric lighting station wanted to work continuously during the 24 hours it would be no longer economical to use the pumped water. But it only wanted to work for four or five hours in the evening, and therefore it was economical to work from the pumped water from the reservoir. The works at Geneva had been so entirely successful up to the present that they expected to have their whole 4,500 H.P. in full operation within five years. They were already deploring the fact that they would not have power enough even then, and were maturing plans for another power station about six kilometres below Geneva, where 12,000 H.P. would be delivered. That system would be on a different plan.

London and Geneva Systems Compared.

He would, in conclusion, make a comparison, from which he would leave them to draw a moral. They had in London an admirable system of hydraulic transmission, perfectly applicable to the purposes to which it was applied, successful in method of working, and he believed successful in financial working also. This reflected the greatest credit on the engineers of the Company who had had the courage to carry the system out. But the system, great as it was, was a limited one. In this enormous and busy metropolis the number of renters of power was under 2,000, and the power supplied was no more than 1,500 effective horse-power. In a comparatively small town, Geneva, with 1-80th the population of London, there were, three years ago, 137 motors, aggregating 280 H.P. on the low-pressure system, and 79 motors, aggregating 1,284 H.P. in daily and regular work on the high-pressure system. The use of the power was then increasing at the rate of 200 H.P. per annum. It appeared that in Geneva more power was daily distributed than in London. It was distributed in a form more adapted for ordinary industrial purposes without in any way being ill-adapted for the special purposes of lifting machinery, which was the chief object of the London system. Further, the power was distributed to consumers at about one-fifth of the cost at which it was distributed in London, for the special purpose of electric lighting it was distributed at one-twelfth the cost of the power distributed in London. There were in London 2,500 gas engines, which represented a power virtually distributed from central stations. It was not his intention to depreciate the efforts of English engineers, but it was well to recognise that, even if the gas engineers were taken into the reckoning, power was more easily and cheaply obtained in Geneva than it was in London. Local conditions had something to say as to that, but it might be that they had not yet adequately realised what an advantage cheaply distributed power was, or tried all possible means to secure so desirable a commodity.

LEGAL INTELLIGENCE.

The National Telephone Company (Limited) and Another v Graff Baker

JUDGMENT.

The judgment in the above action, a full report of which will be found in our issues for December 16th, 23rd, and January 20th, 27th, was delivered on Saturday morning last by Mr. Justice Kekewich:—

As between the National Telephone Company, whom I shall treat as the sole plaintiffs, although another is associated with them, and the Leeds Corporation, whom I shall treat as the real defendants, although not appearing on the Record, there is no question of title, and no question but that each is lawfully exercising undoubted rights; nor is there any question but that the acts of the defendants interfere with the exercise by the plaintiffs of their lawful rights. This would, I think, have been undoubtedly true if the case had been thrashed out on evidence without the advantage of Mr. Macrory's report, but that report renders it unnecessary to deal with the evidence on this point, and the interference is of a serious character, so that if actionable the remedy would properly be by injunction rather than by damages.

The real and only question in the case is whether the interference is actionable. It was practically admitted by the plaintiffs, and my own view certainly is that if they can maintain the action against the defendants at all, it must be on the application of the principle now well-known as that of "*Fletcher* v. *Rylands*." That principle, for the purpose of application to the case in hand, may conveniently be stated by reference to the second of four propositions set out in the fifth chapter of Mr. Garrett's book on the law of nuisance, which I have consulted in connection with more than one point in this case, and gladly take this opportunity of mentioning as a work of uncommon merit. I will read the proposition in the author's own words, but think it capable of improvement by the substitution for "non-natural" of "extraordinary," which is the term employed by Lord Kingsdown in defining somewhat analogous water rights in his well-known judgment in "*Miner* v. *Gilmore*," 12 Moore's Privy Council, page 131. The land into which the plaintiffs and defendants alike discharge their electric current does not belong to either of them, but for the reasons above indicated there cannot, as between them, be any question that the principle ought to be applied, if it be applicable at all, on the basis of their being absolute owners. That principle has never yet been applied in English law to such a matter as is now under consideration, and perhaps it would not be too much to say that those who enunciated the law in *Fletcher* v. *Rylands*, and have commented on and followed it in other cases, never had present to their minds the application of the doctrine to an electric current, and the possible consequences of its discharge into the earth. The question has been carefully considered in America, and I have studied with deep interest the case of *Cumberland Telephone and Telegraph Company* v. *United Electric Railway*, 42 "Federal Reporter," page 273. The judgment of the Court in that case, though in no wise binding on me, has commanded my earnest attention and respect, and, but for one circumstance, I should not hesitate to allow my own conclusion to be guided by the powerful arguments there set forth. That one circumstance is the want of full adoption of the principle of *Fletcher* v. *Rylands*. American law apparently holds the owner of land used for a non-natural or extraordinary purpose responsible for the consequences of such user to his neighbour only when they result from that owner's negligence, and if he can satisfy the Court that he has not been guilty of negligence, the resulting damage to his neighbour is not actionable. It seems to me that if the principle of *Fletcher* v. *Rylands* had been carefully adopted in America, the conclusion of the Court in the case just cited must have been different. I believe that in Scotland, too, the principle of *Fletcher* v. *Rylands* has not been accepted, and is not regarded as consistent with justice between man and man. It

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does not fall to me to consider so large a proposition. The principle is thoroughly well settled here, and my duty is merely to consider whether it is applicable. It would be easy, of course, to point out differences between all the cases to which it has hitherto been applied and the present, and I have already said that injury arising from such a case as the discharge of electric current can scarcely have been contemplated by any judge in previous cases. But after reflecting much on the novelty of the case, on the arguments addressed to me, and on the peculiarity of an electric current as distinguished from every other power, I fail to see any reason why the principle should not be applied to it. I cannot see my way to hold that a man who has created, or, if that be inaccurate, called into special existence, an electric current for his own purposes, and who discharges it into the earth beyond his control, is not as responsible for damage which that current does to his neighbour as he would have been if instead he had discharged a stream of water. The electric current may be more erratic than water, and it may be more difficult to calculate or to control its direction or force; but when once it is established that the particular current is the creation of or owes its special existence to the defendant, and is discharged by him, I hold that if it finds its way on to a neighbour's land, and there damages the neighbour, the latter has a cause of action. At any rate, I think that if a distinction is to be taken between this and other forces for this purpose, that distinction must be made by a higher tribunal, and not by a judge of first instance. It was endeavoured to be argued on behalf of the defendants that the current injuring the plaintiffs was only part of the general body of electricity which may be now said to exist everywhere, and to be proceeding in every direction; but the effect of the defendant's operation is to collect a particular portion of this body and to discharge it into the earth at a particular spot, and there can be no doubt that the disturbance of the plaintiffs' telephone system is caused by the particular quantity thus discharged.

Assuming the action to be maintainable on the principle of *Fletcher* v. *Rylands*, the defendants rely on two answers to the plaintiffs' claim. First, they say that the plaintiffs might by an alteration of their system, that is by the adoption of what is known as the metallic return, prevent the disturbance complained of; and secondly, they say that the defendants are acting under statutory powers, and that if in the proper exercise of those powers they injure the plaintiffs they are free from blame. The first answer is, to my mind, without foundation. The man who complains of his land being thrown out of cultivation by the incursion of water escaping from his neighbour's reservoir must not be told that he has no right of action because if he had interposed a wall or otherwise taken care to protect himself the water would not have reached his land. He is using his land in a natural way, and is not bound to take extraordinary precautions, and is entitled to rely on his neighbour also using his land in a natural way, or, if he uses it otherwise, taking extraordinary precautions to prevent damage to others therefrom. There is no doubt a body of evidence to show that a system different from that adopted by the plaintiffs has been adopted elsewhere with advantage, and may possibly prove to be the most convenient though more expensive for them; but the evidence also proves that their present system has been largely adopted and is received with favour by many competent to form an opinion. It also has the merits of economy. They are carrying on their own business lawfully and in the mode which they deem best, and I cannot oblige them to change their system because they might thereby possibly enable the defendants to conduct their business without the mischievous consequences now ensuing. True it is that the analogy introduced above fails to this extent, that the plaintiffs are using the land for an extraordinary purpose; but admittedly it is a lawful purpose, and though under an obligation to obviate mischief from their own operations to their neighbours they are under none, in my judgment, to protect themselves from the defendants or others. The outflow from one reservoir might easily destroy another, but, so far as I am aware, there is no principle or authority in English law for rejecting a claim for damage by the owner of the latter on the ground that his user, as well as that of the neighbouring owner, is extraordinary.

The second answer of the defendants to the plaintiffs' claim has required more examination. Having recently had occasion in *Allison* v. *The City and South London Railway Company*, and again in *Rapier* v. *The London Tramways Company* to consider such a plea as is here put forward, and to consider many authorities, and in particular the cases of *The Metropolitan Asylum District* v. *Hill* and *London, Brighton and South Coast Railway Company* v. *Truman* and their application to different provisions and circumstances, I do not find it necessary again to state my view of the law or of the lines by which I ought to be guided in applying it to a particular case. Therefore, I shall but briefly explain the reasons for my conclusion that the defendants' plea is good in law, and that they are not responsible to the plaintiffs for the mischief caused by their works. The defendants' authority is derived under a Provisional Order confirmed by Act of Parliament. Such Provisional Orders in connection with tramways and many other undertakings of a public character are now common, and, I think, must be treated as "a well-known and recognised class of legislation" equally as much as the Railway Acts, which were referred to in those terms by the Lord Chancellor in *The London, Brighton and South Coast Railway Company* v. *Truman*, 11 Appeal Cases, page 53. The Railway Acts (again using the language of the Lord Chancellor in the same case) were assumed to establish the proposition that the railway might be made and used whether a nuisance were created or not, and, in my judgment, a like proposition must be assumed to be established by the Provisional Orders, one of which is here under consideration. The defendants are expressly authorised to use electrical power, and the Legislature must be taken to have contemplated it, and to have condoned by anticipation any mischief arising from the reasonable use of such power. A distinction was endeavoured to be made between cases where extraordinary powers are directly sanctioned by the Legislature and those where it is left to some other authority (in this instance the Board of Trade) to determine whether, if at all, they may be brought into operation. It is within the competence of the Legislature to delegate its authority, and when once that delegated authority has been properly exercised by the agent to whom it is entrusted, the sanction is that of the Legislature itself, just as much as if it had been expressed in the first instance in an Act of Parliament. The defendants relied on the 51st section of the Provisional Order. They argue that the exception there made in favour of the telegraph which would include telephonic lines of the Postmaster General indicates that interference with any other like lines was intended to be permitted. The reference supports the more general argument, and I have, therefore, mentioned it, but I rest my decision more on the established principle laid down in many of the cases, and ultimately ratified by the House of Lords in *London, Brighton and South Coast Railway Company* v. *Truman*.

To this plea of statutory power the plaintiffs have a rejoinder. They say that such power cannot avail the defendants unless they have acted reasonably in the exercise thereof, and have done their best to avoid injury to their neighbours. The argument being sound in law, one is compelled to examine the facts. The defendants work their tramways on what is called the single trolley system. There are other systems which have from time to time been used, and it seems are still in use elsewhere, and there are at least some good reasons for the conclusion that by the adoption of one or other of these systems the defendants might wholly or partially avoid the mischief which they now occasion. There is a contest on the evidence whether any of these other systems can be regarded as good apart from comparison with that of the defendants, and there is a further conflict of evidence whether if good they are comparable in merit with that of the defendants. My conclusion from the evidence is that the defendants' system is on the whole the best which practical science has yet discovered, but there is no occasion really to go as far as this. It is enough to say, and about this I entertain no doubt, that it is at least as good as any other, and has been proved by experience, especially in the United States, where there have been larger opportunities for experiment and consideration, to be as likely as any other to meet the requirements of traffic and the convenience of all concerned in the protection of the site of tramways for the use of legitimate purposes other than those of the tramway undertaking. It cannot be that in the application of the law which I am now considering the Court is bound to hold a railway or other company liable for the consequences of acts done under Statutory powers, because it has not adopted the last inventions of ever changing, ever advancing, scientific discovery. It is surely impossible with any regard to that common sense which after all is the foundation of this and many other branches of law to say that a railway which was not liable last year, last month, or even yesterday, because until then its undertaking was carried on according to rules acknowledged to be the best, is liable now not because those rules have been proved to be altogether wrong in practice, or unscientific in principle, but because some diligent worker in this department has discovered what is held for the moment to be a large improvement, but may to-morrow turn out to be only a step in the progress of further advance; and yet this might be the necessary conclusion in many cases, and indeed might be the necessary conclusion here if I were driven to support the plaintiffs' claim on the ground that the single trolley system, so largely approved where it has been largely tried, does not avail the defendants as a proper exercise of their statutory powers because another system is in use and apparently successfully used at Buda Pesth or elsewhere. I do not wish to prejudice the question whether a charge of negligence in the exercise of statutory powers can be supported by cogent evidence that the company exercising those powers has failed to adopt alterations or precautions which sufficient experience has shown to be of large indisputable and permanent value. That question may easily arise in many of the disputes which are likely enough from time to time to occur between public companies and those whom their operations injuriously affect, and it may even arise between the parties to this litigation. Suffice it to say that it does not arise now.

Holding on the above grounds that the plaintiffs cannot maintain an action either for an injunction or for damages against the defendants, I must order them to pay the general costs. If ever there has been or can be a case to which the distinction between the two scales of costs is properly applicable, this is the one, and the costs must be taxed on the higher scale. But it remains to make an exception, and that of some extent. I have already stated that the interference with the plaintiffs by the defendants is beyond doubt. I do not think that this ought to have been litigated. Mr. Macrory's report shows that one fair experiment would have proved the facts about which there was really very little doubt independent of his report, and that much time was uselessly spent on evidence. Not only must the plaintiffs be excused payment of the defendants' costs of this issue, which must be defined to be the issue whether the plaintiffs' telephonic system was in fact interfered with by the defendants' operations, but the costs thus excepted from the general costs of the action must be borne by the defendants and set off. Those costs will, of course, include those incurred in the experiment conducted at Leeds under Mr. Macrory's superintendence. They must also include the fee payable to Mr. Macrory, which it was agreed I should settle. I have communicated with him, and ascertained the time occupied and also the expenses incurred by him in railway journeys and the like, including the expenses of the gentleman, Mr. Cuninghame, whom he asked to assist him; and taking into consideration these items, I have fixed his fee at 50 guineas to cover all expenses, and also such fee as he thinks fit to pay to Mr. Cuninghame. I am glad to think that the course pursued with the concurrence of both parties of sending him down to make experiments and report was not only successful in finally settling an issue of fact, but also shortened the trial, and saved the further costs which further dispute on this point would necessarily have involved.

There will be judgment for the defendants, with costs modified in the manner above expressed.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Jan.* 27, 1893.

The Incandescent Lamp Question.—As outlined in our last week's letter, the General Electric Company seems to have thoroughly defined its position in regard to the incandescent lamp. In pursuance of this policy it has instituted a suit for an injunction against the Beacon Vacuum Pump and Electrical Company of Boston, to prevent its further manufacture of incandescent lamps in violation of previous decisions of the Courts. It was supposed that this suit would take the ordinary course through which the others had gone, and that an injunction would be at once granted, but a surprise was in store for everybody in the stand which that Company took. They introduced testimony and exhibits to prove that one Henry Goebel, a German by birth, had made and used sometime in the eighteen fifties an incandescent lamp embodying the same features, which nearly 20 years afterwards were covered by Mr. Edison's American patents. It seems from the affidavit of Goebel that he used an all-glass globe with platinum leading-in wires and an attenuated filament of carbonised bamboo, arranged in various shapes, among which were the hairpin or horseshoe form, and that he exhibited these frequently at night on the streets of New York. The daily papers, as well as some of the electrical journals, have committed themselves to the statement that Edison was certainly anticipated by Goebel, but these announcements appear to be premature. The General Electric Company claims that the testimony offered in this case was at hand, and known to each of the previous defendants in similar suits, but was by them regarded as of so little importance as to be unworthy of presenting. Prof. Elihu Thomson testified that he was aware of Goebel's work 10 years ago, and that he at that time examined the lamps, and was not impressed with their importance. The case was lately argued on both sides, and occupied the first half of the week. The judge reserved his decision, however, requesting both sides to present their arguments in type by Wednesday, February 1st, at 4 p.m., when he would take the matter into consideration, and give judgment later. The general feeling seems to be that the injunction will eventually be granted, for the burden of proof lies with the defendants. The three exhibits of the Beacon Vacuum Pump and Electrical Company were all of the same type of lamp, and showed leading-in wires and filaments as described, but in all cases the lamps were broken, so that there was no longer a vacuum. It is claimed that these three lamps were lamps made previous to 1860, but it remains to be proved that they are the same identical lamps. However, this withholding of judgment has placed the lamp industry in a very peculiar position. No more suits can be inaugurated until after this decision is rendered, before which time, in all probability, several weeks must elapse. In the meantime those lamp manufacturers who have been enjoined by the General Electric Company are turning over their orders to the other lamp manufacturers that have not been enjoined, and who for the time being are doing an enormous business in the sale of lamps which before had little or no market value. The inevitable result will be to bring the industry into disrepute, and to create such an unsettled condition of the market that it will seriously embarrass the whole industry.

CORRESPONDENCE.

USEFUL FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As Prof. Forbes has called attention to several approximate rules, the following one, for finding the current in a long straight wire, may prove of interest.

Let the wire be placed parallel to the magnetic meridian, and a small watch-charm compass be held vertically over or under the wire and moved nearer to or farther from it until the deflection is 45deg., then the distance of the compass needle from the wire in centimetres multiplied by 0·9 gives the current in amperes passing in the wire. If, instead of 45deg., a deflection of 48deg. is taken it is not necessary to multiply by 0·9, but the distance in centimetres is approximately equal to the current.

Of course, only very rough results can be obtained, as to make the above rule strictly accurate the wire should be infinitely long; but, as a rough-and-ready method of getting an idea of the current in a conductor, it may prove of service.—Yours, &c., E. C. RIMINGTON.

Lynton House, The Park, Norwood, S.E.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to add to Prof. George Forbes' "useful formulæ" a rule I have found very handy for calculating resistances of mains, &c. It is as follows:—

A copper rod, 1 foot long, and having a sectional area of 1 square inch, has a resistance of 0·000008 ohm. This is for pure copper, hard drawn, at a temperature of about 50°F.

The resistance of any wire can be easily found by multiplying the number 0 000008 by the length in feet and dividing by the sectional area in square inches. The above rule is sufficiently accurate for calculating roughly the resistances of mains; but for dynamo and transformer work the result obtained should be increased by 10 per cent.—Yours, &c.,

J. A. KINGDON.

29, Marlborough-hill, N.W., February 6, 1893.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to add to the useful formulæ which appeared in last week's *Electrician*.

A horizontal belt, 1in. wide, running at 10ft. per second (600ft. per minute), will transmit 1 H.P. if the pulleys are not too small. A proportional increase of width at the same speed, or a proportional increase of speed of a belt the same width, will transmit a proportional increase of power.—Yours, &c., J. H. GREENHILL.

New King-street, Belfast, Feb. 7, 1893.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To Prof. Forbes's list of approximate formulæ, I may add the following convenient method of finding the capacity of water pipes and cisterns.

A pipe, *one* inch in diameter, holds *one* pound (or 0·1 gallon) of pure water in *one* yard run, so that the capacity of any pipe for the length given may be represented by its sectional area in inches. If greater accuracy is required, the result must be increased by one-fiftieth.

To find the capacity of a cistern, it is only necessary to remember that eight cubic feet contain 500lb., or 50 gallons, of water, this being a trifle over half a pound in excess of exact measurement.—Yours, &c., N. G. THOMPSON.

13, Victoria-street, London, S.W.,
February 8, 1893.

ELECTRIC LIGHTING IN THE WEST END.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to certain letters which have appeared recently in the Press on the subject of the cost of Electric Lighting in the West End, I beg to inform you that my Company has decided to reduce the standard price for the supply of electricity to all their customers from 7d. to 6d. per Board of Trade unit. Customers will further have the benefit of a sliding scale of charges extending from 6d. to 5d. per Board of Trade unit, based on the amount of electricity consumed in each case.—Yours, &c., F. J. WALKER,

General Manager and Secretary.

The St. James' and Pall Mall Electric Light Company (Limited), February 8, 1893.

The Marseilles-Tunis Cable.—The 725-mile cable which is being laid down between Marseilles and Tunis is the second which has been made in France.

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TRADE NOTES AND NOTICES.

Our readers are reminded that the 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This useful book contains over 1,000 pages, and several new and handy features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

TENDERS INVITED.—The Corporation of the City of Londonderry invite tenders for the supply and erection of steam boilers, steam engines, condensers, steam and water pipes, water tanks, electrical machinery and apparatus, arc lamps, lamp pillars, underground mains, &c., for lighting the streets by electricity. Some particulars are given in our advertisement columns, and plans and particulars have been prepared by Mr. H. W. Blake, engineer to the Corporation, and can be obtained at the Guildhall, Londonderry. Tenders must be sent in to Mr. R. N. Chambers, town clerk, not later than March 1st next.

——— The Directors of the Great Western Railway Company invite tenders for the supply of 60,000 electric light carbons. Specifications and forms of tender can be obtained of Mr. G. K. Mills, secretary, at the Paddington Station, or of the Stores' Superintendent, at Swindon. Tenders must be addressed to the secretary, at Paddington Station, on or before Wednesday, March 1st.

——— The tenders required by the Corporation of Nottingham for the supply and erection of boilers at the electric lighting station in Wollaton-street must be sent in by February 16th.

——— The Corporation of Warrington invite tenders for the erection of telephones and wires to connect the two intercepting depôts at Howley and Hardy-street with the depôt at Longford. Tenders to be sent in to Mr. J. Lyon Whittle, town clerk, by the 14th inst.

——— The Municipal Authorities of Ployesti, Roumania, invite tenders, which will be received until March 10th next, for the concession for the electric lighting of the Town for a period of thirty years.

TENDERS ACCEPTED.—The tender of Messrs. Lowden Brothers, of Dundee, for lighting the Town House by electricity has been accepted, the amount being £79. 15s. The installation is to consist of 89 16 c.p. incandescent lamps.

——— The tender of Mr. G. Jennings, of Lambeth, London, S.E., has been accepted for an installation of Jennings' and Brewer's electro-mechanical apparatus for the engine house at the pumping station of the Suffolk County Asylum at Melton.

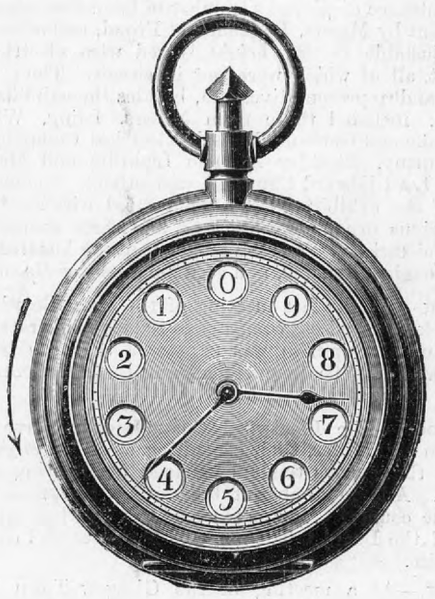
——— The Water Committee of the Plymouth Corporation have accepted Mr. Francis Dagger's tender for the renewal of their telephone line between Hartley and Roborough.

VACANT APPOINTMENT.—The Bolton Corporation are prepared to appoint an electrical engineer to take charge of the construction of the works in connection with their electrical installation, and to manage such works when completed. The salary will commence at £200 per annum. Mr. R. G. Hinnell will receive applications up to February 22nd.

BLOCKLEY ELECTRIC LIGHTING AND MANUFACTURING COMPANY (LIMITED).—This firm have just completed the lighting of the town house of the Hon. Mr. Justice Kekewich, in Park-crescent, Portland-place, W. The fittings (some of which are of special design) were supplied by Messrs. W. S. Benson and Co. and Mr. Richard Crittall.

"STANDARD" TUBULAR SYSTEM OF WIRING.—Messrs. Bagshawe Bros and Co., of Upper Thames-street, E.C., send a fully illustrated description of this system of wiring for electric lighting installations inside buildings. The tubes are made of "successive layers of a special 'papier-maché' thoroughly impregnated and coated with special insulating composition, which is insoluble either in water or acids—it is," according to the description, "therefore damp-proof and is not liable to chemical decomposition." The system seems to resemble that of the "Interior Conduit System" well-known in the United States. In many situations such tubes would be preferable to wood casing; but this is so dear to many fire office inspectors that the suggestion is likely to meet with opposition. Some reliable tests of the insulating properties of these tubes after exposure to damp for a week or two would be interesting. Several advantages are claimed for this system, including high and lasting insulation, compactness, easy fixing, and economy in comparison with other systems. The list includes instructions for making joints, &c.

MAY'S PATENT WATCH-SHAPE REVOLUTION COUNTER.—Where machinery is running it is often necessary to determine the number of revolutions, and there is a want for a portable instrument for this purpose, which does not easily get out of order or damaged by rough handling, and which can be easily read by anybody in the engine-room. May's revolution counter has been constructed to meet this demand. It takes the form of a pocket-watch, and is, therefore, conveniently portable. The watch-case keeps the works protected and clean, and to secure an easy reading the face is silvered and the figures are bold and black. The revolutions read off a dial like that of a watch by two arbors, the long one reading units and tens, the short one reading hundreds. The instrument is so constructed that whichever way the machinery revolves—to the right or left—it is direct reading. There is a disc under the face with a double set of figures, and these figures become visible through the apertures in the face automatically, in accordance with the direction in which the spindle revolves. The figure shows the spindle turning to the left, but the instrument



works automatically in either direction. By a key inside the back cover both arbors are easily placed back to zero. Messrs. O. Berend and Co., of 61, Fore-street, E.C., are the owners of the English patents.

BRIGHTON.—The Electric Lighting Committee of the Town Council have been asked to make arrangements, while installing the electric light on the Parade, to adopt such a system as will enable the light to be increased or decreased according to the state of the weather and the time of year.

BRISTOL.—As stated in a previous issue, Messrs. Siemens Brothers and Co. (Limited) have secured the tender for supplying the cables and laying the mains for the electric light installation of Bristol (subject to the confirmation of the contract by the Council). A sub-contract for the trenches and laying the cables has been given to Mr. Krauss, of Bristol. More than five miles of mains have to be laid, and the work is to be completed by the end of June.

BURTON.—The Health Committee of the Town Council in their last report recommended that advertisements be issued inviting tenders for the electric lighting of the district. The report was adopted.

DOUGLAS, ISLE OF MAN.—An action has been commenced in the High Court of Justice, Douglas, by the Brush Electrical Engineering Company (Limited) against the Douglas Grand Hotel, Theatre, and Baths Company (Limited), to recover £305. 11s. 3d., the balance of an account due for supplying the electric light to the defendants' premises. A delay of a week has been granted to enable the defence to be prepared.

DUNDEE.—The design of the street lamps selected for the public lighting of this City is similar to that of those supplied for the City of London lighting. The lamps will be 18ft. high to the lantern, and the columns will be inserted 4ft. into the ground.

EDINBURGH.—The Electric Light Committee of the Town Council decided on Saturday to take further professional advice before coming to a decision as to whether the Corporation should themselves undertake the work under the Provisional Order, or should hand it over to a company.

EDMONTON.—Mr. Coote, of Edmonton, has been appointed contractor for supplying the electric light to the Strand Workhouse and Schools situated at Edmonton.

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ELECTRICAL EXHIBITION AT WINDSOR.—A successful electrical exhibition was held at the Albert Institute, Windsor, last week, under the auspices of the Windsor and Eton Scientific Society. The energy for producing the light and for operating machinery in motion was supplied by the Windsor and Eton Electric Light Company from their station about half a mile distant from the hall, Mr. Sevenoakes, the secretary, assuming the general superintendence, Mr. Hawkings, the Company's engineer, being in charge of the station. The current varied between 90 and 95 amperes at a voltage of 100, and the service proved very satisfactory. The exhibits were contributed by members and friends of the Society, and by electrical manufacturing firms. At the entrance to the building were suspended two of Messrs. Paterson and Cooper's 1,000 c.p. arcs, two smaller arcs being shown inside, and the main hall was illumined by electroliers and bracket lamps. A stand near the entrance displayed a number of handsome electroliers and brackets lent by Messrs. Benham and Froud, and a brass shaving-stand, adjustable to any height, fitted with electric lamp and attachment, all of which were put in circuit. The exhibits were numerous and representative, and, besides the exhibits previously mentioned, included those from Messrs. Laing, Wharton and Down, Drake and Gorham, Walsall Electrical Company, the Electrical Company, Blockley Electric Lighting and Manufacturing Company, Lord Edward Churchill, and others. Among the special features of the exhibition was a room fitted with an 11-light electrolier, various ornamental brackets, and some cooking apparatus heated by electricity. A small model working installation consisting of gas engine, dynamo, and accumulators was also shown.

EXMOUTH.—At the last meeting of the Local Board it was proposed to ask the local gas company to reduce their rates for public lighting, and the opinion was expressed that the gas company could not afford to be independent now that the electric light was obtainable on favourable terms.

FLEETWOOD.—The Fleetwood Commissioners have received a report from Mr. Miller, their consulting electrical engineer, on the subject of the various tenders received for lighting the town by electricity. A large number of tenders had been received from all parts of the country. It was resolved to refer these to the general meeting of the Board. The name of the successful contractor did not transpire.

GLASGOW.—At a meeting of the Glasgow Town Council, on Thursday, Mr. Burt said that as far as the works were concerned they were progressing satisfactorily, and they were now in a position to supply any number of regular customers with the incandescent light. With regard to street lighting, he expected that before the end of a month they would be in a position to light some of the principal streets.

GLOUCESTER.—The question of the lighting of the City was before the Gloucester Corporation last week, and one of the members of that body gave it as his opinion that "there was a brilliant future in store for gas, and that it would never be superseded by the electric light." We regret being unable to give this gentleman's name. No resolution was, however, moved on the subject.

HASTINGS.—At the last meeting of the Town Council, a resolution was agreed to, that it was desirable to light the Town Hall and the Brassey Institute by the electric light; the matter was referred to the Public Lighting Committee for their consideration and report.

HECKMONDWYKE.—At the last meeting of the General Works Committee of the Board of Health the consulting engineers invited to inform the Committee the terms upon which they were prepared to report and prepare specifications for the proposed lighting were present. A discussion took place on the general subject of lighting, and it was finally agreed that a poll of the ratepayers be taken as to whether the electric light should be introduced or not. The result of the poll is not to hand.

LLANDUDNO.—The Board of Commissioners were invited last week by Mr. John Smith to witness the installation of the electric light which has just been completed at his mansion at Craigside. In congratulating the host on his enterprise in electrical matters, the Chairman of the Board stated that the Committee appointed to inquire into the subject of the electric light and electric traction at Llandudno were giving the matter earnest consideration, and they would probably shortly ask the Board to sanction an installation of some magnitude.

MALVERN.—In reply to one of its members, the Clerk to the Local Board, at the last meeting, stated that unless the Board proceeded to use the powers they had obtained under the Electric Lighting Act, the Board of Trade could cancel the order; but he saw no reason why the Local Board should move in the matter at present. If any proposal was made by a private company for supplying the town with the electric light, the Board would then have to consider their position.

NANTWICH.—At the last meeting of the Local Board, the Chairman of the Electric Lighting Committee announced that that body had discussed various matters, including the advisability of the Committee being supplied with one of the electrical journals. The Chairman said that as it was an invarable rule for the various Boards and Corporations throughout the country who had appointed Lighting Committees to take *The Electrician*, the Committee recommended that this journal be supplied, which was agreed to.

PORTSMOUTH.—The report of the Electric Lighting Committee was discussed and adopted by the Town Council at their meeting on Tuesday, the 7th inst. The Committee submitted the tenders received for the three sections of contract No. 2 in connection with the electric lighting scheme, Section 1 comprising boilers, engines, &c., Section 2 dynamos, transformers, &c., and Section 3 turbine alternators.

	Section No. 1.	Section No. 2.	Section No. 3.	General.
Electric Construction Corporation...	£15,441	£8,652	—	—
Brush Electrical Engineering Company	15,850	9,260	1,750	26,960
Willans and Robinson	18,086	—	—	—
" " Alternative	18,276	4,285	—	—
S. Z. de Ferranti	18,094	11,618	1,750	31,462
" Alternative	17,794	11,118	1,550	30,462
" "	Conbined Plant		—	31,250
" "	"	"	—	74,510
Hammond & Co. & John Fowler & Co	16,906	10,691	1,876	29,250
" " Alternative	17,721	—	—	—
" " "	15,640	—	—	—
G. E. Belliss and Co.	21,500	—	—	—
J. G. Statter and Co.	16,672	9,783	2,060	27,890
Siemens Bros. and Co	—	8,644	—	—
H. M. Leaf	—	13,500	—	—
Fullerton and Co.	14,500	—	—	—
Yates and Thom	14,280	—	—	—
Sharp and Kent	16,875	—	1,835	—
C. A. Parsons and Co.	—	—	1,750	—
Carrick and Wardale	13,570	—	—	—
Laing, Wharton, and Down Construction Syndicate	—	11,127	—	—
Johnson and Phillips	—	9,348	—	—
James Watt and Co.	13,780	—	—	—
Drake and Gorham	—	11,910	1,855	—
Latimer Clark, Muirhead and Co.	14,484	8,654	1,837	24,976
Daniel Adamson and Co.	16,050	—	—	—
Julius G. Neville and Co.	Not on form of tender.			

The Committee considered carefully the whole of these tenders, although some of them were variations from the specification, and the whole of the tenders were referred to the engineers for their consideration and advice. The Committee were at first disposed to recommend the acceptance of Messrs. Yates and Thoms' tender for Section 1, that of the Electric Construction Corporation for Section 2, and that of Messrs. Parsons and Co. for Section 3; but it will be seen that Messrs. S. Z. de Ferranti and Co. submitted an alternative tender for direct running plant, which provided, however, for a much larger output than had been contemplated, and they submitted a proposal for a reduction in the plant and a co-operation with Messrs. Yates and Thom, as the makers of the engines and boilers proposed to be recommended, which appeared to offer many advantages. This proposal was therefore further considered, and the engineers were again consulted, and they pointed out that there were many advantages which would accrue from the adoption of the latter suggestion. Under it the total price for Sections 1 and 2 would be £21,780, and it would therefore be seen that this sum was £434 below the total of the lowest tenders for Sections 1 and 2, apart from the question of whether the joint tender would be more advantageous in other respects. The engineers, however, reported that there would also be great economy in space in the engine room, a reduction in the number of machines requiring supervision, a considerable saving in fuel, an increased output at present, and a saving in capital upon the tenders which it was at first proposed to recommend of £1,152. Under these circumstances, and bearing in mind the advantages which, as stated, would accrue from the tender of Messrs. Yates and Thom and Messrs. S. Z. de Ferranti and Co. for Sections 1 and 2, the Committee recommended that such tender be accepted at £21,780. The Committee also recommended that the tender of Messrs. Parsons and Co. for Section 3 be accepted at £1,750. The Committee further submitted a certificate from Messrs. Waller and Manville for payment to the contractor for the erection of the electric lighting station in Gunwharf-road of the sum of £240, on account of the work executed, and recommended that such amount be paid. As already mentioned, the Committee's recommendation was adopted.

ROCHDALE.—The decoration of the Town Hall having been completed, a suggestion has been made that the electric light should be adopted in order to protect these costly decorations, and that the river weir, on the Rochdale Corporation's estate at Roach Mills, should be utilised for power.

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ST. GILES, BLOOMSBURY.—The clock of the St. Giles' Workhouse, Broad-street, Bloomsbury, W.C., is to be lighted by electricity at a cost of £150.

STAFFORDSHIRE.—At the last County Council meeting the Chairman notified that the electric lighting installation at the Werrington Industrial School had been started, and with excellent results.

SUNDERLAND.—At a special meeting of the Highways Committee of the Corporation last week it was reported that replies had been received from six consulting engineers regarding the terms upon which they were prepared to report for the proposed electric lighting of the Borough. It was ultimately decided to make still further inquiries.

TAUNTON.—Electricity has been used for about five years for blowing the organ at St. John's Parish Church, but notice has been received by the churchwardens from the Electric Lighting Company to the effect that after next month no more power can be supplied.

THE TEMPLE.—It is stated that an attempt is to be made to overrule a decision come to by the Honourable Society of the Middle Temple some time back, by which the installation of the electric light was rejected. A number of the residents in the Temple are, we understand, anxious to have the light, and are agitating for a lighting station to be erected in the grounds.

WAYLEAVES.—Three wiremen were brought up before the magistrate at the West London Police-court last week, charged with obtaining admission to the residence of Earl Poulett by false representation. It transpired that, owing to the difficulty of obtaining access to the roofs of private houses, the men had represented they were in the employ of the District Messengers Electric Service Company, which statement was untrue. The excuse given was the great difficulty experienced in running wires for private telephone installations. The accused were discharged with a caution.

COMPANIES' MEETINGS & REPORTS.

Liverpool Overhead Railway Company.

The following brief report of the Directors of this Company to December 31st last is to be submitted to the ninth half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, Cook-street, Liverpool, on Tuesday next, the 14th inst., at three o'clock :—

The Directors report the approaching completion of the undertaking. The Marquis of Salisbury formally opened the line on the 4th inst., and it is hoped that in about a fortnight from that date it will be opened for public traffic. The preliminary trials have been very satisfactory, and the Directors believe that their anticipations, as to the efficiency and economy in working, will be realised.

To complete the present undertaking, and to provide for the cost of the Northern Extension, your Directors have issued 7,500 Five per Cent. £10 Perpetual Preference Shares, which were fully subscribed.

The Directors retiring by rotation at this meeting are Sir W. B. Forwood and Mr. Harold Brocklebank, and, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. J. S. Harmood Benner, who is also eligible for re-election.

The report is followed by a statement of accounts and auditors' report.

Kensington and Knightsbridge Electric Lighting Company (Limited).

The following report is issued by the Directors of this Company, which will be presented at the sixth ordinary general meeting, to be held at 1, Great George-street, Westminster, S.W., on Thursday, the 16th inst., at five o'clock :—

The Company's mains, which extended for a length of 12½ miles in the previous year, have been increased during the year 1892 to 13 miles, and many of the existing mains have been increased in sectional area. During the year the number of houses and shops connected with the system has increased from 436 on December 31, 1891, to 550 on December 31, 1892; while the number of lamps calculated on the usual basis of 8 c.p. has increased from 38,408 to 47,441. The improvement in the efficiency of working the plant reported as being made at the last meeting has been maintained throughout the year.

In view of the increase in the business of the Company from the present district and in contemplation of the increase from the area mentioned in the next paragraph, the plant at Kensington-court and at Chapel-place has been extended, and further machinery is on order.

Negotiations are pending, and, subject to the approval of Parliament, may be regarded as practically concluded, for the transfer to this Company of that portion of the parish of St. Mary's Abbotts Kensington, which is at present served by the Chelsea Electricity Supply Company (Limited). The transfer cannot be carried into effect without the sanction of Parliament, and the necessary Bill has already been approved by the shareholders in two successive meetings, and has been introduced into Parliament. This transfer, if sanctioned, will add to the Company's area of supply an important district, which, in the opinion of your Directors will materially improve the Company's position.

The dividend on the Six per Cent. Preference Shares was duly paid to June 30, 1892, and an Interim Dividend at the rate of 4 per cent. per annum was paid on the Ordinary Shares for the first half of the year, and out of the balance standing to the credit of the net revenue for the year 1892, £3,792. 13s. 5d., the sum of £1,462. 10s. 0d. has been appropriated for the payment of the Preference Dividend to the end of the year, leaving £2,330. 3s. 5d., out of which it is proposed to pay a further dividend on the Ordinary Shares at the rate of 4 per cent. for the past half-year leaving a balance of £867. 13s. 5d.. It will be observed that no provision has been made in Accounts for Directors' remuneration.

In accordance with the Articles of Association, Mr. G. H. Hopkinson and Mr. Granville R. Ryder, retire from the directorship, and, being eligible, offer themselves for re-election. The auditors, Messrs. Lovelock, H. W. Whiffin and Dickinson, offer themselves for re-election.

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

The following is the Directors' report for the year ending December 31st last, to be presented at the twenty-ninth ordinary general meeting of the shareholders at the Cannon-street Hotel, E.C., on Tuesday, the 14th inst., at 12 o'clock :—

The accounts show the net profit for the past year to be £99,161. 11s. 7d. Adding £42,073. 5s. 10d. brought forward, and £43,110 premium on 8,400 new shares issued in March, and deducting £25,000 interim dividend paid in July, there remains a disposable balance of £159,344. 17s. 5d. Of this balance the Directors have added to the reserve fund £75,000 (including the premium on new shares), and recommend the distribution of a dividend of 10s. and a bonus of 5s. a share, free of income tax, amounting to £37,500, making, with the interim dividend, a total payment for the year of 12½ per cent., and leaving £46,844. 17s. 5d. to be carried forward.

The Company's ordinary business continues satisfactory. The principal cable work of the year has been the completion of the manufacture and the laying of about 2,200 miles for the South American Cable Company, and the manufacture of about 2,600 miles for the Central and South American Telegraph Company. The steamship "Silvertown" sailed on the 22nd of last month to lay the latter cable between Peru and Mexico.

The works and machinery at Silvertown and at Persan-Beaumont are in the usual state of efficiency.

Mr. S. Wm. Silver and the Hon. Henry Marsham, the Directors retiring by rotation, offer themselves for re-election. Mr. J. Weise, of Messrs. Turquand, Youngs, Weise, Bishop, and Clarke, retires from the auditorship; but Mr. J. F. Clarke, of the same firm, offers himself for election in his place.

CITY NOTES, &c.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The Directors have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent. (the maximum allowed as an interim dividend) on the ordinary shares of the Company, for the six months ended December 31, 1892, payable February 27, 1893. The transfer books will be closed from the 15th to 28th inst. In view of the interest payable March 1st on the Debenture Stock of the Company, the transfer books of this Stock will be closed from February 20th to March 2nd.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended February 5th were £956, as against £824 for the corresponding period of last year, being an increase of £132. The total receipts for half-year amount to £4,910, against £4,152 in the corresponding period of 1892, being an increase of £758.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—At a meeting of the Directors, on Wednesday, the audited accounts for the half-year to December 31st were submitted, and it was resolved, after providing for the interest on the Preference shares, to recommend the payment of a dividend on the Ordinary at the rate of 8 per cent. per annum, free of income tax. —The estimated traffic receipts of this Company for the month of January were £3,800, as compared with £3,518 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the month of January were £1,901, against £2,195 for the corresponding period of last year.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of January, 1893, amounted to £43,040, and to £42,805 in the corresponding period of 1892, or an increase of £235.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for January amounted to £20,800. In the corresponding month of 1892 and 1891 the amounts were £20,000 and £20,800 respectively.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—Subject to audit, the Directors of this Company propose paying a dividend of 10 per cent. (£1. 4s. per share) in addition to the 5 per cent. already paid, making 15 per cent. for the year 1892.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended January 31st were £3,046, as compared with £2,727 for the corresponding period of last year.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended February 3, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited, were £3,559.

YORKSHIRE BOILER INSURANCE AND STEAM USERS' COMPANY.—At the twentieth annual meeting of this Company, held at Bradford recently, a dividend of 7½ per cent. was declared, and £1,090 added to the reserve fund, and the carry forward was £164. 13s. The chairman stated that 94⅓ per cent. of the whole of the boilers insured had been examined, and he was able to report that no explosion had occurred to any boiler under the Company's care since its formation.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 2.		Price Wednesday, Feb. 9.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 9.	
			TELEGRAPHS					£ s. d.		Highest	Lowest.
£1,247,720	Stock	12/6	Anglo-American	53½	54½	53½	54½	4 11 9	Jan., Apr., July, Oct.	54½	..
£2,876,140	Stock	25/0	Do. Preferred	95½	96½	96	97	5 8 3	" "	96⅝	96
£2,876,140	Stock	5/0	Do. Deferred	12½	13	12½	13	..	" "	13	12⅞
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100	103	100	103	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11¼	11⅝	11½	11⅝	5 10 8	Mar., June, Oct., Dec.	11⅝	11⅜
£68,200	£100	5%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	104	108	104	108	4 12 7	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175	180	175	180	3 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	12⅜	..
6,000	10	10%	Do. Preference 10%	18	19	18	19	6 5 3	" "	18⅜	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2	3	2	3	5 6 8	April and October..	..	..
6,000	5	10%	Do. Preference 10%	9	10	9	10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅝	11⅞	11⅞	12	5 16 8	Jan., Apr., July, Oct.	11⅛	11⅛
400,000	10	2/6	Eastern	14⅜	15	14⅜	15	4 6 8	" "	15	14⅛
70,000	10	6%	Do. 6 per Cent. Preference	16	17	15½	16½	3 12 9	" "	16⅛	15⅝
£1,194,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	111	114	111	114	3 10 2	May and November	112⅝	112¼
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	106	109	106	109	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension	14⅞	15⅛	14⅞	15⅛	4 12 7	Jan., Apr., July, Oct.	15⅛	14¾
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109	112	109	112	3 11 5	February & August	110½	110
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor Deb., 1900	102	105	102	105	4 15 3	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101	104	101	104	3 16 11	February & August	102⅜	..
180,227	10	1/3	Globe Telegraph and Trust	9⅜	10	9⅝	9⅞	5 1 4	Jan., Apr., July, Oct.	9⅛	9⅛
180,042	10	6%	Do. 6 per Cent. Preference	15	15½	15	15½	3 18 8	" "	15½	15
150,000	10	5/0	Great Northern	18¾	19¼	18⅜	19½	4 8 4	Jan., April, and July	19½	19
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105	108	105	108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	43	45	43	45	5 11 1	May and November	44½	..
38,348	10	4/0	London Platino-Brazilian	4	6	4	6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108	111	108	111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½	8½	7½	8½	4 14 1	April and October..	..	..
3,381	£100 Cert.	30/0	Submarine Cables Trust 6% *	120	125	119	124	4 16 9	" "	120½	..
15,609	10	5/0	West African Telegraph	6½	7½	6⅜	7⅜	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	102	105	102	105	4 15 3	March & September	104½	103½
30,000	10	2/0	West Coast of America	2½	3½	2⅜	3⅜	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	101	105	102	106	7 10 11	June and December	..	..
88,321	10	6d.	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	1⅛	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½	11	10½	11	5 9 1	May and November	11¾	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref	8½	9½	8½	9½	6 6 4	.. ..	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 7	June and December	..	..
64,242	15	3/0	Western and Brazilian	7⅜	8⅛	7⅜	8⅛	5 9 1	" "	8⅛	..
33,129	7½	3/0	Do. 5 per Cent. Cumulative Preferred	5⅜	6⅛	5⅜	6⅛	6 0 1	" "	6⅛	6
33,129	7½	4/6	Do. 5 per Cent. Deferred	1⅜	2⅛	1⅜	2⅛	..	" "	2⅛	2⅛
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104	107	104	107	5 12 2	" "	107	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120	125	120	125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	103	106	103	106	5 13 2	March & September	..	..
			TELEPHONES.								
40,000	£5	10/0	Chili Telephone	3	4	3	4	..	..	..	..
22,000	14/0	1½d.	Consolidated Telephone Const. & Maintenance	⅝	⅝	⅝	⅝	7 16 5	May and November	..	..
200,000	£1	4½d.	Oriental (11s. paid)	¼	¼	¼	¼	7 18 2	Yearly	..	..
454,747	5	2/6	National	5½	5⅝	5½	5½	5 9 1	June and December	5⅞	5½
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 6	" "	14⅜	14⅛
15,000	10	6%	Do 6% Cumulative 2nd Pref	13⅜	14½	13⅜	14½	4 4 3	" "	14⅜	14
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref (£3 paid)	4½	4½	4⅜	4⅝	..	" "	4⅝	..
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112	115	112	115	3 18 3	January and July ..	114¼	113⅜
48,000	£10	..	New Telephone, Limited (£4 paid)	..	..	..	..	..	..	..	..
58,000	5	1/0	United River Plate	2½	3	2½	3	..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
30,152	£10	..	City of London Electric Lighting (fully paid)	11⅜	14½	12½	13	..	..	12⅜	11⅛
20,000	£10	..	Do. 6 per Cent. Preference	7¼	8¼	7¼	8¼	2 18 2	..	8⅜	8
19,900	£5	..	Electricity Supply Co. of Spain	..	..	..	..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	..	..	5	5¼	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	..	..	..	..	..
8,332	£5	..	House to House Electric	..	..	1½	2½	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	..	..	5	5½	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..	..	6	6½	..	January and July ..	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	4	4½	4	4¼	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5⅜	6	5¾	6	..	March	..	..
111,000	5	..	London Electric Supply	⅜	⅝	½	1	..	..	..	..
48,000	£10	2/0	Metropolitan Electric Supply (fully paid)	6½	7	6⅝	7	..	..	6⅛	6⅝
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102	105	102	105	4 15 3	June and December	104½	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5½	6⅜	5½	6⅜	..	..	..	..
18,680	£5	9½%	St. James' and Pall Mall	7¾	8¼	7¾	8¼	..	..	..	..
7,900	£5	7%	Do. 7% Preference	8	8½	8	8½	4 2 4	..	8⅜	..
42,853	5	3%	Westminster Electric Supply (fully paid)	5¾	6¼	5¾	6¼	2 8 0	..	6⅛	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	1/9⅜	Brush Electrical Engineering	3⅛	3⅜	3⅛	3⅜	..	..	3⅛	3⅛
69,996	2	6%	Do. 6 per Cent. Preference	2⅜	2⅝	2⅜	2⅝	4 11 5	..	2⅝	2½
£125,000	Stock	..	Do. 4½ per Cent. Debentures	103	105	104	106	..	..	105¼	104½
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5	5½	5	5½	6 7 3	January and July ..	5⅜	..
12,189	5	..	Edison and Swan United	..	..	..	..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..	..	1¾	2¼	..	..	..	..
45,000	10	12/0	Electric Construction	2½	2⅝	2½	3	..	..	2⅝	2½
70,000	2	10/0	Elmore's Patent Copper Depositing	½	¾	⅝	⅝	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	2	3	2	3	..	..	..	..
50,000	10	10/0	India Rubber, Gutta Percha & c., Works	22½	23½	22½	23½	5 6 4	February & August	23½	22½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	103	105	103	105	4 5 9	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½	3½	2½	3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6	7	6	7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	4/0	6/0	5/0	6/0	..	..	..	..
78,949	5	4½%	Swan United (£3. 10s. paid)	3	3½	3	3½	10 0 0	May and November	3⅝	3⅜
37,350	12	12/0	Telegraph Construction and Maintenance	45	47	38	42	5 14 3	March and July....	47	45
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	101	104	4 16 2	January and July ..	102¼	102⅛
..	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..	..	..	..	..	..	..	..
..	£5	8%	Do. Preference (fully paid)	..	..	¾	1¼	..	..	..	..
			RAILWAYS AND TRAMWAYS.								
63,000	£10	..	City and South London Railway	..	..	..	..	..	..	..	..
600,000	Stock	½%	Do. Stock	37	39	37	39	1 5 7	May and November	38	37

* 30s. balance of Coupon October 15, 1892.

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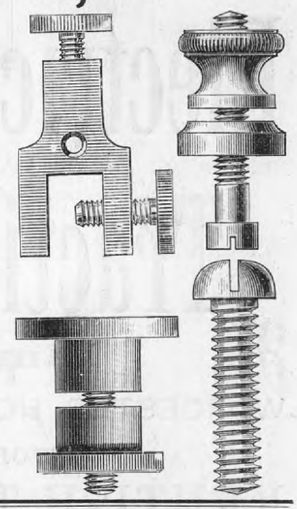

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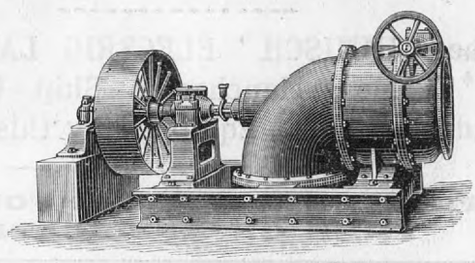

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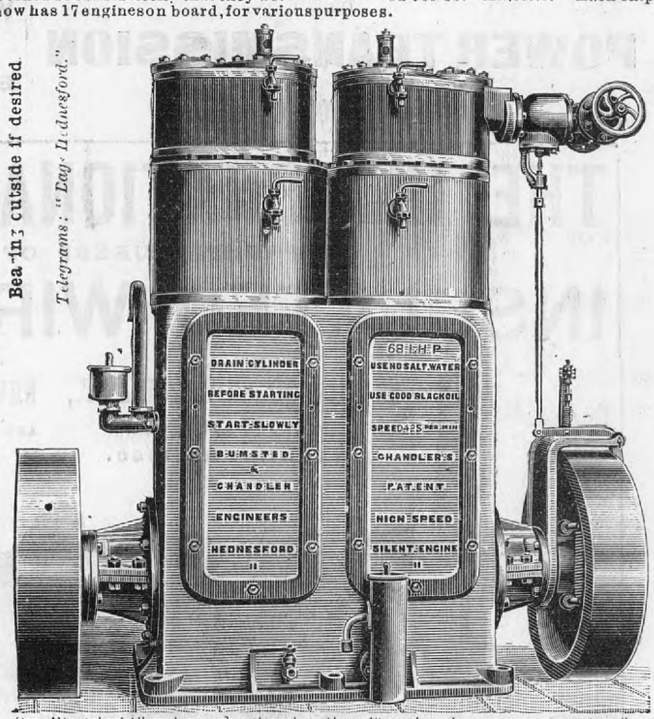

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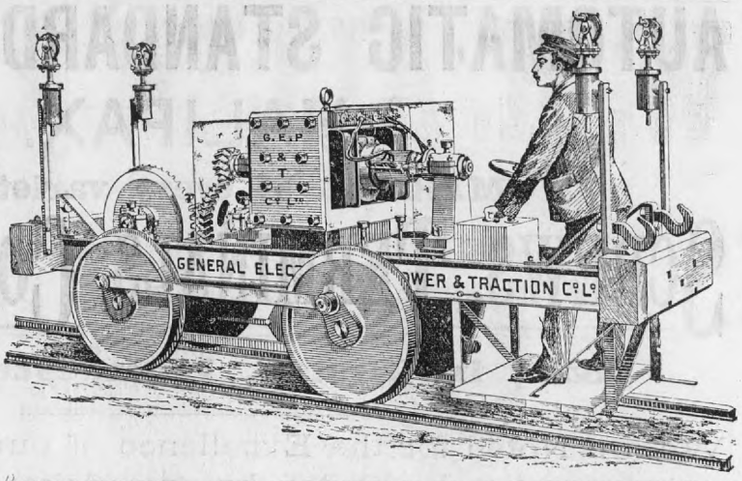

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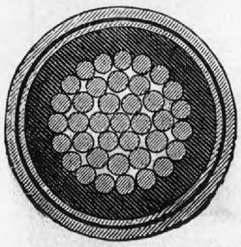

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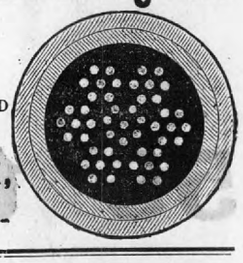

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London County Council Regulations as to Theatre Lighting.
Rules and Regulations for the Prevention of Fire Risks arising from Electric Lighting: British, American and French.
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Electrical Standards Committee, Board of Trade, Report of the.
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Electric Railways and Tramways in the United Kingdom.
Electric Traction Calculations.
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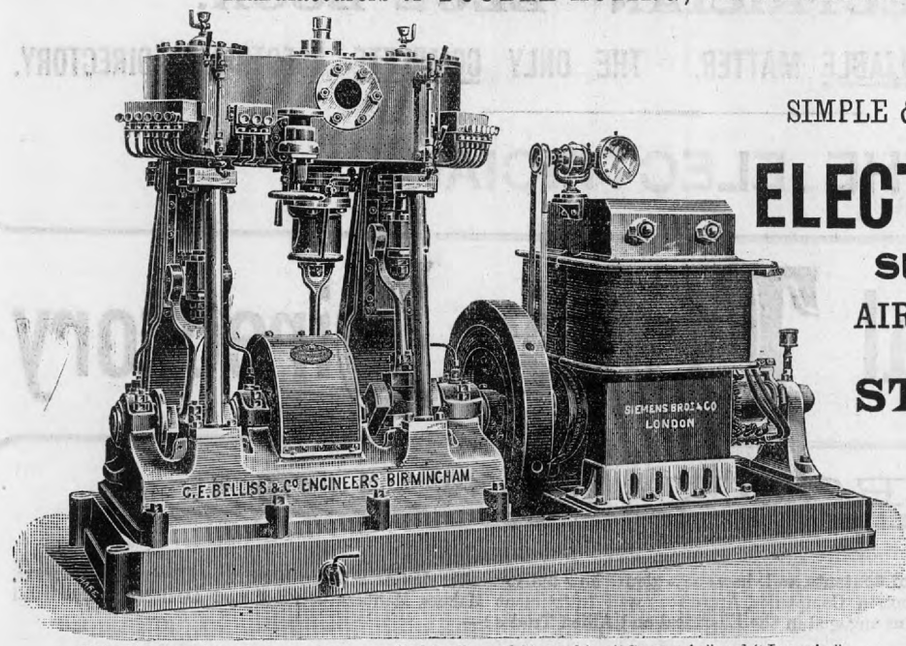

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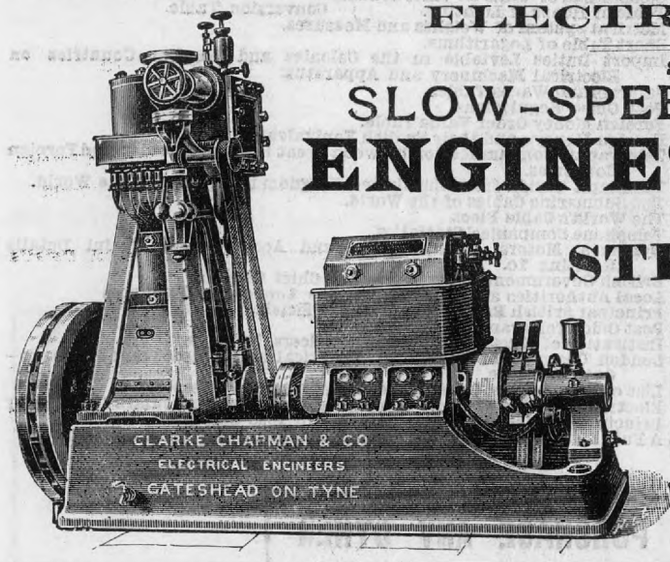

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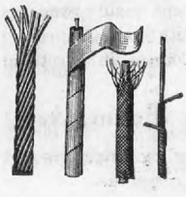

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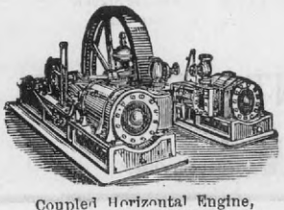

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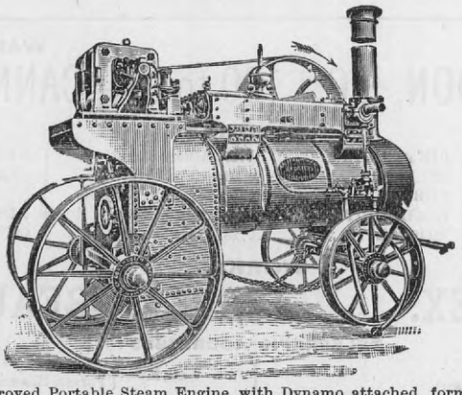

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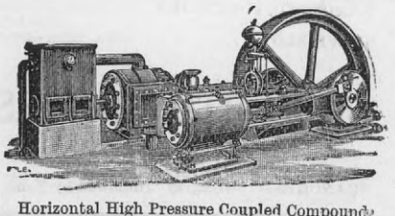

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 770.—Vol. XXX. FRIDAY, FEBRUARY 17, 1893. PRICE FOURPENCE.
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NOTES.

The electricity supply business is evidently settling down to the prosaic but healthy function of dividend paying. Following on the declaration of a 7¼ per cent. dividend by the St. James' and Pall Mall Company come similar announcements of a more modest character from the Kensington and Knightsbridge Company and from the Westminster and Electricity Supply Corporations. The Kensington and Knightsbridge Company is able to give its ordinary shareholders a 4 per cent. return for their money, the Westminster Corporation gives them ½ per cent. less, and the Electricity Supply Corporation leads the way with a 5 per cent. dividend. The alternately inflated and vanishing dividends of many electrical manufacturing concerns have consisted of oscillations, obeying no doubt some law of financial inertia, and proportional, perhaps, to the square root of the tightness of the market divided by the capital. These oscillations have died away with a logarithmic decrement, and the moderate returns of electricity supply companies are decidedly welcome, the more so since, so far as we can judge without that full knowledge of all the facts to which managing directors can alone lay claim, these dividends are the *bona fide* outcome of hard work.

With the very full figures supplied by the Board of Trade form of accounts, there is a great temptation to indulge in all manner of comparisons and statistical juggling, with the result that the deductions made are almost as wearisome as the actual accounts themselves. We shall therefore only call attention to a few leading facts in these accounts and compare one or two items in each set.

Taking the Kensington–Knightsbridge and Westminster accounts together, as relating to areas of much the same character, the following comparative table may be helpful to a general idea of their relative positions. Both concerns it may be observed have a modest depreciation or renewal fund.

—	Kensington and Knightsbridge.	Westminster.
Paid-up Capital	£154,000	£370,000
Net area of District supplied	·67 sq. mile	1·9 sq. miles
Capital density per sq. mile	£230,000	£194,736
Lamps connected, Dec. 31,1892	47,441	98,686
Increase on 1891	23%	57%
Lamp density per sq. mile	70,807	51,940
Dividend	4%	3½%

The areas covered by the St. James' and Pall Mall Company and the Electricity Supply Corporation are alike in character and similar in size, so that a bald comparative table is even less likely to do injustice to one side or the other than in the previous instance. It should be added that the St. James' and Pall Mall Company have set aside something for depreciation and to redemption of capital, in addition to maintaining their plant in good repair, whilst the Electricity Supply Corporation has not as yet done so.

—	St. James' and Pall Mall.	Electricity Supply Corporation.
Paid-up capital	£200,000	£200,900
Net area	0·24 sq. mile	0·18 sq. mile
Capital density per square mile	£833,333	£1,116,111
Lamps connected Dec. 31, 1892	48,000	29,000
Increase on 1891	24·4%	—
Lamp density per square mile	200,000	161,111
Dividend	7¼%	5%

At the centenary celebration of the Newcastle Literary and Philosophical Society last week Lord Armstrong showed the interesting "dust figures" produced by Leyden jar discharges on dust-strewn glass plates. These figures are of great intricacy and beauty, but until theory can be made to explain them, or until they can throw some light upon theory, it is difficult to give them a place in electrical science. Knowledge for knowledge' sake is, as Lord Armstrong says, a worthy object of pursuit, but unless it is co-ordinated knowledge it is not scientific knowledge.

Another experiment, less popular, perhaps, but more interesting because less complicated, was the relative motion of cotton thread and of the water with which it was wetted, under electrical influence. Two glasses were filled to the brim with pure water, and were connected by a cotton thread. A powerful induction coil discharge was passed, and the thread was rapidly drawn over, while water not only passed in the opposite direction, but when the whole of the thread had been deposited in one glass, there remained "for a few seconds a rope of water suspended between the lips of the two glasses." A modification of this experiment was performed with a cotton wick in a glass vessel submerged in water, and two concentric currents of water were shown, the inner one moving in what may be called the direction of the current, and carrying the cotton with it, but remaining distinctly visible when the cotton was removed, and a surrounding sheath of water moving against the current.

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A DEFECT of the Baconian system is that it tends to divide and subdivide the phenomena of nature into categories which are daily increasing in number; every fresh experiment or group of experiments is found to present new classes or species of results. It becomes necessary at times to generalise, not so much for the higher purpose of arriving at some underlying principle by which they may all be explained, as to find some rational head under which they may be conveniently grouped. Electrolysis remained for many years the only known process of molecular transference. It was and must still be considered as a chemical process, and the migrating components have been called "ions." A number of cases of transfer are now known in which no chemical decomposition takes place; none, at all events, need be postulated. Such are the phenomena which take place in gases as described by Mr. BALY in his Paper before the Physical Society last week; in the oils mentioned by Prof. S. P. THOMPSON in the discussion following this Paper; in the tannin in electrical tanning; in the cataphoric transfer of drugs; with FARADAY'S silk threads; with Prof. RAMSAY'S indigo; and even with the cotton wicks in Lord ARMSTRONG'S experiment. There are no ions here, and where such components are found they may, perhaps, be regarded as the result of so strong a tendency to transference that chemical decomposition is effected. It would be well if attention were directed to the phenomena of electrical transference as a whole, of which electrolysis is but a special case.

THE vigorous attack by Mr. SAM MAVOR on the usual method of wiring, and his forcible, though we do not say convincing, plea for concentric conductors, is worth half-a-dozen colourless articles on the subject. The reader knows, at all events, that he is listening to a warm partisan, and weighing the merits of each argument in turn, he will not be so confused as if he had attempted to digest a mixture of conflicting opinions. When Mr. MAVOR offered us the article which will be found in another column, we asked him to include in it some details of experience with wiring that had stood at least two years, but he informed us that it was impossible to do so, since "the beauty of concentric wiring is that its use is absolutely void of incident," and added that he had examples (he called them installations, by the bye) which had been running for four, five, and six years. We do not wish to criticise his arguments, but would point out that, as far as disturbance of compasses on board ship is concerned, concentric wiring is in precisely the same case as single wiring.

CONCENTRIC wiring labours under two disadvantages. It is hedged in on all sides by patents; none of these can be called master-patents, but it seems hardly worth while to go to the trouble of avoiding patented devices. Another difficulty is that its use either entails the earthing of one side, a practice on which not only opinions but authorities differ, or, owing to the necessarily large diameter of the outer conductor, expensive external insulation. If insulating tubes such as those mentioned in our Trade Notes of last week are to be relied on for this purpose, they might meet this difficulty, but on this point we have no information.

THE endeavour to find a material to replace platinum in the construction of glow lamps is not likely to cease because the price of that metal has fallen, although the search will not be so important as once appeared. Ordinary iron wire appears to be used in the new Westinghouse lamp, and a long length imbedded in the glass appears to be relied upon. An alloy of iron, nickel, and antimony platinised, has, according to *La Lumière Electrique*, been proposed by Dr. LANGHANS, and is said to have nearly the same co-efficient of expansion as glass. It is not at all clear why this should be the case. Brass and bronze alloys have a co-efficient of expansion nearly proportional to their constituents, while in the case of tin and zinc the co-efficient is higher than that of either of the components. The co-efficient of expansion of antimony between freezing and boiling point is 0·00113, of nickel 0·00125, and of wrought iron from 0·00112 to 0·00116. Cast-iron promises best, with a coefficient of 0·001; but all these are a long way above glass, which is about 0 00089. Platinum has a coefficient of 0·000863, and, as is well known, it is not difficult to make a special kind of glass which will approach much more nearly to platinum in its expansion than ordinary qualities. The coefficient of porcelain is considerably lower than that of glass. A German journal says that an alloy of "melted copper, added to 95 per cent. melted tin," holds excellently to clean glass, having nearly the same coefficient of expansion. Its melting point is said to be 360°C. Unless the coefficient of this alloy differs in some remarkable manner from those of its components, the result might be expected to be rather worse than ordinary copper, which has a coefficient of 0·0016. The determination of the coefficient of various alloys is a rather tedious operation, and, like many other properties of mixed metals, has received very little attention.

FOR fire-office inspectors and electricity supply company officials the Syndicat Professionnel des Industries Électriques have, with characteristic logic and precision, substituted a Bureau de Contrôle des Installations Électriques, with M. R. V. PICOU at its head. This Bureau is to undertake the testing and periodic inspection of wiring and the collection of electrical data of all sorts. Although an offshoot of the Syndicat Professionnel, the operations of the Bureau are to be entirely independent of it. The question of ways and means appears to be satisfactorily settled for the present by subsidies, and a sufficient income is expected to be derived in future from fees for work done. The institution of this Bureau de Contrôle is another instance that our French neighbours are not to be deterred from taking a certain course merely because it happens to be logical.

Southport.—The Local Government Board have sanctioned the borrowing of £28,000 for electric lighting.

Ipswich.—The Board of Trade have given notice that they have revoked the Ipswich Borough Electric Lighting Order.

Cable Interruptions—

	Interrupted.
Cayenne-Vizeu	Sept 24, 1892

The Chicago-St. Louis Electric Railway.—The contract for the construction of this railway has, it is said, been let, and the line is to be completed one year from the beginning of work.

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"Electrical Railways."—Under this title a Paper by Dr. Edward Hopkinson was read before the Institution of Civil Engineers on Tuesday last. The Paper was practically confined to a general description of the City and South London Railway. An interesting discussion may be expected.

Royal Society.—The following Paper was down for reading yesterday, by E. H. Griffiths:—"The Value of the Mechanical Equivalent of Heat, deduced from some Experiments performed with the view of establishing the Relation between the Electrical and Mechanical Units."

The Lighting of the Embankment.—The Parliamentary Committee of the County Council have asked for an additional £5,000 to complete the sum required for lighting the Albert Embankment, Westminster, and Waterloo Bridges, and the Victoria Embankment, by electricity. The total cost is now set down at £15,000.

London Electric Supply Corporation.—The London Electric Supply Corporation announce that from April 1st next their standard charge for electrical energy will be 6d. per Board of Trade Unit. All customers will also be entitled to the benefit of a sliding scale extending from the standard rate of 5d. per unit, based on their consumption of energy.

Hanley.—The Local Government Board have given their consent to the borrowing of the money necessary for the carrying out of the electric light project of the Town Council. A Provisional Order was obtained by the Council in June, 1891. On September 6th last the Council accepted the tender of the Brush Electric Engineering Company of £15,760.

The Endowment of Research.—Mr. Ludwig Mond, who has contributed so munificently to the expenses of the special researches on oxygen which Prof. Dewar is carrying out in the laboratory of the Royal Institution, has, it is stated, given a donation of £2,000 to the Royal Society in aid of the further compilation of their catalogue of scientific papers.

The Brown Non-Synchronous Motor.—We have received, too late for our correspondence columns, a letter from MM. Hutin and Leblanc, in which they state that the motor described by Mr. Brown in our issue of Jan. 27 was invented by them in 1890. They refer to a complete description of the theory in *La Lumière Electrique* of May 30, 1890. On referring to this publication (Vol. 40, p. 418) we find a highly mathematical article, containing a plan and an elevation of a 15-kilowatt motor, which had been built at the factory of the Société l'Eclairage Electrique.

Institution of Electrical Engineers.—At the last meeting of this Institution the President announced that the Council had received from Sir David Salomons a very handsome donation in the shape of £500 New South Wales Three and a-Half per Cent. Stock, to be added to the Salomons Scholarship Fund; and at the same time £20 for the Benevolent Fund.

The Göbel Glow Lamp.—In the *Electrical Engineer* of New York, of January 25th, under the title of "The Carbon Filament Lamp of 1859: the Story of an Overlooked Invention," Mr. Franklin Leonard Pope gives an interesting little sketch of the life and doings of Heinrich Göbel, the alleged anticipator of Edison, to whom our New York correspondent referred in his letter last week.

Lambeth Vestry.—The Electric Lighting Committee of this Vestry submitted a long report at the last meeting, recommending the Vestry to take steps to put in force the provisions of the Lambeth Electric Lighting Order, asking that the Committee might be authorised to negotiate for a site for a central station, and recommending the Vestry to obtain powers to borrow £75,000 to be solely supplied for the purposes of electric lighting. This recommendation was adopted.

Bath.—At the last meeting of the Town Council a report was presented from the Lighting Committee, which said that the inspector reported that the experiments to detect faults were not successful, and that the Company proposed to send out two men at proper intervals each night to ascertain and report as to lamps gone out. It was resolved that the penalty of 5s. per extinguished lamp should be enforced against the Company from and after February 1st, and that notice should be given to the Company.

Soldering Aluminium.—It is announced that the problem of soldering aluminium has been solved by Prof. J. W. Richards, of the Metallurgical Department, Lehigh University, U.S.A. Very soon after the birth of the aluminium industry the Société d'Encouragement in France voted a prize of £1,000 for its successful solution. De Mourey, of Paris, was awarded the prize. His solders were only moderately successful. The sole agent for the Richards solders in this country is Mr. W Archibald Briggs, East Dock-street, Dundee.

Bradford.—At the last meeting of the Town Council, Alderman Priestman, in moving the adoption of the minutes of the Gas and Electricity Supply Committee, said that he had just got the half-yearly statement of his two departments. The gas section showed a profit for the half-year of £2,274, and in the electricity department the profit for the half-year had been £1,089. He also stated that the total amount expended on capital account in connection with the electric supply was £48,568. They at present owed to the bank £4,308, and on loans £47,291, and they had paid to sinking fund, out of revenue, £3,198.

The Plymouth Telephone Service.—At the annual meeting of the Plymouth Mercantile Association last Monday the report of the Association contained the following passage:—

> The members of the Association will recollect that towards the close of the preceding year many complaints of the inefficiency of the telephone service were brought to the notice of the Committee. These were tabulated, and a general consensus of opinion was obtained, and the information gathered handed over to a Committee of the subscribers to the local exchange. The Association is pleased to have been instrumental in assisting so important a section of its members, and to know that considerable improvement has resulted. The telephone service is still far from perfect, and it is improbable that it can be as efficient as the subscribers would desire and are entitled to until a double metallic circuit is provided.

The Boudreaux Dynamo Brush.—In *L'Electricien* for January 28th, M. Em. Dieudonné sings the praises of a dynamo brush devised by a M. Boudreaux, an electrotyper. The material of which the brushes are composed is an alloy of copper, zinc, and silicium. This alloy is highly malleable, and is beaten out into thin strips two to three hundredths of a millimetre (0·8 to 1·2 mils.) thick, and is then made up into suitably shaped brushes, presenting a foliated texture, the mass of the brushes being far more homogeneous than that of wire or copper-strip brushes. M. Dieudonné claims that this type of brush keeps the commutator smooth, and that the wear is inappreciable.

The Vienna-Buda Pesth Electric Railway Scheme.—Lecturing a few days ago in Vienna on the projected electric railway between that city and Buda Pesth, Mr. J. Kareis, of the Vienna Electrotechnical Society, stated that the cost of constructing the line would amount to two and a-half times that of an ordinary railway. The present traffic between the two cities was 200,000 passengers per annum, and even if all these were diverted to the electric railway Mr. Kareis was of opinion that the receipts would not provide anything for depreciation or any interest on the capital outlay. If, however, the suggested speed were reduced to 93 miles an hour, the cost of construction would be diminished.

Sunspots and Magnetic Disturbances.—In a note in the *Comptes Rendus* of the 6th inst., Prof. G. E. Hale, of Chicago, refers to the commonly held belief that there is a close connection between terrestrial magnetic disturbances and the passage of spots or of faculæ across the centre of the solar disc. Observations taken by the spectroheliograph at Kenwood Observatory since February, 1892, however, tend to upset this theory. Spots and faculæ are shown to be so numerous that the chances are about nine to one that at any instant some are crossing the solar meridian. Hence, it is not surprising, says Prof. Hale, that at the moment of any given magnetic disturbance on the earth there should be a group of faculæ or spots either on the central meridian or at the edge of the sun.

The London County Council and Technical Education.—The debate on the proposals of the London County Council's Special Committee on Technical Education was resumed on Wednesday. The proposal that the Technical Education Board should be appointed for a term of three years, and be composed of 35 members, of whom 20 should be members of the

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County Council, was discussed. It was decided that the Board should be elected annually, instead of triennially as originally proposed. The representation of the School Board was reduced from five to three, and that of the London Trades' Council was raised from one to three. An amendment, giving a seat to the London Chamber of Commerce was rejected. The Committee's next recommendation that an annual report and financial statement should be presented by the Board to the Council was adopted without discussion. The next recommendation, to the effect that "every district of London ought to be adequately provided with technical education of every grade, rising from the school to the workshop and the university, and appropriate to the chief occupation of its inhabitants," was discussed at length before adoption. The last recommendation that one-third of the total amount estimated to be receivable under the Local Taxation Act 1890 should be appropriated to technical education, was carried after an unsuccessful attempt to get one-half substituted for one-third.

A Recently-Discovered Anomaly in the Secular Variation of the Magnetic Needle.—In the *Comptes Rendus* of January 9th, M. Léon Descroix states that in 1882 he published a comparative table of the observed and calculated values of the magnetic declination for 150 years. The interpolation formula which he deduced represented the facts at that time with a fair degree of accuracy, and it was considered justifiable to extrapolate the probable value of the magnetic declination for a quarter of a century ahead. A memoir of M. Faelheggen, of the Gottingen Observatory, in which a completely different mathematical method was employed, showed that the deviation of the needle at Paris between 1880 to 1890 would be 81′, a similar figure to that arrived at by M. Descroix. As a matter of fact, it was only 65′. M. Descroix then states that in order to obtain further verification of this interesting anomaly, attributable, perhaps, to the exceptional physical disturbances of recent years, he again went over his data. Moreover, he consulted the publications of the observatories of Paris, St. Maur, Bordeaux, London, Copenhagen, Palermo, and Coimbra, and the net result went to show that there was an appreciable retardation of the excursion of the magnetic needle. M. Descroix then asks whether this is only a temporary variation, or whether the predicted slowing-down of the excursion has definitely commenced. It may be stated that it is thought that something of the kind happened in 1760.

Telegraphing Mr. Gladstone's Speech.—In view of the telegraphic despatch of reports of Mr. Gladstone's speech on Monday evening last, great preparations were made by the postal telegraph officials. Extra Wheatstones and "punchers" were fitted up at the central telegraph office, wires were added to all the principal circuits of the kingdom, and several towns not normally in direct connection with London were put through. The main East Coast line of the Postal Telegraph Department carrying twenty important wires, was subjected to considerable damage near Hatfield on Monday morning. Some workmen engaged in cutting trees allowed a heavy branch to fall right across the wires, smashing all of them at that point, and breaking six wires and four wires in the two adjacent spans. The accident occurred between twelve and one o'clock. The sectional engineer, Mr. Parkinson, was at Welwyn at the time, and received intimation of the disaster at 1 p.m. He drove at once to Hatfield, a distance of 10 miles, taking with him a line man and some necessary stores. They arrived on the scene of the breakdown at 1:50, got three of the wires through by 3:15, and the whole 20 were again working by 4:10. This was sharp work, and enabled the line to carry its share of the very heavy traffic caused that evening by the introduction of the Home Rule Bill. Three-quarters of a million words were sent out on Monday evening from the Central Telegraph Office. This is a very high figure, but it has been exceeded on two or three occasions.

Obituary.—The death is announced of Dr. Norvin Green, President of the Western Union Telegraph Company. Dr. Norvin Green was born in 1818. He studied medicine at the University of Louisville, where he graduated in 1840 with honours. He then established a successful medical practice, and became the physician of the Western Military Academy at Drennon Springs, Kentucky. He was elected for several terms to the Kentucky Legislature. He ultimately became one of the lessees of the United Morse and People's Telegraph line between Louisville and New Orleans. Thenceforth Dr. Green identified himself with the history of the telegraph, and in 1866, when the American United States and Western Union lines were consolidated, Dr. Green was chosen Vice-President, and, with the exception of about three years, retained that office until, in 1878, he succeeded Mr. William Orton as President of the Western Union Telegraph Company, which position he held until his death. His early life was characteristic of the extreme West, and made him an example of the best type of the American youth. In his sixteenth year he procured a flat boat, stocked it with groceries and other ordinary supplies, and floated down the Mississippi River. His chief customers were lumbermen, who at certain seasons entered the low river lands to make rafts ready to be floated out on high water. The venture was a successful one, and laid the foundation of his business experience. Dr. Green was a man of many remarkable qualities. His disposition was gentle, kind, and charitable, and his loss is sincerely mourned.

The Proposed Cable to New Caledonia.—The French Government have submitted to the Chamber a Bill to subsidise the laying of a cable before September 22nd next between Queensland and New Caledonia on the ground of the inconvenience and delay in the existing postal service between Australia and New Caledonia. They propose guaranteeing £8,000 yearly for thirty years on condition that the cable, &c., must be laid by a French ship, worked by a French staff, and controlled by a French Directorate in Paris, such control not to be transferred without the special consent of the French Government. The Government of Queensland's undertaking to give this foreign venture exclusive landing rights for thirty years forms part of the arrangement, but no provision or promise of assistance appears in the Bill for any extension of the cable across the Pacific, which, according to the Queensland Government Postal Report 1891, was to form the principal feature of the project. It is difficult to understand the action of Queensland in this matter, because that colony has always been foremost in advocating the establishment of submarine communication across the Pacific to the United States or Canada *entirely under British control.* The scheme is consequently adversely criticised in this country as preventing the laying in the future of a British cable from Queensland, and encouraging foreign enterprise. It is to be noted that the late Mr. Sandford Fleming, as well as other eminent Canadians and several Australian Statesmen have in the past objected to any Pacific cable being laid which would be in any way in foreign hands.

Water-Tube Boilers.—At a recent meeting of the Junior Engineering Society a Paper was read by Mr. Harry Fraser on "Water-tube Steam Boilers." The author stated that so much trouble had arisen from fluctuations of pressure in water-tube boilers that their adoption had been much retarded. To overcome this defect the diameter of the water and steam receivers had been largely increased. It was necessary that ample means should be provided for downward circulation. Straight tubes should be used in preference to bent, and they should be arranged in such a way that any one tube could be replaced without interference with the others. A water space should receive the first vertical heat from the fire, and should have an adequate supply of the coldest water of the boiler, and an efficient means of escape for the steam direct to the receiver. The good result of fitting a water-cased furnace was shown graphically by a diagram prepared from figures obtained from trials. The usual angle of inclination of the tubes was 20deg. with the horizontal. The methods of fixing tube ends adopted by De Naeyer, Yarrow, De Temple, Debarbe, Montorpet, and Fraser were described and illustrated. Of water-tube boilers for land use, particulars and results of working were given of the Babcock and Wilcox, De Naeyer, Mills, and the author's. Of those for torpedo boats the De Temple, Thornycroft, and Yarrow were described. Two water-tube boilers adapted for marine use had been designed by the writer for the s.s. "Grappler," on which there was at present a boiler of the ordinary marine kind, so that comparisons of their performances would be readily drawn, and would doubtless prove of considerable interest and value.

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THE DIFFUSION OF LIGHT.

BY W. E. SUMPNER, D.SC.

(*Concluded from page 412.*)

A convenient way of ascertaining the reflecting power of a diffusing surface is to compare it directly with that of blotting paper. If, instead of the Methven standard at L (*see* Fig. 1), a sheet of blotting paper, of area A′, be erected at the end of the bench opposite the screen O R, the reflecting power of the surface of O R is given by the formula

$$r = 0{\cdot}82 \frac{x^4}{y^4} \frac{A'}{A}.$$

This method has the advantage that it is independent of any fluctuation which may occur in the light K.

There is one remarkable peculiarity of a diffusive reflector which is well worthy of notice. An ordinary mirror reflects light almost equally well for all directions of incidence, and where any difference exists it is found that rays which make a large angle with the normal to the surface suffer less absorption than those which are nearly perpendicular to it. With a diffusive reflector, on the other hand, the light is mostly sent off in the normal direction, and however the light may be incident upon the surface, it is diffused.

This can easily be shown by placing immediately behind a glow lamp first a piece of common mirror and secondly a sheet of white paper. In the former case the candle power of the lamp is found to be nearly doubled, but in the latter case it is far more than doubled. In the former case, however, the candle power is doubled in all directions on one side of the mirror, while in the latter the statement is only true for directions in the neighbourhood of the normal to the paper reflector. A plane white reflector is therefore more efficient than a plane mirror when it is desired to increase the light in one direction only, for it reflects about twice as much light as the mirror in different directions in accordance with a perfectly fixed law of proportions. A common mirror reflecting 80 per cent. of the light incident upon it from a lamp, produces an image of the lamp whose candle power is 0·8 times that of the lamp, and this candle power is nearly the same for all directions. But a piece of white paper illuminated by a lamp sends off most of its rays in the normal direction, and, although its reflecting power may not exceed 80 per cent., it is quite possible for a white reflector to more than double the candle power of the lamp for a particular direction.

Measurement of Absorption.

The absorbing power of some of the preceding substances were determined by measuring the candle-power of the light from a glow-lamp, first when this was uncovered, and afterwards when it was surrounded with a cylinder of the paper under test. The cylinders were short, being just longer than the height of the lamp, and were closed at top and bottom with caps of the same paper, so that the lamp was completely enveloped by the paper tested. The ratio of the diminution of candle-power to the original candle-power gave the *apparent* absorption of the paper. If the candle-power in some particular case was found to diminish 30 per cent., it would have been erroneous to conclude that the envelope absorbed as much as 30 per cent. of the light incident upon it, or that 70 per cent. was transmitted. If the reflecting, absorbing, and transmitting powers of a material be respectively denoted by r, a, and t, there must exist between these quantities the relation

$$r + a + t = 1.$$

Also if Q be the quantity of light given out per second by the light source within the envelope, the quantity of light incident per second upon the surface of the envelope will, owing to internal reflexion, be increased to Q′, where

$$Q'(1 - r) = Q;$$

the quantity of light absorbed and transmitted will respectively be

$$a\,Q' \text{ and } t\,Q',$$

and the ratios these quantities bear to Q will similarly be

$$a/(1 - r) \text{ and } t/(1 - r);$$

the sum, of course, being unity.

If the light source can be assumed to radiate equally in all directions, the ratio of its candle-power, after putting on the envelope, to the original candle-power will not be t, but $t/(1 - r)$. The influence of internal reflection is to increase *both* the absorption and the transmission, and unless it is taken into account large errors may be made in estimating the coefficients. A very simple way of showing the effect of internal reflection consists in surrounding a glow lamp with a white paper cylinder, open at the top, and adjusting a photometer screen till the illumination caused by it is balanced against that of some standard source of light. If now a piece of white paper be placed on the top of the cylinder, so as to shut in the vertical rays of the lamp, the candle-power in the horizontal direction will be found to increase considerably. In some of the tests, in order to avoid error caused by non-uniform radiation of the lamp, this was first surrounded with an envelope of tracing-cloth, or blotting-paper, and the combination used as the light source. If k_0 be its candle-power in this condition, and if k_1 be the observed candle-power after completely surrounding it with an envelope of the substance to be tested, the apparent absorption of this material is

$$\frac{k_0 - k_1}{k_0},$$

and the true absorption coefficient a is given by

$$a = (1 - r)\frac{k_0 - k_1}{k_0},$$

where r is the previously found reflexion co-efficient. (*See* Table I., page 381).

When an inner envelope is used to produce a light which radiates equally well in all directions, it is necessary for the outer envelope to be large compared with it, since otherwise the formula for the increase of illumination due to internal reflexion cannot be applied.

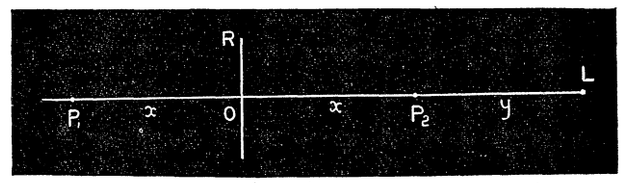

FIG. 3.

The following table gives the values of the absorbing coefficients expressed as percentages, for the four substances at the head of Table I. :—

Table IV.

——	Apparent absorption.	Absorption coefficient.
White blotting-paper	77 per cent.	13·8 per cent.
White cartridge-paper	61 ,,	12·2 ,,
Tracing-cloth	23 ,,	15·0 ,,
Tracing-paper	9 ,,	7·0 ,,

Three large glass globes, made for arc-lamps, were also tested. As the reflective powers of the globes could not easily be found, only the apparent absorption was measured. One globe was of opal glass (almost transparent), and the ratio of apparent absorption was 15 per cent. A second globe was of ground glass and absorbed 42 per cent. The remaining one was of opal glass, too opaque to allow any bright object placed within it to be distinguished. This absorbed 39 per cent.

Measurements of Transmitting Power.

The amount of light transmitted through the surfaces above mentioned was measured in a very similar manner to that in which their reflective powers were determined; the only difference being that the glow-lamp at P_1 (*see* Fig. 1, page 412) was moved to the opposite side of the surface as in Fig. 3.

O R represents the screen of paper, pinned on a wooden frame, and placed perpendicular to the optical bench P_1 L. The glow-lamp was at P_1, the photometer at P_2, and the Methven standard at L. In all the tests the distances O P_1, O P_2, were arranged to be equal, and balance was obtained by moving L

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along the bench. It can then be shown that the formula already given for reflection holds equally well for transmission, and with the same notation as before we have

$$t = \frac{L}{K}\frac{x^2}{y^2}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\},$$

t being the coefficient of transmission, assuming that all the light transmitted is diffused. It was found, however, that all the four substances tested were more or less transparent, so that while a portion t_1 of the incident light was scattered in accordance with the law of diffusion, another part t_2 was transmitted without change of direction. This must obviously be the case with substances like thin opal glass, which are sufficiently transparent to enable the eye to clearly distinguish objects through them, and it seems only natural for it to be true of translucent surfaces, which, when placed between the eye and the light, appear brightest just where the surface is cut by the straight line joining the light to the eye. The result, however, appears true for nearly all surfaces which transmit light at all, and even thick blotting paper transmits nearly 3 per cent. of the incident light without any change of direction.

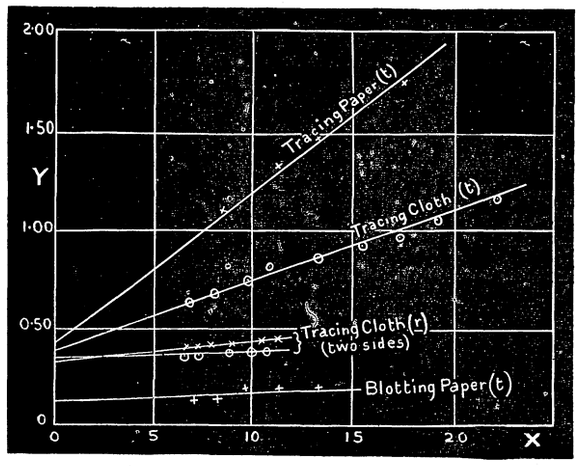

FIG. 2.—Value of $X = \frac{\pi x^2}{A} + 1{\cdot}75$.

Value of $Y = \frac{L}{K}\frac{x^2}{y^2}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\}$.

In order to separate the effects of diffused and regular transmission, it became necessary, as before, to make measurements for several values of the distance x. The coefficients t_1 and t_2 are connected by the equation

$$\frac{L}{K}\frac{x^2}{y^2}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\} = t_1 + \frac{t_2}{4}\left\{\frac{\pi x^2}{A} + 1{\cdot}75\right\},$$

and, as before, by plotting a curve connecting the observed values of Y and X, where

$$Y = \frac{L}{K}\frac{x^2}{y^2}X,$$

and

$$X = \frac{\pi x^2}{A} + 1{\cdot}75,$$

the values of t_1 and t_2 were found. The numbers given in Tables V. and VI. indicate the nature of the results obtained, and the general agreement of the experimental numbers with those calculated from the formulæ. The observations are plotted in Fig. 2, and the results are summarised in Table VII.

In Table VIII. the reflecting, absorbing, and transmitting coefficients have been collected, and the sum of these quantities is given in the last column. This sum should be unity, or 100 per cent. The excess above the theoretical value is probably due to a slight difference between the actual law of diffusion and that which is generally assumed to hold. The formulæ used above have been obtained on the assumption that a diffusing surface scatters its light in different directions with an intensity proportional to the cosine of the angle which the direction considered makes with the normal to the surface. A very slight divergence from this law would be amply sufficient to account for the small discrepancies shown in the last column of Table VIII.

Table V.—*Transmitting Power of Blotting-Paper.*

A = 980. K = 26. L = 2. t = 9·2. $Y_{calc.} = 6{\cdot}50 + 2{\cdot}7\ X/4$.

r	60	50	40	45	55	60
y	154	120	88·4	104·6	137	154
X	13·6	9·8	7·0	8.25	11.40	13·6
$Y_{obs.}$	15·5	13·2	11·2	12·0	14·4	15·5
$Y_{calc.}$	15·7	13·1	11·2	12·1	14·2	15·7

Table VI.—*Transmitting-Power of Tracing-Cloth.*

A = 980. K = 23·1. L = 2. t = 54·4. $Y_{calc.} = 41{\cdot}0 + 13{\cdot}4\ X/4$.

x	40	50	60	70	80	75	65	55	45
y	39·2	53·5	70·1	89·4	105·6	95·8	77·7	61	46·1
X	6·98	9·80	13·6	17·4	22·30	19·4	15·4	11·2	8·25
$Y_{obs.}$ ...	63·5	74·3	86·1	97·0	116	107	91·8	81·7	69·3
$Y_{calc.}$ ..	64·4	73·7	85·6	99·2	115·8	106	94·0	78·5	68·7

Table VII.—*Transmitting Powers.*

	Diffused t_1.	Direct t_2.	Total t.
Blotting-paper	6·5 per cent.	2·7 per cent.	9·2 per cent.
Cartridge-paper	8·7 ,,	2·5 ,,	11·2 ,,
Tracing-cloth	41·0 ,,	13·4 ,,	54·4 ,,
Tracing-paper.....	46·0 ,,	29·8 ,,	76·0 ,,

Table VIII.

—	Reflection. r	Absorption. a	Transmission. t	$r+a+t$
Blotting-paper..	82 per cent.	13·8 per cent.	9·2 per cent.	105·0 per cent.
Cartridge-paper	80 ,,	12·2 ,,	11·2 ,,	103·4 ,,
Tracing-cloth ...	35 ,,	15·0 ,,	54·4 ,,	104·4 ,,
Tracing-paper..	22 ,,	7·0 ,,	76·0 ,,	105·0 ,,

ON THE DETERMINATION OF THE INSULATION RESISTANCE AND OF FAULTS IN ELECTRICAL PLANTS DURING THE WORKING.

BY DR. O. FROELICH.

(*Continued from page 414.*)

Method 3. (Fig. 3. Two-galvanometer method.)—This method is more suitable for observing the insulation continuously in the engine room, for example, but it will also serve

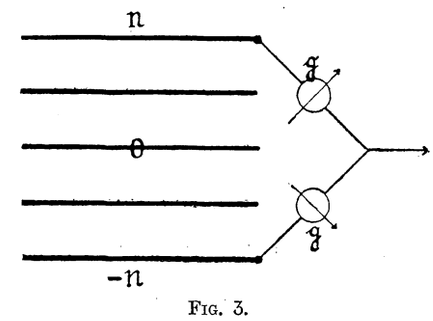

FIG. 3.

to determine the insulation. If one galvanometer is inserted between the point n and earth and, at the same time, a second one between $-n$ and earth, the deflections of the two instruments are in different directions, but equal when the faults on both sides of the middle point are symmetrically distributed ($h = 0$); the algebraic difference of the deflections gives the difference of potential of the points n and $-n$. When a fault developes on one side of the circuit, the deflection of the instrument, which is nearer to the fault, diminishes, and the deflection of the other instrument increases in the same portion;

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the (absolute) difference in the deflections is proportional to h or, generally speaking, to the difference of insulation on either side of the middle point. If we take off one galvanometer and read the deflection of the other one, and *vice versa*, we can calculate the resistance of the insulation by the simultaneous and the separate deflections.

When both instruments are simultaneously inserted, the potential of the middle point is

$$P'_0 = (h - n/g + ng)/(K + 2/g) = (h)/(K + 2/g).$$

whence the sum of the potentials at n and $-n$:—

$$P'_n + P'_{-n} = 2\,P'_0 = (2\,h)/(K + 2/g).$$

If only one instrument is inserted at n, the potential at n is

$$P''_n = (h - n/g)/(K + 1/g) + n\,\delta.$$

If the same operation is executed at $-n$, the potential at $-n$ is

$$P''_n = (h + n/g)/(K + 1/g) - n\,\delta, \text{ whence}$$

$$P''_n + P''_{-n} = (2\,h)/(K + 1/g). \quad . \quad . \quad . \quad (3b)$$

By the equations 3*a* and 3*b* we find

$$K = -1/g + 1/g[P'_n + P'_{-n}]/[P''_n + P''_{-n} - (P'_n + P'_{-n})] \quad (3c)$$

As in methods 1, 2, 3, the expressions for K and F contain only quotients of the potentials, the galvanometers need not be calibrated in volts; but it is nevertheless useful to do so, in order to know the absolute potentials.

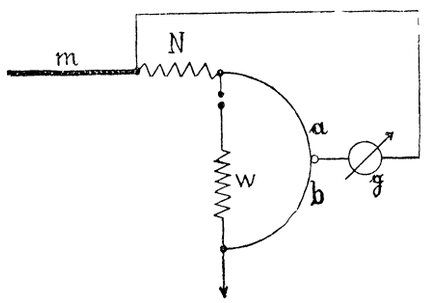

Fig. 4.

Method 4. (Fig. 4. Bridge method.)—Here we consider the whole circuit as one point connected to earth by the resistance F, and insert this resistance as fourth side branch of an ordinary bridge, the known resistance N serving as third side branch. The contact moving on the branches a and b is placed so that by opening and closing the diagonal branch w the galvanometer g shows the same current. Then we have

$$F = N\,b/a \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Single or Resultant Fault.

If there exists only one fault, or if the other faults are so small that the resultant fault coincides nearly with the heavy

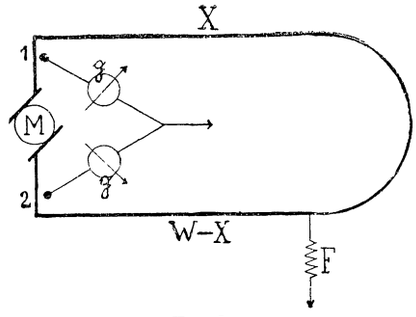

Fig. 5.

one, we can determine, during the working of the plant, not only the resistance, but also the position of the resultant fault.

Method 5. (Fig. 5. One Galvanometer at Two Points.)—Herr Frisch has determined the resistance of the insulation by inserting a galvanometer between two points, one after the other, of the circuit and earth; and by the same process we can also determine the position of the resultant fault. Let us denote by: I the main current, X the resistance between the pole 1 and the fault, W the external resistance between the poles 1 and 2, g the resistance of the galvanometer, F of the fault, i_1, i_2 the currents (taken positive towards earth) measured by the galvanometer, when it is inserted between 1 and earth and between 2 and earth respectively. Then we have

$$i_1 = I\,(X)/(g + F),\ i_2 = -I\,(W - X)/(g + F),$$

whence

$$X/W = i_1/i_1 - i_2 = 1 + i_2/(i_1 - i_2) \quad . \quad . \quad . \quad (5)$$

This very simple method is best combined with the two galvanometer method No. 3. If in the use of this last method we observe a considerable difference of the two simultaneous deflections, we take off one instrument and read the other, and *vice versa*; so the currents and i_1, i_2 are obtained, and from these the locus of the fault. As there is no difference of the deflections taken simultaneously when the fault is at the middle point or the insulation is symmetrical to the middle point, it is useful to read from time to time the single deflections also; by that we make sure that there is no resultant fault at the middle point.

Method 6. (Figs. 6 and 6A. Bridge method.)—The wire of the bridge or the ends of the bobbins forming the two variable branches of the bridge are connected to the poles of the dynamo, the galvanometer is inserted between the moveable contact and earth, the resistance W with a contact breaker is also placed between the poles; the contact is placed so that by

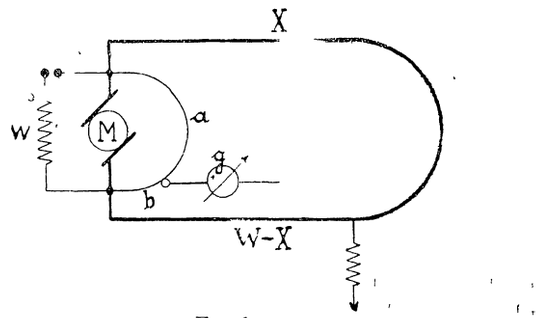

Fig. 6.

opening and closing w the deflection of the galvanometer does not change. Then we have

$$X/W = a/(a + l) \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The same method can be applied to find the place of a fault in a machine during the working of the machine (*see* Fig. 6*a*). The connections are the same, only the external circuit is best removed; but it can also remain in connection, if its insulation is good. If the fault is in the shunt n of the machine, the place found by the test is the real place of the fault; if the fault is in the armature the place found by the test will be in the middle between the poles, in consequence of the rotation.

If in a central station a heavy fault appears, the main conductor, which contains the fault, can be determined by methods 4 or 5.

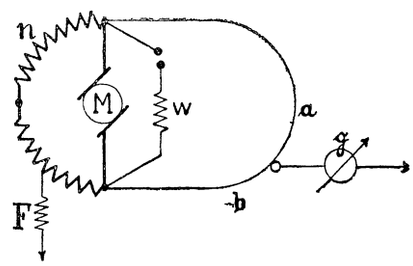

Fig. 6A.

Several Faults at Known Places; Faults on the Main Conductors of a Central Station.

Method 7. (Fig. 7.)—The problem of how to find the positions and resistances of several faults, which exist together on a circuit, has not been solved up to the present; but it is possible to solve it, when the places are known beforehand. If a central station contain only arc and incandescent lamps faults can only possibly exist on the main conductors and feeding

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cables, which are here considered as one. Let us develop this case, and show how to find, during the working of the plant, the resistance of the fault of each main conductor. These tests can be carried out every day, and serve to show continuously the state of the insulation of each main conductor, and enable us to get warning of faults, which are increasing slowly, previous to becoming serious defects. This is possible when the insulation of the whole circuit is known and bridge tests are taken between two neighbouring main conductors (*see* Fig. 7). The number of the faults is equal to the number of main conductors and to the number of the bridge tests; but one of these tests is always a consequence of the other ones, so that the bridge tests do not suffice, and the knowledge of the insulation must be made to help us.

To find the formula, by which the quotient a/b, found in the balancing the bridge, is expressed by the resistances f or the conductivities k of the faults of the main conductors, the theory of the bridge (*see* Diagram C) had to be developed; the Wheatstone bridge is only a special case of this system. I shall only give the results of this theory for the systems of five, three, and two conductors. The connections for the bridge test in a system of three wires are shown in Fig. 7.

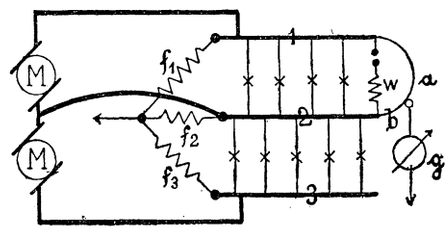

FIG. 7.

System of Five Conductors.—In this p, q, r, s, t are the resistances denoted in Diagram C, by f_1, f_2, f_3, f_4, f_5, the resistances of the faults; let us put $k_1 = 1/f_1$, $k_2 = 1/f_2$, &c., $K = \Sigma 1/f = \Sigma k$; m_{51} may be the value of a/b, if, as in Diagram C, the wire of the bridge is inserted between 5 and 1; m_{12} the value of a/b, if the insertion takes place between 1 and 2, &c.

We form the expressions:

$$\text{(7a.)}\quad \begin{aligned} \mu_{51} &= (1-m_{51})/(1+m_{51}),\\ \mu_{12} &= (1-m_{12})/(1+m_{12}),\\ \mu_{23} &= (1-m_{23})/(1+m_{23}),\\ \mu_{34} &= (1-m_{34})/(1+m_{34}),\\ \mu_{45} &= (1-m_{45})/(1+m_{45}); \end{aligned}$$

then the following relation exists between the five values μ:

$$\text{(7b.)}\quad \begin{aligned} 0 = \mu_{51}\, t\,(p+q+r+s) + \mu_{12}\, p\,(q+r+s+t)\\ + \mu_{23}\, q\,(r+s+t+p) + \mu_{34}\, r\,(s+t+p+q)\\ + \mu_{45}\, s\,(t+p+q+r). \end{aligned}$$

If we calculate k_1, k_2, &c., from the known values μ and p, q, &c., and suppose that the resistances p, q, r, s, t of the lamps and machines are small in proportion to those of the faults f_1, f_2, &c., we arrive at last at the following formulæ:—

$$\text{(7c.)}\quad \begin{aligned} \frac{k_1}{K} &= \frac{t+p+\mu_{51}\,(p+q+r+s)-\mu_{12}\,(q+r+s+t)}{2\,(p+q+r+s+t)}\\ \frac{k_2}{K} &= \frac{p+q+\mu_{12}\,(q+r+s-t)-\mu_{23}\,(r+s+t+p)}{2\,(p+q+r+s+t)}\\ \frac{k_3}{K} &= \frac{q+r+\mu_{23}\,(r+s+t+p)-\mu_{34}\,(s+t+p+q)}{2\,(p+q+r+s+t)}\\ \frac{k_4}{K} &= \frac{r+s+\mu_{34}\,(s+t+p+q)-\mu_{45}\,(t+p+q+r)}{2\,(p+q+r+s+t)}\\ \frac{k_5}{K} &= \frac{s+t+\mu_{45}\,(t+p+q+r)-\mu_{51}\,(p+q+r+s)}{2\,(p+q+r+s+t)} \end{aligned}$$

In practice we can suppose that the resistance l, inserted between two neighbouring main conductors, is the same everywhere, because, if the numbers of the lamps are not equal, the equalisation is obtained by insertion of resistances, accumulators or dynamos. Consequently we can put $p=q=r=s=l$ and $t=m$, the resistance of the machines, and we obtain:—

$$\text{(7d.)}\quad \begin{aligned} \frac{k_1}{K} &= \frac{l+m+4\,l\mu_{51}-(3l+m)\,\mu_{12}}{2\,(4\,l+m)}\\ \frac{k_2}{K} &= \frac{2\,l+(3\,l+m)\,\mu_{12}-(3\,l+m)\,\mu_{23}}{2\,(4\,l+m)}\\ \frac{k_3}{K} &= \frac{2\,l+(3\,l+m)\,\mu_{23}-(3\,l+m)\,\mu_{34}}{2\,(4\,l+m)}\\ \frac{k_4}{K} &= \frac{2\,l+(3\,l+m)\,\mu_{34}-(3\,l+m)\,\mu_{45}}{2\,(4\,l+m)}\\ \frac{k_5}{K} &= \frac{l+m+(3\,l+m)\,\mu_{45}-4\,l\,\mu_{51}}{2\,(4\,l+m)} \end{aligned}$$

m is known and remains constant; l can be calculated by the main current and the difference of potential between two neighbouring conductors; thus we can, when the conductivity K of the insulation is known, and the values μ are calculated from the bridge tests, determine the conductivity k, or the resistance f, of the fault of every main conductor.

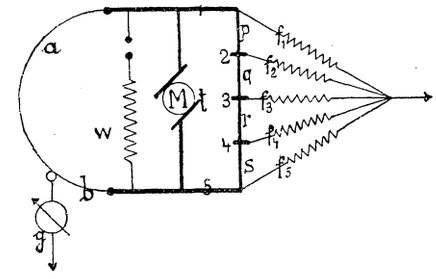

Diagram C.

System of Three Conductors.—If we denote again by t the resistance of the machine, by p, q those of the lamps, the formulæ are as follows:—

$$\text{(7e.)}\quad \begin{aligned} \frac{k_1}{K} &= \frac{t+p+\mu_{31}\,(p+q)-\mu_{12}\,(q+t)}{2\,(p+q+t)}\\ \frac{k_2}{K} &= \frac{p+q+\mu_{12}\,(q+t)-\mu_{23}\,(t+p)}{2\,(p+q+t)}\\ \frac{k_3}{K} &= \frac{p+t+\mu_{23}\,(t+p)-\mu_{31}\,(p+q)}{2\,(p+q+t)}. \end{aligned}$$

If we again put $t=m$, $p=q=l$, we have—

$$\text{(7f.)}\quad \begin{aligned} \frac{k_1}{K} &= \frac{l+m+2\,l\,\mu_{31}-(l+m)\,\mu_{12}}{2\,(2\,l+m)}\\ \frac{k_2}{K} &= \frac{2\,l+(l+m)\,\mu_{12}-(l+m)\mu_{23}}{2\,(2\,l+m)}\\ \frac{k_3}{K} &= \frac{l+m+(l+m)\,\mu_{23}-2\,l\,\mu_{31}}{2\,(2\,l+m)}. \end{aligned}$$

(To be continued.)

CONCENTRIC WIRING.

BY SAM MAVOR, M.I.E.E.

Engineers who are engaged in or associated with electric light wiring constantly have impressed upon them the extreme unsatisfactoryness, from a mechanical point of view, of the methods usually employed. The lavish use—amounting to a craze—of crockery is the most prominent and jarring feature, from a mechanical standpoint, of existing practice. It is used for switches, cut-outs, ceiling roses, pulleys, counter-weights, lampholders, shades, shade-carriers, &c. This is due chiefly to the Fire Office inspectors, and is a splendid tribute to their persistent influence. The attitude which they have rightly adopted in insisting upon a high standard of insulation combined with fireproof parts has led to the almost universal introduction of this unmechanical and, in appearance, clumsy and cheap and nasty material. The use of porcelain is not

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here condemned, but its misuse. Another weak point in present practice is the very large number of parts involved. Take, for example, an ordinary ceiling rose with cut-out, such as is commonly used. In this piece of apparatus there are a porcelain base, three small brass plates, six small brass screws, and a porcelain cover—11 parts, inclusive of the base. If a cord grip is used additional parts are added. In a mill with 500 lights there are thus, in the ceiling roses alone, 5,500 separate and individual parts. When switches, sub-main cut-outs, &c., are reckoned, the total number of parts is appalling. As Mr. Preece long ago pointed out, every binding screw and every unsoldered contact is a weak point which will probably cause trouble sooner or later. Where, as on board ship and in many factories, vibration and a damp atmosphere are encountered the probability becomes a certainty. The necessity of providing wood casing for the mechanical protection of the conductors is another objection to existing practice. It is impossible to lay wood casing throughout a completed building without excessive damage to floors and joists or interference with the decorations. Owing to the expense involved in making good work of the wood casing and the usual absence of a clerk of works to supervise, this portion of the work is rarely equal to the other wood work of a building. The wood casing where laid on the surface in many of the best buildings in London is a disgrace, and would not for a moment have been tolerated either in arrangement or workmanship, by an architect or his clerk of works. Further, wood casing harbours moisture, does not protect from rats, and in mansions frequently costs 50 per cent. of the total cost of wiring. Electric light wiring carried out with double conductors laid in wood casing *cannot*, even with the best materials and workmanship, be made absolutely and infallibly fireproof.

How are all these objections, mechanical, electrical and insurance, to be surmounted? The adoption of concentric wiring consistently and well carried out with uninsulated return makes a clean sweep of them—wipes them right out. The outer conductor in a concentric system must have conductivity at least equal to the centre wire, and must form a complete and continuous metallic envelope or sheathing around it. The continuity, mechanical and electrical, of this metallic envelope must be uninterrupted throughout the system. Where fuses, cut-outs or switches are used these must be in the centre wire, and must be entirely enclosed in metallic boxes or covers. All such boxes or covers must form part of the outer conductor. The outer conductor should not only be left uninsulated throughout its length, but should be positively "earthed" at the main switchboard or distributing centres. It has been objected that by adopting concentric wiring with earthed return the risk of breakdown is doubled, owing to one conductor being already earthed. This is a mistake when applied to concentric wiring. The outer conductor being at earth potential no shock or spark or risk can be experienced from it. There is therefore only one vulnerable conductor, and this being enclosed throughout its entire length by a metallic sheathing is well protected against injury. The liability to breakdown is therefore very much less with concentric than with double wiring. The risk attending a breakdown of insulation in double wiring with wood casing due to dampness or other injury is great, and has resulted more than once within the writer's experience in the casing being set on fire by the leakage—fuses notwithstanding. With concentric wiring there is no such risk. A leak in a concentric conductor cannot endure. In the event of the insulation between the inner and outer conductor being damaged the fault immediately developes into a short circuit and burns out the fuse. The spark passes from the centre conductor to the inner side of the metallic sheathing, and being entirely *within* the sheathing cannot communicate fire to its surroundings. Concentric wiring when consistently carried out is absolutely fireproof.

Concentric wiring may also be readily made waterproof. The conductors are waterproofed by a sheathing of lead laid under or over the outer conductor. Waterproof joints are easily made between the lead sheathing and the cast brass switch or fuse boxes. The simplicity with which this may be done can only be appreciated by those who have laboriously endeavoured to make double wiring waterproof. A system of double wiring recently illustrated and described in a contemporary was devised to comply with the latest regulations issued by the Home Office in regard to the electric lighting of explosives factories. The essential requirements in such a case are that the wiring shall be fireproof, dust proof and waterproof. The methods employed in the effort to meet these requirements with double wiring were laudable attempts to make the best of a bad job. Had the designer known with what simplicity and safety these and other stringent regulations have been met by concentric wiring he would have been spared the perverted exercise of his ingenuity.

With regard to shipwork—it is well known to those experienced in this department that wiring in order to be durable under the conditions met with at sea must be waterproof. The difficulty of rendering double wiring waterproof, coupled with the keenness with which this class of work is competed for has led to the matter being shirked by contractors. Notwithstanding the extensive and constant repairs required to the wiring of steamships, and the frequently reported cases of fires on board ship due to defective wiring the old methods go merrily along. The British Admiralty four years ago realized the necessity of waterproof wiring, and at that time began to specify lead-covered conductors, but this, although a vast improvement on the old methods, was only a step in the right direction. For while specifying waterproof conductors and joints throughout, the old pattern switches, cut-outs, fittings, &c., were retained, with the result that faults constantly developed in them and at their bases. The necessity of having these appliances made waterproof has for years been strongly urged upon the Admiralty by several contractors and impressed upon them by their own experience. The result was the adoption about six months ago of waterproof patterns of switches, cut-outs, distributing boxes, fittings, &c. And in taking this further step the difficulty indicated above—of making a system of double wiring waterproof—has been encountered in full force. The new Admiralty patterns are the result of much care and deliberation. Waterproof they may be, but clumsy and expensive they certainly are. Their appearance is strong evidence of the difficulty of designing waterproof fittings for double wiring, where the two sides of the circuit must be insulated from each other and from the containing boxes. The simplicity and compactness of concentric fittings complying with the necessary requirements are a striking contrast. Now that the Admiralty have fully realised the necessity of waterproof wiring their next step may be to adopt in concentric wiring the readiest means of attaining the desired result. There is prejudice to be overcome on the part of the navigating officers, who have an idea that disturbances to the compasses arise from the use of concentric wiring. It is certainly possible to so arrange concentric wiring that the compasses shall be disturbed; but when the proper precautions, now well understood, are taken, there is no chance of such disturbance. A very large number of concentric wired ships are now at sea, and trouble to the compasses from this cause is unheard of. The danger may, indeed, be greater from double wiring. A fault may develop in one conductor, connecting it with the ship's ironwork in the neighbourhood of a compass. A disturbance might thus be caused to the compass by the current in the sound conductor—all the more dangerous from the fancied security which double wiring gives. For petroleum vessels also, where fire risk is great, concentric wiring affords the readiest, most effective, and least expensive means of rendering the wiring fireproof.

The standard of insulation attained in concentric wiring is uniformly very much higher than is usual in double wiring. From eight to twelve times the requirements of the Phœnix Fire Office is the normal result. And with conductors, joints, &c., in a continuously hermetically sealed metallic sheathing, and switches and fuses in cast brass waterproof boxes, the insulation is unaffected by moist atmosphere or surroundings. Herein lies a very important point in favour of concentric wiring, namely, that it excludes the arch enemy of good insulation, moisture, and gives permanency to the high standard of insulation.

Much more might be said on behalf of concentric wiring if space permitted, but only one other important feature will

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here be noted, namely, that it lends itself so admirably to mechanical treatment. That concentric wiring, having all the advantages herein claimed, has not hitherto received a larger measure of attention from electrical engineers is matter for surprise. There is a natural reluctance of contractors, who have been at much pains to standardise their patterns, to organise their system of working, and train their staffs in their methods, to change their system.

Such a change, unless carried out gradually, would inevitably lead to temporary friction and a good deal of worry. But the possible friction attending the initiation of an improvement would be a poor argument against its introduction. The prejudice which has existed against concentric wiring has almost disappeared. The groundlessness of this prejudice is shown by the absence of valid objections to counterbalance the unquestionable advantages. A little experience of concentric wiring always converts its most strenuous opponent into its most enthusiastic advocate.

NON-SYNCHRONOUS MOTOR FOR ORDINARY ALTERNATE CURRENTS.

BY E. ARNOLD.

In No. 767, January 27th, you publish a communication from Mr. C. E. L. Brown on the above subject. For those who have followed the literature or have been engaged in the development of alternate current motors it is of interest to know the way in which Mr. Brown uses the methods of Elihu Thomson and Nikola Tesla in the construction of his alternate current motors. It is evident that the development of a good alternate current motor is of first importance for the distribution of power, and that the experience gained in the construction of multi-phase current motors is of the greatest value in the construction of motors for ordinary alternate currents.

The Oerlikon Works are well known as constructors of multi-phase motors, and recently a table of results was published by Mr. E. Kolben. They have also for some time been constructing single-phase motors, and early in 1892 the first non-synchronous motor was built. It was not a complete success, but by repeated experiments and careful study they succeeded in constructing a series of motors for ordinary alternate currents as standard types of the following sizes : $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{4}$, $1\frac{1}{2}$, 2, 3, $4\frac{1}{2}$, 6, and 9-H.P. These motors have neither commutator, brushes, nor contact rings. They run non-synchronously, and their efficiency is very nearly equal to that of triple-circuit motors.

In Chur (Switzerland), where the Oerlikon Works have fitted up an alternate current central station, there are three of these motors running—namely, a 2-H.P. motor driving the printing machinery of the *Neue Brindner Zeitung ;* a $4\frac{1}{2}$-H.P. motor on the premises of Mr. Schmid, butcher ; and a 9-H.P. motor used for starting the 100-H.P. synchronous alternate current motor in Messrs. Lendi and Parli's mill.

The inducing winding of these motors is either "Gramme" or "drum" wound, and is embedded in grooves in the laminated iron ; the induced or rotating part carries a winding which is short circuited in certain groups or with a complete ring at each end.

For starting, the rotating part must be given a certain speed : this can be done in various ways—viz., for the smaller sizes a pull on the belt is sufficient, the motor will then get up the proper speed itself and take the load. To start with a load, the method given by Nikola Tesla may be adopted, that is to say, the method described by Mr. Brown in Figs. Nos. 7, 8, and 9. Another method, pointed out at the same time by Dr. Behn and the writer, is used by the Oerlikon Works, namely, the inducing winding is divided into several sections, and is connected with the segments of a current reverser (built up like a collector) fixed on the switchboard ; by means of a hand wheel with double brush-contacts sliding on the segments of the current reverser a rotating field is produced and the motor will start, the motion of the brushes on the current reverser can then be stopped in any position.

A third method suitable for large motors has been devised by the writer ; it is quite similar to that shown by Mr. Brown in Figs. 12 and 13. The following extract from the specification for Provisional Protection, sent to the English and American Patent Offices last year, will show the full similarity.

Extract from specification (pages 7 and 8) :—

"The armature is assumed to be a Gramme ring. As in a continuous current machine the separate bobbins are connected with the segments of a collector, on which slide two brushes. On starting the motor the primary current is supplied not only to the field, but also to the armature. The alternate current motor now works with correct position of the brushes as a series motor for continuous current. The maximum current in the armature always coincides with the maximum field. The motor will consequently start under favourable conditions, and with considerable torque. The resistance included in the circuit allows the strength of current and torque to be regulated. As soon as the armature approaches the synchronous motion, which takes place in a short time, the collector segments are short circuited with each other. For this purpose serves an insulated ring capable of sliding on the shaft, and which is slid by means of a lever against the collector plates. The current now passes directly from one brush to the other. The sparking on the collector is entirely obviated, and the armature works as a short circuit armature. By the use of a short circuiting device the brushes can be entirely removed from the collector after starting the motor. By means of a centrifugal governor the pulling in and out of gear of the short circuiting ring can be effected automatically, &c.'

PHYSICAL SOCIETY.

At the ordinary meeting, which followed the annual general meeting on February 10th, Mr. E. C. C. BALY made a communication on

"Separation and Striation of Rarefied Gases under the Influence of the Electric Discharge."

On examining with a spectroscope a vacuum tube containing a small quantity of hydrogen, the author noticed that the hydrogen lines were strongly visible in the negative glow, but could not be seen in the body of the tube. This observation was confirmed by examining other tubes, and seemed to point to a separation of gases in the tube. From subsequent experiments it also appeared that the striæ were due to this separation. By using a double tube containing a mixture of carbon dioxide and hydrogen, whose parts were connected by a narrow, neck which could be sealed and the part detached, the gases were fractionated by the discharge. After sealing off, the spectra of the two parts were examined ; the one that had formed the positive pole showed only a trace of hydrogen, whilst the other showed it brilliantly. Other mixtures gave similar results, and the separation was found not to depend on the relative molecular weights of the gases. A very close connection between separation and striæ was noticed, the two phenomena always occurring together. If the author's views were correct a pure vapour or gas should not striate. Experiments tended to confirm this. The author therefore concludes, first, that when an electric current is passed through a rarefied mixture of two gases, one is separated from the other and appears in the negative glow ; second, that striæ are caused by the separation of the two gases, and do not act in a single pure gas or vapour.

Mr. BLAKESLEY read a communication from Dr. W. Crookes relating to Mr. Baly's Paper, and pointing out that in his Presidential Address to the Institution of Electrical Engineers in January, 1891, he had given reason for believing that stratification was due to the gas not being homogeneous.

Prof. RAMSAY said no proof had been given that electrolysis occurred in such tubes, and it was an open question whether molecules could convey electricity as ions do. So far as was seen, no ions existed in vacuum tubes. Possibly the stratification resulted from collisions of molecules giving higher temperatures at some parts of the tube ; but this was doubtful.

Mr. ENRIGHT thought the analogy with electrolysis was not quite clear, for in a mixture of simple gases the elements were not combined chemically, and electrolysis involved the splitting up of chemical compounds.

Prof. S. P. THOMPSON hoped the author would continue his important work, and clear up the doubtful points in vacuum tube phenomena. Some difficulty existed in classifying the separation of the gases, with electrolysis, for in the latter the effects were only visible at the electrodes, and not in intermediate portions of the substance. The question whether vacuum tube discharges were strictly analogous might be tried by fractionating through a series of tubes. Prof. Schuster had considered the analogies in his Bakerian Lecture, and published some important results, some of which tended to show that wandering ions existed in vacuum tubes through which discharges were being passed. Referring to Prof. Ramsay's remarks about molecules not carrying electricity, he said that electric winds were phenomena which pointed to the opposite conclusion. Similar convective action also occurred in turpentine and other insulating liquids. He wished to know whether the author had tried if a low voltage (say 100 volts) applied for a long time to a vacuum tube would produce separation of the contained gases. Porret's phenomenon of electric osmose seemed to have

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some bearing on the subject, as also Faraday's observations on the movements of scraps of silk in turpentine, and showing that in non-conducting liquids there were phenomena somewhat analogous to electrolysis.

Prof. RAMSAY said that if indigo were put in a poor conductor, such as distilled water, and the mixture subjected to electrolysis, all the blue colour became concentrated about one electrode, whilst if arsenic sulphide be similarly treated the colour went to the other pole. On mixing the two solutions all coagulates and goes down. He could give no explanation of these remarkable effects.

In his reply, Mr. BALY said that he had tried the experiment with complicated tubes as suggested by Prof. Thompson, but the result was not conclusive.

THE MAGNETIC PROPERTIES OF SUBSTANCES AT VARIOUS TEMPERATURES.*

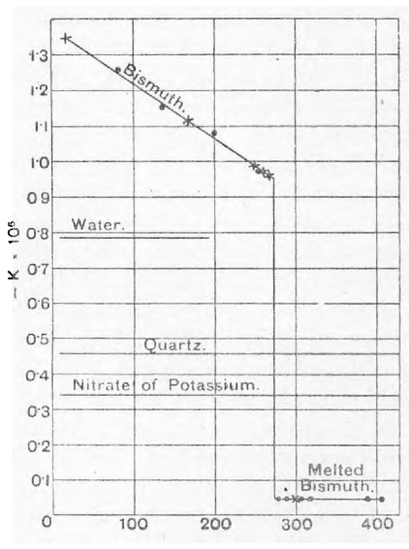
BY P. CURIE.

The author investigated the magnetic properties at different temperatures of a large number of diamagnetic bodies. None of these substances exhibited any sensible remanent magnetism, and the coefficient of magnetisation was constant at each temperature for fields varying from 50 to 1,350 C.G.S. units. The results are given in the table below, in which K = coeff. of sp. magnetisation per gramme :—

Substance.	Temp. C	$10^6 \times K$
Bismuth (solid)	20°	−1·350
„ „	273°	−0·957
„ (liquid)	273°−405°	−0·038
Antimony (electrolytically deposited)	20°	−0·680
„ (solid)	535°	−0·460
„ (after heating to 535°)	20°	−0·940
Phosphorus (ordinary liquid or solid)	19°−71°	−0·920
„ (red)	20°−275°	−0·740
Water	15°−189°	−0·790
Rock salt	16°−455°	−0·573
Chloride of potassium	18°−465°	−0·550
Sulphate of potassium	17°−460°	−0·430
Nitrate of potassium (solid or liquid)	18°−420°	−0·329
Quartz (parallel or normal to axis)	18°−430°	−0·441
Sulphur (octahedric, prismatic, flowers, solid or liquid)	15°−225°	−0·510
Selenium (solid or liquid)	20°−415°	−0·320*
Tellurium	20°−305°	−0·311
Bromium	20°	−0·410*
Iodine (solid or liquid)	18°−164°	−0·380*
Palladium	14°	+5·150
Oxygen	20°	+115·000

* Samples not as pure as could be wished.

It will be observed that the coefficients of sulphur, nitrate of potassium, iodine, and selenium are unaffected by change of state in these bodies. Antimony and bismuth, on the other hand, have decreasing coefficients with rising temperatures. These results,

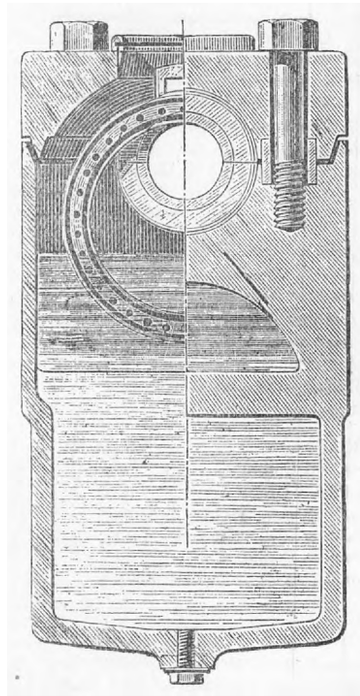


obtained with diamagnetic bodies, are interesting when compared with those obtained for magnetic bodies, for which, generally speaking, the coefficient diminishes as the temperature rises, the diminution following a hyperbolic curve. The law followed by bismuth (*see* curve) is something very different to the hyperbolic law.

* Abstract from the *Comptes Rendus*, January 23rd, Vol. CXVI., No. 4.

THE HENRION SYSTEM OF OILING BEARINGS.*

A modification of the well-known system of oiling bearings by means of a ring dipping into an oil bath has been introduced by M. Fabius Henrion, of Nancy. The objection to the plain ring is that it throws off the lubricant by centrifugal force in all directions which results in waste and other inconveniences. As shown in the annexed cut M. Henrion provides the ring with a number



Henrion Bearing Lubricator. Sectional Elevation.

of cavities which enable it to bring the oil up to the top whence it is spread over the bearing by a number of grooves. By means of a piece of glass let in at the top the condition of the bearing can be inspected.

* From the *Revue Industrielle*.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 17th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Cost of Private Installations," by W. L. Bayley.

MONDAY, February 20th.

CHEMICAL SOCIETY.

8 p.m. Extra Meeting. Kopp Memorial Lecture by Prof. T. E. Thorpe, F.R.S.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture (4): "The Practical Measurement of Alternating Electric Currents," by Dr. J. A. Fleming, F.R.S.

TUESDAY, February 21st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "Electrical Railways," by Dr. Edward Hopkinson, M.A., and monthly reception by the President and Council.

WEDNESDAY, February 22nd.

OLD STUDENTS' ASSOCIATION.

7.30 p.m. Meeting at Finsbury Technical College. Paper to be read and discussed: "The Series Method of Teaching Foreign Languages, and its Application to the Technical Professions," by Howard Swan.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Old Age Pensions," by T. Mackay.

THURSDAY, February 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Note on testing Alternators," by W. M. Mordey.

FRIDAY, February 24th.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "A handy Focometer," by Prof. J. D. Everett; (2) "Plane and Spherical Sound Waves," by Dr. C. V. Burton; (3) "Motion of a Perforated Solid in a Fluid," by G. H. Bryan, M.A.

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DR. FLEMING ON TRANSFORMERS.

Dr. FLEMING'S Paper on "Experimental Researches on Alternate Current Transformers" forms an important addition to the literature of the subject, and the statistical information in which it abounds will be of considerable value for both practical and for theoretical purposes. It will be referred to by transformer makers, who may learn what their transformers must do if they are to compete with those of the leading makers; by engineers who may discover reliable data for designing supply systems; and, we hope also, by theoretical men who are so fond of writing about the performance of imaginary combinations of iron and coils of wire. Besides this, the Paper contains much useful information about methods of electrical measurement, and not only bare descriptions of such methods, such as are to be found in books, but careful considerations of the errors that are likely to arise, and of the corrections that should be made or precautions that must be observed. Important as the Paper is, there has been a sad waste of time over the discussion. The Paper was read on November 24, 1892, and the next communication to the Institution of Electrical Engineers will not be made until the 23rd of this month. Christmas and the Presidential Address have intervened it is true, but the additional information brought out during the debate bears no proportion to the large part of the session which has been spent upon it.

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The conclusions arrived at in Dr. FLEMING's Paper are not numerous, and, compared with the final conclusion brought out in his reply, are not of great importance. He has disproved, we hope for the last time, the theory that the losses in transformers fall off at heavy loads; we have opposed this idea from the very first, not on account of a private revelation of the laws of nature, but, firstly, on the strength of a common sense intuition, and, secondly, owing to a total absence of reasons to support the supposed experimental evidence. The same conclusion was buried in a British Association Paper by Prof. AYRTON and Dr. SUMPNER last year, together with a comparison of the losses of closed and open-circuit transformers. Dr. FLEMING has confirmed these tests, and his results are more general since his experiments were made on many types of transformers; and as his method of testing is more intelligible, his work appeals to a wider audience. The fact that the core losses in open-circuit transformers are nearly four times as much as theory indicates is a mystery which has yet to be solved. If a mere reduction of mechanical pressure on the iron wires is all that is needed, or even if, as a further precaution, the secondary conductor is stranded, will these transformers then justify the promises made in regard to them in 1889 at Newcastle? Neither Dr. FLEMING nor anyone else has pointed out any fallacy in the calculations on which these open-circuit transformers have been designed, and there is at present reason to suppose that faults of construction, or, perhaps, of the quality of the iron, have given rise to the abnormal losses. It must be remembered that when "Hedgehog" transformers came out with a flourish of trumpets, their calculated performances were compared with the actual results of the transformers of those days. Dr. FLEMING's Paper shows what advances have been made since then, but if the original calculations were not fallacious, it may be supposed that open-circuit transformers, when properly made, will have some *raison d'être* other than mere cheapness, since the "Hedgehog" transformers tested by Dr. FLEMING gave at full load as high an efficiency as that of the average closed-circuit transformers of corresponding output, while at low loads the difference between the two types is not very noticeable. Mr. SWINBURNE's reply to the attack was far too brief, and he sometimes stands in danger of being regarded as an electrical LABOUCHERE, quaintly critical, but not to be taken seriously. The defects in the wattmeter which Dr. FLEMING discovered are more easily remedied than those of the transformers, since they are less obscure; and the Parthian shot in Dr. FLEMING's reply, at the use of a condenser for supplying the magnetising current, must not be considered to put this appliance *hors de combat* until further information is forthcoming.

The most novel part of the Paper is that which refers to the action of transformers at the moment of switching them on or off the mains. The sudden rush of current and the increase of voltage occasionally arising in this way is a remarkable fact, the truth of which was confirmed in the discussion. As, however, we have already pointed out, it is only the increase of voltage which is of any practical importance. The sudden rush of current cannot produce any dangerous amount of heating, for it only lasts for a small fraction of the time corresponding to the alternation of the current, and even if the maximum value of the current is twenty times as much as the ordinary magnetising current it does not exceed the full load current of the transformer. The rise of pressure may, however, manifest itself in a disagreeable manner, by damaging a voltmeter or by breaking down the insulation of the transformer which is being connected with the mains, or by piercing the cable or other weak point in the circuit. Dr. FLEMING's explanation of the rush of current appears sufficient, but his account of the manner in which the rise of pressure occurs is rather bald, and the matter seems to need further examination.

This protracted discussion gave rise, however, to a matter of more practical importance than anything mentioned in Dr. FLEMING's Paper. This was the reference made by Mr. CROMPTON to the losses which arise in the mains and feeders. The subject was further alluded to by Mr. ARTHUR WRIGHT, and Dr. FLEMING took up the matter in a very spirited fashion in his reply, and both he and other advocates of alternating currents seemed to think that his conclusions involved a signal defeat of the continuous-current system. His assumed load-factor may be accepted for the purpose of the argument, bearing in mind that motors are coming into use on continuous-current circuits, and that no simple alternate-current motor is yet on the market. Dr. FLEMING then finds that with a pair of 24-kilowatt feeders a mile long, one carrying a continuous current with a 40 per cent. drop of voltage on full load, and the other supplying six 6,000-watt transformers with a 2 per cent. drop, the efficiency is precisely the same. He finds, of course, that the "Hedgehog" transformers as supplied to him were out of the running. It would be too much to expect Dr. FLEMING to calculate a fourth case, viz., an open-circuit transformer as calculated and described at Newcastle, since that would only have been a hypothetical matter; but, after all, six 6,000-watt transformers supplying a low-pressure network is still a hypothetical case. In the practice of to-day transformers are placed in the customers' houses, although everybody talks about transformer sub-stations. We are not informed whether the transformer in this calculation was intended for sub-station work or no; open-circuit tranformers, at all events, may be specially calculated for such work.

While carefully maintaining an impartial attitude towards the rival systems, we cannot but think that Dr. FLEMING has blessed where he had been expected to curse, and that the result of his calculations is all that most continuous-current men want to confirm their convictions, while it all but fulfils the claims of the most ambitious advocates of low-pressure supply. Mr. CROMPTON has never discussed a greater length of feeding main than 2,000 yards, and in his Paper of April, 1888, he compared two mains of this length, with such data as were then available. Dr. FLEMING's mile is only 12 per cent. less than this. In commenting on Mr. ARTHUR WRIGHT's dictum that there is no room for a transformer within a radius of one mile and a quarter from a generating station, we remarked that advocates of continuous-current supply had never contemplated the supply of so large a district, and that only two London supply companies and three provincial stations out of twenty-four from whom we have received information, work at a greater radius than this. The ardent alternate-current men seemed to jump to the conclusion that because the losses were balanced according to calculation, *at the end* of a one mile feeder, a circle of this radius defined the district beyond which no continuous-current supply could hold its own. But the supply only *begins* at the end of the mile, and beyond this the low-pressure network extends just as it does round every continuous-current station in the country. The Westminster Company supplies Hyde Park Corner from Eccleston-place and from Davies-street, about three-quarters of a mile distant from either, so Mr. ARTHUR WRIGHTS' mile and a quarter as the radius of supply seems to be more than confirmed by Dr. FLEMING's one mile radius of feeding. On the other hand a radius of one mile from the Bankside or from the Wool Quay stations of the City of London Company em-

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braces the whole of the City and plenty to spare. We do not wish to push Dr. FLEMING'S arguments too far, but it really seems, that from this point of view, the City would have been better served by continuous current! That there is plenty of room for alternating currents nearly everybody will admit; and many companies who have adopted this system, even though their farthest lamp—to say nothing of their feeding points—are within a mile from the station, are well advised in their choice, since their business will extend. In some cases the station being outside the town, alternating currents are almost indispensible, even though the consumers are debarred from electric motors (unless, indeed, mathematical literature on the subject will satisfy them), and though they are placed at a great disadvantage in the use of arc lamps. We believe Dr. FLEMING has rather overdone his comparison, and we are loth to believe that the result is so greatly in favour of continuous currents as his calculations show.

NOTES ON SUBMARINE CABLE WORK.*

BY H. D. WILKINSON.

(Concluded from page 322.)

27. Cable Depots.—Part of the system of maintaining submarine cables consists in means for storing cable on shore at convenient centres, and in the establishment of depots where cable can be stored, tested, turned over, examined, made up in good condition and drawn from as required by the cable ships. The Government have two such depots, one at Woolwich and one at Dover; the Eastern Telegraph Company have cable tanks at Gibraltar, Malta, Suez and Perim; the Eastern and South African Company tanks at Cape Town and cable hulks at Zanzibar and Mossamedes; the Great Northern Company depot and tanks at Woosung; and the Eastern Extension Telegraph Company at Georgetown (Tasmania), Sydney, Hongkong and a large central depot at Singapore, where some eleven tanks are fitted besides boiler house, engine shop, serving shop and stores. The first step in this direction was the utilisation of the hulks of old sailing ships, moored in harbours most centrally situated to the system of cables.

The tanks on shore are usually built of riveted iron plates, similar to those on ships, and are bedded on blocks of granite or concrete and roofed in by sheds of light angle-iron girders and corrugated iron. The construction of the tanks at Malta is an exception, being built of concrete and opening at the top flush with the ground. The illustration (Fig. 93) represents the tank sheds at the Island of Perim, a military station at the Indian end of the Red Sea. Cables were first landed here in 1884, and the Island is now a point of call on one of the Suakim-Aden and one of the Suez-Aden cables besides having one cable to the Arabian and two to the African coast, making seven in all. The place has rapidly grown and will probably become as important, if not more so, as a port than Aden.

For transferring cable from the ship to the tanks a small hauling machine is used, consisting simply of a V sheave with jockey pulley (as in Fig. 96), intermediate gear of small speed reduction, and a V pulley for a rope or messenger to drive it. A machine such as this is fixed on a platform immediately over the tank into which cable is to be coiled, and by means of a rope is driven off a small steam winch below. In the Cape Town tank shed a vertical boiler and engine are permanently fixed for this purpose (*see* Fig. 94), while at Singapore a portable steam gear with boiler complete is mounted on a line of rails between tank house and wharf. This is like a portable steam crane with a winding drum instead of a jib, and has a V sheave for the rope to drive the hauling machines over tanks. When being transferred from ship to tanks cable is taken three or four times round the drum of this gear, which supplies the power to pull it from the ship some distance away to the front of the tank house, whence it is lifted to the tanks by the small hauling machine described. When simply turning over cable from one tank to another it is only necessary to drive the hauling machines over the two tanks, and experiments at this depot have proved it most convenient and economical to drive them by an electric motor supplied with current from a dynamo in the engine shop. Sometimes one cable is being taken aboard from the tanks and another ashore from ship at the same time.

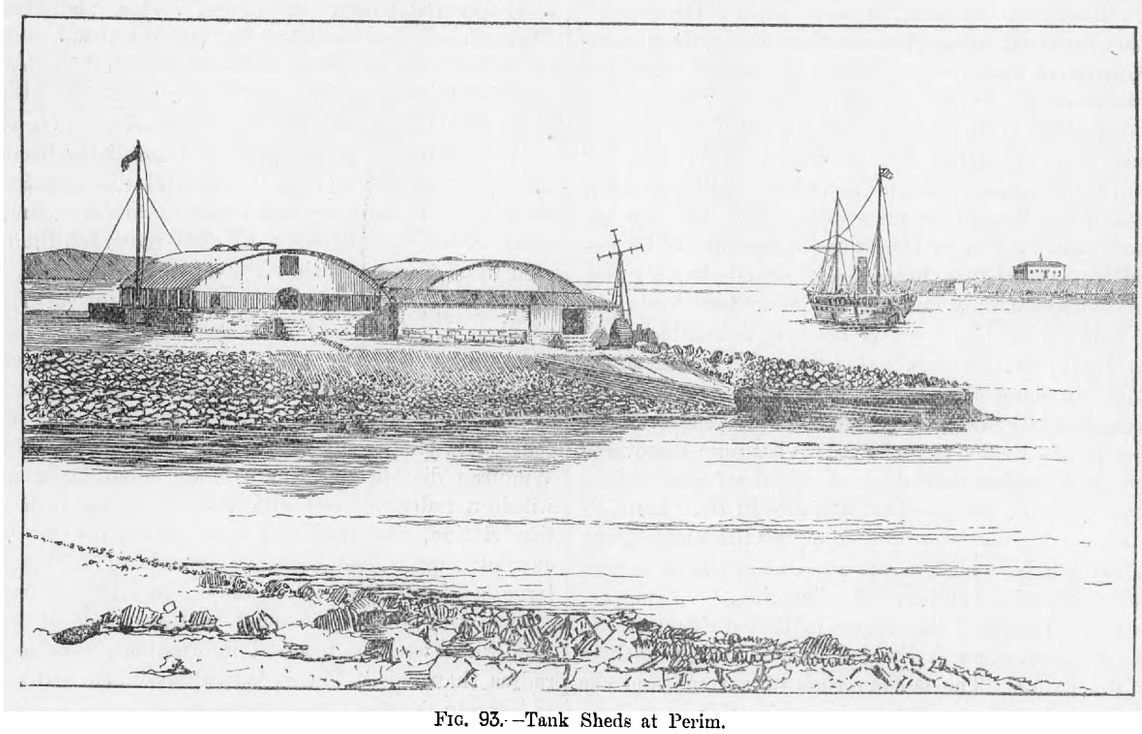

FIG. 93.—Tank Sheds at Perim.

The tank-shed at Cape Town (Fig. 94) encloses 6,000 sq. feet of floor space, and contains three tanks, one of 30ft. diameter and 6ft. deep, and two of 40ft. diameter and 8ft. deep. The total capacity to within one foot of the top is about 21,000 cubic feet, and deducting 4 per cent. for cone space, and allow-

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ing 40 cubic feet of coiling space per knot of type D, it is seen that the tanks will hold about 500 knots of this type of cable. Foundations of rough concrete 1ft. 6in. deep are prepared, and when properly set the tanks are got into position and held 2ft. above the floor by screw jacks, while a 1½in. layer of cement and sand is spread over the concrete bed. Before this has had time to set the jacks are lowered and the tank bedded and grouted in all round. The inlet and outlet water-pipes come in at the bottom of the tanks in the centre, and to facilitate drainage a layer of cement is run inside the bottom, tapering from 1½in. at the sides to 1in. at the centre. Cable is kept in its best condition when covered with water, but when turning over cable the water has to be discharged to allow the men to work inside.

A site is always selected as near as possible to where the ship can be moored, so that cable can be transferred easily. The Cape Town tank house is built on the promontory of land from which the new breakwater starts, immediately overlooking the docks and within 100 yards from where the ship can be berthed. To ship cable from the tank house or *vice versâ*, pairs of legs are rigged up every 20 yards and guyed, and a wire rope stretched along the top of them from tank house to ship. The cable then runs on V sheaves suspended about 10 yards apart on the wire rope, as in illustration. Where it enters the tank house the cable passes between a pair of vertical rollers, as in Fig. 95, and then passes over a sheave fixed to a bracket on the inside wall and thence to the hauling machine. The engine, a double-cylinder with reversing gear, transmits the power through mitre wheels and a vertical shaft to the hauling machine above, the speed being reduced about eight times.

A completely fitted testing room with concrete or brick and cement pillar for the reflecting galvanometer is also a part of the equipment of a tank house. Cable is overhauled at the depots and tested; if condemned the sheathing wires are stripped off and the core stored; if passed, the separate lengths of similar type are joined up and if necessary re-served. The process of re-serving consists first in running the cable—thoroughly dried—through a mixture of Stockholm tar and resin and then "parcelling" or taping over the sheathing wires with canvas strip. Over this is put a layer of soft compound and then another tape in the opposite direction to the first and finally a smear of hard compound. The latter is Bright and Clark's compound consisting of mineral pitch, tar and silica made from calcined flints ground to a powder, the object of which is to resist the attacks of the teredo by damaging its boring tool. Outside all, the cable is whitewashed as it is coiled in the tanks to prevent the turns from sticking together, as it would be dangerous for the men in the tank were this to happen during paying out.

When taking cable aboard it is convenient to use a portable steam hauling machine which can be fixed to the deck alongside any tank into which it is required to coil the cable. The tractive power is then just where it ought to be and as delivered from this machine the cable has only to fall by its own weight into the tank, where men receive and coil it. In a machine for this purpose a faster running engine can be used than with the ship's picking-up gear as there is no strain on the cable. When loading up from the factory a high-speed horizontal engine is sometimes fixed to the deck temporarily to drive a small hauling machine, but it would be inconvenient to have the two things separate when out abroad. A combined hauling machine coupled direct to a small high-speed Brotherhood steam engine has been brought out by Messrs. Johnson and Phillips, for which all the preparation necessary is to make an inch steam connection to the donkey boilers, generally a flexible steam pipe.

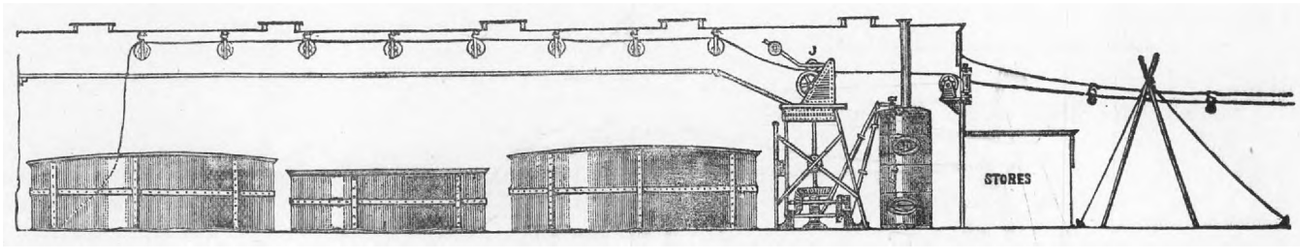

FIG. 94.—Tank Shed at Cape Town.

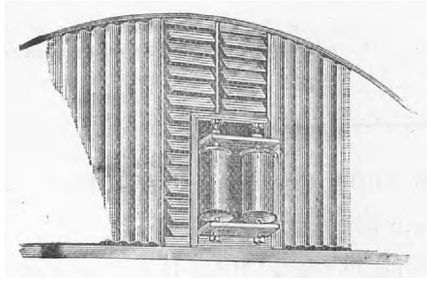

FIG 95.—In-leads to Tank House.

28. The Cable Ship "Retriever."—This vessel (Fig. 96), belonging to the West Coast of America Telegraph Company, and stationed at Callao, Peru, attracted public notice during the Chilian revolution of 1891, when the cables of this Company connecting the principal ports of Chili were cut and interfered with by war vessels of both parties. She was built on the Clyde in 1878, and passed her third survey under the regulations of Lloyd's Committee in 1891. Her principal dimensions are 180ft. by 30ft. by 16ft. deep; gross tonnage 775, and horse-power 95. She carries two tanks, each of 26ft. diameter, and 7ft. deep, having, therefore, a capacity of 200 knots of deep sea cable. The Company's system of cables kept in repair by this vessel run from Chorillos, near to Callao and Lima (Peru), down to Valparaiso, in Chili, touching at the intermediate ports of Mollendo, Arica, Iquique, Antofagasta, Caldera, and Serena. The total length of these cables is 1,700 knots. During the revolution, the war vessels of the Congressionalists cut the Mollendo-Arica and Arica-Iquique sections in one day; two days later the Iquique-Antofagasta section, and five weeks later that between Antofagasta and Caldera. As soon as the existing condition of affairs permitted, the "Retriever" proceeded to pick up the eight ends, and put them through, and including about 700 miles steaming had

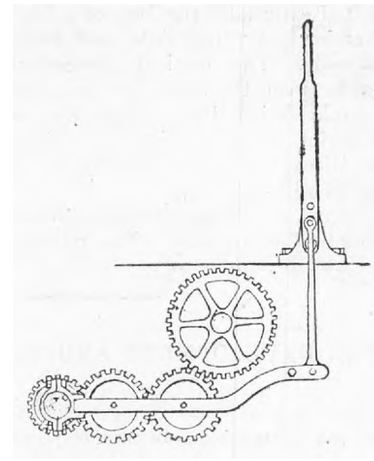

FIG. 97.—Gear for Driving Hauling Pulley.

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the cables in working order within three weeks' time. The illustration is from a photograph of this vessel kindly lent by the Company.

29. **Cable Gear on the "John Pender."**—This vessel belonging to the Eastern Telegraph Company was fitted in the spring of 1890 with the new cable gear illustrated in *The Electrician*, Vol. XXV., p. 198. In this gear, designed by Messrs. Johnson and Phillips, the two drums are quite independent, being connected to independent trains of gear, each having a double purchase by which the ratio of engine speed to drum speed can be made either 100 : 3 or 100 : 6. There are also two independent engines, but by means of a connecting clutch between the two first motion shafts either engine can be made to work either drum or both.

The engines are by Messrs. Robey and Co., and, as will be seen in the engraving, are double cylinder verticals. The support to the cylinders in each engine is in two castings, bolted together with front and back plates, forming a hollow framework, in which the crank shaft revolves in oil and water. This framework forms internally the guides for the crossheads, and to it are bolted externally the brackets for valve spindle guides and reversing gear, the links and excentrics for the latter being outside. The vertical space occupied by the engines and gear between the main deck and bridge is about 6ft. 6in., the stroke being 15in. Sight-feed lubricators are fitted to each engine. The holding down bolts are secured underneath the deck, which is of iron, by 8in. baulks of timber and large plate iron washers.

The starting valves, reversing gear and brake wheels are all operated from the bridge platform. The hauling-off pulley is thrown in or out of gear by lever (Fig. 97). When it is required to disconnect and run the pulley on the brake as in paying out, a pin is removed, and the lever is let down. A separator is fitted to the steam pipe supplying the engines, and all water drained off here is returned to the boilers by a pipe arranged on the principle of the steam loop.

Steam used for working the cable gear, electric light engine, winches, and Gwynne's circulating pump, is all condensed and returned to the boilers. The common exhaust from these engines is taken to one of Kirkaldy's condensers, the circulating water for which is supplied by the Gwynne pump. This condenser delivers the fresh water into a tank, from which it can be sucked into the condensers of the main engines by the vacuum, and thus worked round again to the boilers by the air-pump, hot-well, and feed-pumps. The small deficiency is made up in the usual way by sucking in a little sea-water into main condenser from delivery side of main circulating pump, where it mixes with the condensed steam, and is pumped up into the hot-well.

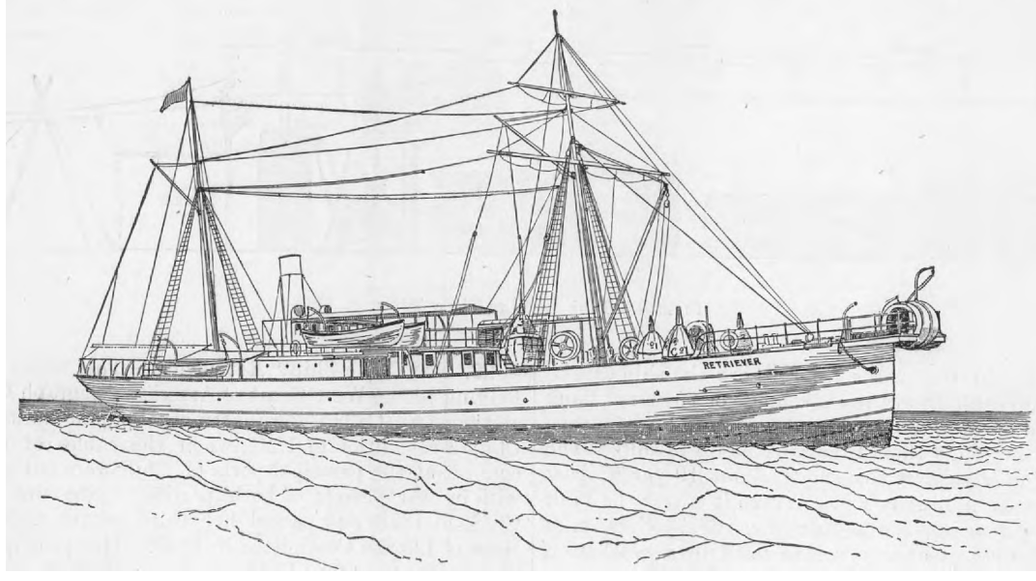

Fig. 96.—Cable Ship "Retriever."

The work of repairing cables has now been treated upon in detail and in simple form, and different types of ships and gear described up to date. In the concluding portion the author intends treating upon modern electrical tests for localisation of faults, also cable laying operations, including the surveying of routes, sounding apparatus, ship and shore tests, and the landing of shore ends.

[*This series of articles will be suspended owing to the author's absence abroad. We hope the series will be resumed in the course of our next volume.*]

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

BY PROF. W. CAWTHORNE UNWIN, F.R.S.

The suggestion that transmission of motive power to a distance could be effected by air was an old one. As early as 1845 at some mines in Belgium power was transmitted 750ft. by compressed air. A great impetus to the use of compressed air as a means of power was its application to the working of boring machines in tunnels. Compressed air was used in the boring of the Mont Cenis tunnel. The machines first employed were very inefficient. From that time the use of compressed air in mining operations made very rapid progress. In 1877 Mekarski used air compressed to 25 or 30 atmospheres, in conjunction with a small amount of high pressure steam to drive tramway cars, and the Mekarski cars were still running in Paris. Mekarski was amongst the first to use a compound compressor.

Hughes and Lancaster Compressed Air Tram.

Whilst speaking of tramways, he might say that a rather interesting system of compressed air tramway had been invented by Messrs. Hughes and Lancaster, at Chester, which seemed efficient in certain cases, and which might be a solution of the problem of tramway traction. There was no application of motive power which had proved more difficult than the working of tramways. The cable tramway did admirably well when there was a large enough traffic, but a very large traffic was required to make the system pay. The steam tramway was a dreadful thing. Electric tramways existed only in the shape of tramways with overhead

* Howard Lecture V., delivered before the Society of Arts, Friday, February 10th.

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conductors, and although in America they had an extension of 4,000 miles, that form of tramway did not seem to be adapted to this country. In the system which Hughes and Lancaster had adopted they had on the tramcar an arrangement for obtaining, almost automatically, a charge of air at charging stations a quarter or half a mile apart. The apparatus on the car was attached to a pipe, which, as the car passed over the charging station, went down into a pipe placed in an ordinary manhole at the side of the tramway, forced open a valve, and took its charge of air. He experimented with that system some time ago, and it really gave good results. The car experimented with was an old ordinary horse-tramcar with reservoirs containing 50 cubic feet crammed underneath it in a very uncomfortable position. The air available was only 150lb. pressure, but the car worked very well. The engine on it was a Rigg motor, and it worked exceedingly well, except for one thing: the valves were not tight, and there was a good deal of leakage, which was against the favourable action of the car. However, starting with a pressure of 150lb., it ran distances of from 600 to 1,500ft., with a full load of passengers, weighing about six tons, on gradients varying from level to 1 in 45. On a special trial the car ran 1,230ft. up a very steep hill, with gradients varying from 1 in 130 to 1 in 24. He did not think that particular application of compressed air was very well known, but it seemed to him exceedingly likely to be a very useful application.

The Advantages of Compressed Air.

Compressed air was a perfectly general mode of transmitting motive power. Whether in any particular case it was the most advantageous, the most economical, the one which would cost least in installation, might be a question; but it could be used in all cases, even when the distance of transmission was very great. The air mains could be carried by any path, however winding and broken, and the method had the advantage that differences of elevation between the generating station and the motors did not affect the efficiency of the arrangement. In hydraulic transmission the water must be collected, generally stored, sometimes bought, and arrangements must be made for getting rid of the water. In a compressed air system they got air anywhere for nothing, and it was discharged anywhere without nuisance. Compressed air had obviously very great advantages in the case of underground transmissions. It might replace manual labour where hardly any other mechanical agent could be employed. In boring a tunnel, for instance, the saving was so great, even with uneconomical machinery, that there was no great inducement to improvement, and in those cases cheap plant was more important than efficient plant; hence much of the compressing plant used in mines was extravagantly wasteful in power. In many cases the machines were worked by water-power, and this again militated against attention being paid to economy of working. It was only lately, as compressed air had been adopted as a means of distributing power in towns, that any careful consideration had been given to the question of economical working. The earlier and rougher applications of compressed air had given ample ground for the popular opinion that the efficiency of compressed air transmission was exceedingly low; probably in many cases it did not exceed 20 per cent. In great towns like Paris and Birmingham attention had been given to economy, and better results had in fact been obtained; but in both those cases the conditions under which the works had been carried out had been disastrously unfavourable to a complete trial of compressed air. In cases like Geneva and Zurich, where they had an abundant supply of water-power, where reservoirs could be constructed at a sufficient but not excessive height, hydraulic transmission had great advantages; but in the much more numerous cases where these local conditions were not present, compressed air transmissions were likely to play a considerable rôle.

Compressed air was the most formidable rival of the electrical transmission of power. For ordinary power purposes, excluding the application of power for transit and lighting, probably at this moment, enormously more work was being done by compressed air than by electricity. There were a few cases where power was distributed for industrial purposes by continuous current electrical systems. Such systems were perfectly effective, but too costly. Electricians told them the alternating system would be much cheaper. At present there was no case where power was distributed by the alternating current system; there were only certain elements of such a system which might be employed in the future. From the standpoint of past experience it might be asserted that power distribution in towns, in cases where the distribution was not merely a subordinate function of a plant intended primarily for electric lighting, especially in cases where the work had previously been done by steam engines which could be converted into air motors, could be more economically and efficiently effected by compressed air than by electricity.

Air Compressors.

With regard to the general arrangement of a system of compressed air distribution, it consisted first of a compressing plant, worked often by a steam engine or water power. Then there was provision for a certain amount of storage of compressed air. Secondly, there were the mains for conveying the air to the working points; and thirdly, the motors actuated by the compressed air. These were provided sometimes with re-heaters and other arrangements for increasing their efficiency. They had, therefore, to deal with the three different considerations of the compressors and their efficiency, the mains and their efficiency, and the air motors and their efficiency.

In the compression of air, in an air compressor, the principal practical loss which arose was due to the heat generated in the process of compression. In ordinary cases during compression, the air was considerably heated. If the air motor worked close to the air compressor, that involved no particular loss. But generally the air had to be conveyed to long distances. In that case the air cooled down before it was used, and the whole of the work expended in generating heat in the compressor was for practical purposes lost. The ideal compressor for power distribution would be one in which the compression was isothermal. The heat losses increased rapidly as the pressure to which the air was compressed was greater. It increased nearly as the square of the ratio of the pressure of the compression to the atmospheric pressure. There was no doubt this rapid loss of heat had led to the use of comparatively low pressures for compressed air in a great many cases. This involved an oversight. With the higher working pressures the increased loss of the compressing plant was largely balanced by greater efficiency of the motors, so that although in compressing to high pressure they lost more in heat, their air motors worked more efficiently, and part of the loss was made up.

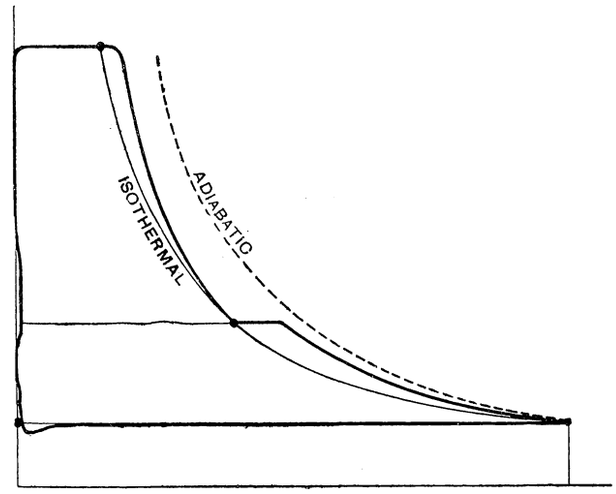

FIG. 1.—Compression Diagram of Riedler Compound Compressor.

Various means had been adopted to cool the air during compression. Some had replaced the jacket of the air chamber with a cylinder through which cold water passed. This had disadvantages, for the surface was small for the heat produced, and air did not readily part with its heat to a metallic surface. The employment of a water piston had some effect in cooling the air, and the wet cylinder walls in a compressor worked with a water piston absorbed heat rather more rapidly than the dry metallic walls in an ordinary compressor. But the best direct means of cooling air during compression consisted in ejecting water into the compressor in the shape of fine spray; a method first proposed by Prof. Colladon in the works for the St. Gothard tunnel. There was another method of obviating a great deal of the heating losses, which was to use a compound compressor. By whom the compound compressor was first used he did not know; it was certainly used by Mekarski for comparatively high air pressures at a comparatively early date, and at any rate as early as 1880 it was used in America in ordinary mining compressing plants. He believed in some of the early compressors which were made compound, the object was merely to equalise the piston load, but it was very soon found, as would be seen from Fig. 1, that the compound compressor gave means of annulling the greatest part of the heating loss.

The earliest compressors, which did at all a tolerably good duty were water piston compressors. In one of the St. Gothard tunnels water piston compressors, made by the Humboldt Company, a ram worked into two cylinders, and at each end they had a water piston. This was in many respects an exceedingly efficient compressor. Its defect was that it could not be run at a greater piston speed than 100ft. permanently, and therefore it was a very large and costly compressor for the amount of work it did. That compressor got laid aside simply because it was too costly. It was superseded by compressors which worked with a spray injection, such as that of François and Dubois, which could be run at two or three times the speed of the water piston compressors, therefore it was a

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much smaller machine for a given amount of work and very much less costly. By far the largest number of compressors used in mines and so on were compressors of this type, but although they gave a discharge of comparatively cold air, the cooling effect of the spray was not quite so great as it appeared to be. A good deal of the cooling went on too late in the stroke, and the compression curve was not lowered so nearly to the isothermal curve as it ought to be if the cooling took place earlier in the stroke. The effect of the spray was a little deceptive. They could not get a better result, however, except by resort to the compound compressor. The compound compressor in itself was a more expensive machine, and it became in that case particularly desirable to reduce as far as possible the size of the machine for the work it had to do. That could only be done by adopting arrangements whereby a compressor could be run at a high piston speed, and to secure that Prof. Riedler had introduced in the compressors constructed under his instructions, especially in the large 2,000 H.P. compressors in Paris, a system of mechanically moved valves. He was in the compressor house in Paris a few months ago. It really was a very fine sight indeed. They had there four triple steam engines, each of 2,000 H.P. Three of them were working continuously. For a few hours at night only one of them worked, he believed, but during the greater part of the day three of them worked at a speed of 40 revolutions a minute. Towards evening, when the compressed air was being largely used for electric lighting, the engines were speeded up and ran at a speed of nearly 70 revolutions. He believed they would run perfectly well at 80 revolutions, and it was on record that through some mismanagement the engine once ran nearly up to 200 revolutions a minute. A 2,000 H.P. engine running at that speed was not seen every day.

Compressed Air Mains.

He now came to speak a little of the losses in transmitting air from the generating station to the working point. First of all, it was to be noted that the frictional resistance in pipes containing fluid was proportional to the density of the fluid. Consequently at equal velocities the friction of air flowing in the mains was enormously less than that of water. In air mains there was nothing analogous to the hydraulic shock which so very much limited the speed at which water mains could be worked. In air mains velocities of from 30 to 50 feet per second were allowed without serious frictional loss, and it was this high velocity which enabled them to transmit at moderate pressures, with engines of moderate size, a very large amount of power. The author had pointed out that hydraulic 6in. mains, working at 750lb. pressure per square inch, at a velocity of 3ft. per second, would only transmit 90 utilisable H.P., allowing for losses at the motor. Air at 45lb. pressure in these mains, with a velocity of 50ft. per second, would transmit nearly twice as much. The largest hydraulic mains were 7in. in diameter, but air mains could be constructed of any size. In Paris there was a main 7 kilometres in length, which was 24in. in diameter and transmitted 6,000 H.P. In the older Paris mains, which were carried chiefly through the sewers, and had an exceptionally large number of bends, draining boxes, and other sources of resistance, and in which the velocity of the air varied from 25 to 30ft. per second, the frictional loss only amounted to 2lb. per square inch per mile of main. As to the exact way in which the resistance of the air mains influenced the efficiency there was still a word to be said. Supposing the main received air at 60lbs. gauge pressure which reached the other end at 55lbs., then there was 5lb. loss due to friction. It was commonly assumed that as there was 5lb. loss out of 60lb. 5-60ths of the energy of the air was wasted. That was altogether erroneous, and was based on a false hydraulic analogy. The expansion of the volume of the air largely compensated for the loss of pressure. The frictional loss was only indirect, energy at 55lb. being not quite so available as the same amount of energy in an equal weight of air at 60lb. pressure. He would not go into the exact calculations, but would mention that in the case he had considered, where there was a 5lb. loss in 60lb., instead of the loss being 5-60ths, he had found by calculation that the real loss was about 3 per cent. For short distance transmissions the consideration just stated was not perhaps very important, but the principle involved became important when long distances had to be considered. The author believed that it could be shown by data, verified by experiments on a line over 20 miles in length, that long distance transmission by compressed air was perfectly practicable; it was quite possible to transmit 10,000 H.P. by an air main of not unusual size to a distance of 20 miles, and to use the compressed air for motor purposes, obtaining an efficiency of 40 and 50 per cent. if the air were used cold, or 70 to 80 per cent. if the air were, as it ought to be, re-heated before use.

Now, he should like to say something about the construction of the mains. Unfortunately fo the compressed air system, a very large and very interesting installation at Birmingham had completely failed. One ought not to speak ill of the dead, and he was not going to say much, but, certainly, he thought there the most serious engineering mistake made was in attempting to transmit compressed air through steel mains with ordinary lead joints. In those mains the air went in at one end during a great part of the day at a temperature of 280deg.; they were heated up to 280deg. once a day and cooled down at night to a much lower temperature. No ordinary joints would stand that action, and the result was that there was a continual leakage, and a very large leakage before the installation finally expired. There was at the time that installation was carried out a perfectly successful air main in Paris with perfectly simple joints in which there was no appreciable leakage. The pipes in that case were plain spigot-ended pipes; a kind of ring was placed over the joint (*see* Fig. 2.); against each end of the ring there were two india-rubber washers, which were pressed against the ring and against the pipe by two clips. That was a perfectly successful joint; it allowed an expansion at every length of the main, and it allowed the main to bend if there was a settlement of the ground without any harm. The only question raised about it was whether india-rubber joints were durable. The joints were arranged so that the rubber was nowhere exposed to the air. So far as experience went, and it extended over a number of years, the joints were found to have the india-rubber in perfectly good condition, in fact as good as when they were put down. That joint was now being used in all important new air compressing arrangements. The Paris main, and still later the Offenbach main, showed that they could have a compressed air main in which the leakage was an absolutely insignificant quantity.

Compressed Air Motors.

The air motor was essentially a reversed compressor. It was free, however, from the heating which caused so much difficulty in the compressor. The air cooled in expanding, and in some cases this gave rise to difficulty from the production of ice. Some special air motors of simple construction and small size were used in Paris, but most air motors were simple non-condensing steam engines adapted to the use of compressed air. Probably the greatest source of inefficiency in the air motors was leakage, especially piston leakage. In steam engines condensation helped to keep the piston

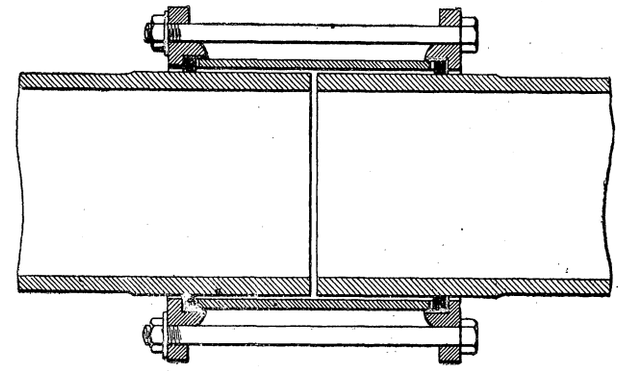

FIG. 2.—Paris Compressed Air-Main Joint, with India-rubber Washers.

tight. In air motors they had dry pistons, and therefore the leakage was a more serious difficulty. Unfortunately he did not think anyone had set to work to see exactly how a proper air motor ought to be constructed. But in the case of air motors now used in Paris they had efficiency data. In the very small and imperfect rotary motors used in Paris the consumption of compressed air was about 750 to 850 cubic feet of air compressed to five atmospheres for each effective horse-power hour. In the old steam engines converted for use as air motors the consumption was 450 cubic feet of air compressed to five atmospheres for one effective horse-power hour. In the new compressing station on the Quai de la Gare they compressed a cubic metre of air —that was at 7 atmospheres, but that fact might be overlooked— for 0·4 of a centime. Suppose they allowed, as careful estimates for the waste of the installation showed to be sufficient, that they compressed air at 0·4 of a centime per cubic metre and charged for it 0·7 of a centime per cubic metre, to allow for interest and depreciation on compressing and distributing plant. He found on that basis that in Paris the cost worked out to nearly 1d. per horse-power-hour for the small and extravagant rotary motors, and ½d. for the old converted steam engines used as air motors. In the latter case the cost corresponded very nearly to £6. 5s. per effective horse-power per year of 3,000 working hours. He thought there was no question that still better results would be attained very soon, when motors were built expressly as air motors, and in the most suitable form in which air motors could be used.

The amount of expansion which could practically be permitted in the air motor without inconvenience from the excessive fall of temperature in expansion was limited. It varied with the dryness of the compressed air and with some other conditions, but a practical limitation of the efficiency of the air motor was thus imposed. All difficulty arising in that way was obviated by re-heating

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the air before it was used in the motor, and this added to the mechanical work obtained. Part of the heat applied was transformed into work, and the given quantity of air supplied did more work. As the motor was charged for by quantity of air consumed, the cost of the horse-power hour was thus diminished. Whether it was economical or the reverse to heat the air before using it in the air motor depended upon whether the value of the additional work done was more than the value of the coal or other fuel employed in heating the air. General experience had shown that it was extremely advantageous and economical to heat the air before using it. This arose partly out of the circumstance that heat so applied was very efficiently used, and a very much larger fraction of it was converted into work than in ordinary heat engines. The desirability of heating the air being conceded, it remained to consider whether it was troublesome or involved costly apparatus. Experience showed that extremely small, easily managed, and simple furnaces could be used in heating the air. According to Prof. Riedler's experiments, the heat thus used was five times as efficient as an equal amount of heat in an ordinary steam engine. They had in Paris tried a slight improvement. As air did not very readily take up heat from metal surfaces it was advantageous to introduce a small quantity of water into the spiral pipes of the re-heater; this water took up heat readily; it was converted into steam, and passed with the air into the motor. Some years ago he suggested in connection with air transmission that the proper way of using heat in compressed air transmission was to burn the fuel in the current of air. His friend Dr. Sellers took the suggestion to America, and someone had tried it there in a crude form with a petroleum lamp (*see* Fig. 3). Another suggestion was made at Dresden of working gas engines in conjunction with air motors, the heated products of combustion in the gas engine being taken through the jacket of the air motor, and conversely the air going to the air motor being taken through the jacket of the gas engine. In the use of compressed air in town distribution there was no difficulty in measuring the quantity of air used by each consumer. There were perfectly simple forms of meter by which the quantity used could be quite accurately ascertained.

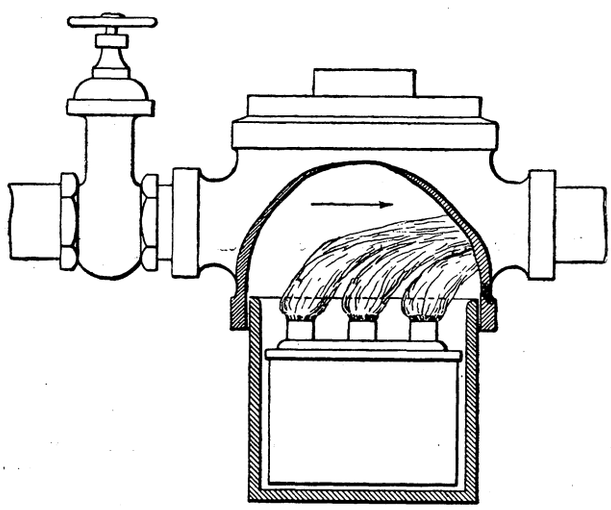

FIG. 3.—Petroleum Lamp Re-heater for Compressed Air Main.

The Paris and Offenbach Compressed Air Systems.

The Paris system of compressed air power distribution was the largest in Europe. It developed out of very small beginnings. First it was merely a system of regulating clocks by impulses of compressed air. In its earliest condition there was a reservoir with air at two or three atmospheres pressure. There were two clocks which actuated valves which sent a pulse of air lasting for 20 seconds once in every minute through the mains. In 1889, 8,000 clocks were driven and regulated from the central clock by the pneumatic arrangement. The system proved very successful, and a new station was built. In 1887 a demand arose for compressed air for working small motors, and a large extension of the system was made. A second installation was erected, and in this were placed Davey Paxman engines, the whole of the steam engines aggregating 2,000 H.P. Very soon that installation became insufficient. A third installation was added to the station in the Rue Saint Fargeau, consisting of five compound engines and compressors built by Cockerill, that also worked at 2,000 H.P. Finally a fourth installation was constructed, designed initially to work to 24,000 H.P. Part of that station had been erected at the Quai de la Gare on the Seine some distance above Paris, and that was a station where they now had 8,000 H.P. The air was used for the most various purposes. At some of the theatres and restaurants it drove dynamos for electric lighting; at the printing office of the *Figaro* there was a 50 H.P. motor, and at the office of the *Petit Journal* a 100 H.P. motor; and in numerous workshops the power was used to drive small motors. It was used also for producing cold in extensive refrigerating stores. There was one electric lighting station worked by air motors in which were eight 50 H.P. air motors. Up to the time of the beginning of the new central station the system had been worked with considerable success. In the new station they adopted Riedler's large compound compressors in the place of the François-Dubois compressors, and they used triple steam engines working at 180lb. pressure, and the effect of this and of other arrangements for economy was that they obtained a cubic metre of air for four-tenths of the cost for which it had been previously obtained. The cost of working the new station as compared with that of the old one was so low that he believed that the old one was not now used. Unfortunately, at the present moment the Paris Air Company was in more or less considerable difficulty. So far as he could learn, the supply of power by compressed air was, on the whole, a perfectly successful operation; but the Company was hampered by the fact that the compressed air power distribution was associated with a very unremunerative electric system, and while the distribution of compressed air was fairly successful, the very costly electric-lighting stations, which also belonged to the same company, were worked far less successfully.

At Offenbach, near Frankfort, there was, probably, the most perfect compressed air distribution which had been hitherto constructed. It was not a very large station, but its arrangements throughout were as good as, with the present knowledge, they could be. The station had been working for about a couple of years delivering compressed air through about 23,000ft. of mains. Those mains had been tested for leakage, and the loss by leakage in the whole of that length of main with a pressure of six and three-quarter atmospheres was only one and a-half cubic feet per mile per hour.

EXPERIMENTAL RESEARCHES ON ALTERNATE CURRENT TRANSFORMERS.

The following is an abstract of the discussion on Dr. Fleming's paper, which took place on Thursday evening last week, at the Institution of Electrical Engineers. Speakers whose remarks are prefaced by an asterisk have returned their proofs revised :—

* Prof. AYRTON did not think Dr. Fleming quite understood the way in which it was proposed that the three voltmeter method should be used. It was not proposed that every time they wished to measure the power given to an alternating current circuit the three voltmeter method should be employed. But it was intended that the accuracy of wattmeters, &c., might be checked by means of this method. He wished also to point out that Dr. Fleming's description of the method of testing transformers used at the Central Institution did not adequately describe it; for first, it was essentially a workshop method, secondly, it gave directly the losses in the transformer, and thirdly, it separated the iron and copper losses, each being read off directly on a wattmeter. Throughout the paper Dr. Fleming used the abbreviations P.D. and ammeter, and so by winning the hearts of the proposer of those abbreviations, all criticism had been almost disarmed on his part. He had noticed that P.D. was called slang in one paper; it was *The Electrician*. He supposed "Salisbury-court, E.C.," would be also slang; he thought of writing to say so, but remembering that "W. E. Ayrton", and all other abbreviations would be slang too, he refrained from doing so. He ventured to propose another abbreviation. He proposed to drop the expressions virtual current and effective current altogether, and to use abbreviations for the particular things they wanted to measure. The D'Arsonval galvanometer for instance measured the mean current. Let this be called the M. current. An ammeter with a soft iron needle, or an electro-dynamometer, measured the mean square of the current. Let that be called the M.S. current. If the dynamometer were graduated so that the square roots of the deflections were taken, allowance being, of course, made for the variation of constant at different parts of the scale arising from the distortion of the spring, then they got what had been unwisely called the effective current, or the virtual current; it was really the root of the mean square of the current. He proposed, therefore, to call it the R.M.S. current.

Prof. PERRY hoped Prof. Ayrton would be allowed to leave out the latter part of his remarks in correcting his proof.

The PRESIDENT: He can do what he likes, sir; he generally does.

*Dr. FLEMING, in his reply, said that it often happened that at the end of a long discussion, the author of the Paper under discussion found that many of those who had spoken had answered one another's difficulties, criticisms, or objections. In the present instance, however, there were reasons for answering his critics, with some care and detail, and he would take the speakers in the order in which they had spoken.

Mr. Swinburne might be considered the chief defendant, and his first remark concerned his electrostatic voltmeter. Mr. Swinburne said his firm had considered the question of employing the oil damping arrangement suggested by the author, but preferred electro-magnetic damping. Mr. Swin-

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burne's speech was made on Dec. 1st, and reported in *The Electrician* of Dec. 16th, and being marked by an asterisk as having been corrected by the author, might perhaps be taken to represent correctly what he stated when he took part in the discussion on Dec. 1st. On referring to *The Electrician* for December 2nd they would find a short article, having all the appearance of an inspired communication, in which the following statement occured, in speaking of the Swinburne electrostatic voltmeter :—"The electro-magnetic damping arrangement has been done away with, and an adjustable oil damper substituted, which enables any degree of damping desired to be obtained." His (Dr. Fleming's) Paper was read on November 24th, so that practically it came to this : Mr. Swinburne adopted and utilised the suggestions about oil damping on December 2nd, and repudiated them again on December 16th. With regard to the use of mica for preventing discharges from the cable to the case, it was quite true that they used the voltmeters for higher pressures than those for which they were originally designed, but they deserve every credit for thus converting an instrument arranged by its maker for 1,200 volts, into one which could be used up to 3,000. The only objection which Mr. Swinburne was able to urge against the use of mica for clothing the "needle" was that it rendered it impossible to calibrate the instrument from standard cells. The calibration of an instrument up to 2,000 volts, with standard cells, was an operation that required the very greatest care, in order to avoid serious errors, and he (Dr. Fleming) could not conceive how anybody could delibrately prefer that method to the exceedingly simple and effective one which he had described, employing a non-inductive divided resistance and a voltmeter working up to 100 volts. Coming next to the much-discussed wattmeters, it was admitted that the first wattmeter Mr. Swinburne sent was not correct, but that the second one was, and the only difference of opinion which existed was as to the cause of error. Mr. Swinburne still thought, judging from his printed remarks in the report of the discussion, that eddy currents in the case had something to do with this error. It was perfectly clear that he failed to notice in his (Dr. Fleming's) Paper a table of experiments in which that particular wattmeter was used with the case *on* and with the case *off*, and in which it was shown that the removal of the brass case made very little or no difference in the erroneous low readings of the wattmeter. Hence, it was perfectly evident that the substantial cause of error was not eddy currents in the case. The interesting figures which Dr. Sumpner had obtained from his own experiments, and from the analysis of the figures in the author's Paper, sufficiently showed that, at any rate, in that wattmeter practically the whole of the error could be accounted for by local currents set up in the brass plates which carried the series coil. In the next place, Mr. Swinburne objected to the term "power factor." It was very difficult to know how to please Mr. Swinburne in the matter of terms.

He now came to the real question at issue, namely, the question of open *versus* closed magnetic circuit transformers. Mr. Swinburne said that he (Dr. Fleming) had not settled it. No matter of the kind ever was settled. What he *did* claim to have settled was the fact that up to date the best open-circuit transformer that could be produced was not electrically better than the closed-circuit transformer of equal output. In order to properly test the matter, they must assume certain conditions of working, in other words, assume a certain load diagram, and then, on that load diagram, compare the all-day efficiencies of two transformers of equal nominal output, working under the same conditions. The figures in his Paper would enable them to do that for themselves ; but in order to bring home the facts, he had prepared a series of tables for the purpose of such comparison. He had compared together the all-day efficiency of a 6,000-watt "Hedgehog" and a 6,000-watt "Mordey" transformer when working on a 10 per cent. load factor. In Tables I. and II. he had compared the performance of the two transformers by making an energy balance-sheet for each transformer for the 24 hours. They would see from them that for the open circuit transformer the all-day efficiency was 74·2 per cent., and for the closed circuit transformer it was 74·3 per cent. Let them vary the diagrams as they pleased they would find that under all the ordinary conditions of work the 6,000-watt closed circuit transformer gave a slightly higher all-day efficiency than the 6,000 open circuit transformer, and that the accuracy of these figures could not be impugned. It was interesting to go a little further, and see how far the internal losses in the transformers were supplemented by losses in the primary main when the transformers were working on the same load diagram. He had, therefore, assumed a case, which was quite capable of being realised in practice, namely, a primary main a mile long, consisting of a 7/16 cable in each branch, and four 6,000-watt transformers placed at the end of that primary line. In Table III. were calculated out the 24 hours' loss in the primary cable for each case. In the case of the four "Hedgehog" transformers the 24 hours' loss in the line would be 2·659 units. For the four Mordey transformers the 24 hours' loss in the primary line would be 0·454 of a unit. If the total losses in the transformers and cable were taken for the 24 hours in the two cases, they found that while the four "Hedgehogs" plus cable dissipated 18·155 units, the four Mordey transformers of the same size and on the cable dissipated only 15·798 units, the secondary circuit delivery in both cases being 60 units. In addition to the cable losses there would also be the relative losses in the dynamo armature, but on calculation it would be found that, owing to the low resistance of modern armatures, the armature loss was really quite negligible. Was there, in face of this, any foundation in fact, whatever, for the statement so frequently made that they could afford to throw away their closed-circuit transformers, and replace them by the much more economical open magnetic circuit transformers. The difference between the total energy losses in the two cases in the 24 hours would amount to about 2·36 units, and in about 365 days that would signify a total of 860 units, which at 3d. a unit was £10. Mr. Swinburne proposed to remedy the defect of a large magnetising current by employing condensers, and had spent a considerable amount of time in developing a condenser for the purpose. It was a very important matter to ascertain whether the proposed remedy was really a remedy. Now, none of the condensers submitted to him (Dr. Fleming) for testing had proved themselves to be without dielectric hysteresis. For instance, a certain condenser submitted passed, at a pressure of 2,400 volts, a current of about four amperes—such a condenser would probably be used to supply current for four 6,000-watt "Hedgehog" transformers. That condenser absorbed 120 watts. Suppose that such a condenser were placed at the dynamo end of the primary line to supply the four transformers at the other end with magnetising current. Now, he very much doubted whether a condenser made of paper could be made to have a power factor of less than 0·01, and would be found to take up quite 100 watts in power. If this were the case, it was then obvious that in the 24 hours such a condenser would dissipate 2·4 B.T.U. of electric energy. The object of putting a condenser there at all was to save the line loss. If they looked for a moment at Table III. they would see that the loss in the

Table I.—*All-Day Efficiency of 6,000-Watt "Hedgehog" Transformer on a 10 per cent. Load-Factor.*

Let the load diagram be taken as equivalent to

$$24 = \begin{cases} 11 \text{ hours working at no secondary load} \\ 5 \quad \text{,,} \quad \text{,,} \quad \text{1-10th of full load} \\ 4 \quad \text{,,} \quad \text{,,} \quad \text{1-8th ,, ,,} \\ 3 \quad \text{,,} \quad \text{,,} \quad \text{1-4th ,, ,,} \\ 1 \quad \text{,,} \quad \text{,,} \quad \text{3-4ths ,, ,,} \end{cases}$$

which is equivalent to 2·5 hours at full load, or to a load-factor of *very* nearly 10 per cent.

The energy balance-sheet for the transformer on this load, as derived from tables of observations, is as follows :—

Energy in watt-hours given to primary circuit.	Energy in watt-hours taken from secondary circuit.
11 × 151 = 1,661	11 × 0 = 0
5 × 767 = 3,835	5 × 600 = 3,000
4 × 919 = 3,676	4 × 750 = 3,000
3 × 1,674 = 5,022	3 × 1,500 = 4,500
1 × 4,680 = 4,680	1 × 4,500 = 4,500
Total = 18·874 B.T.U.	Total = 15·000 B.T.U.

Energy loss = difference = 3,874 units in 24 hours.
Iron all-day loss = 24 × 151 = 3·624 units.
Copper all-day loss = 0·250 ,,
Total loss = 3·874

All-day efficiency on this 10 per cent. load-factor $= \frac{15{\cdot}000}{18{\cdot}874} = 74{\cdot}2$ per cent.

Table II.—*All-Day Efficiency of 6,000-Watt Mordey Transformer on the same above 10 per cent. Load-Factor.*

The energy balance-sheet for the transformer on this load, as derived from the table is as follows :—

Energy in watt-hours given to primary circuit.	Energy in watt-hours taken from secondary circuit.
11 × 148 = 1,628	11 × 0 = 0
5 × 768 = 3,840	5 × 600 = 3,000
4 × 911 = 3,644	4 × 750 = 3,000
3 × 1,668 = 5,004	3 × 500 = 4,500
1 × 4,720 = 4,720	1 × 4,500 = 4,500
Total = 18·836 B.T.U.	Total = 15·000 B.T.U.

Energy loss = difference = 3·836 units in 24 hours.
Iron all-day loss = 24 × 148 = 3·552 units.
Copper all-day loss = 0·284 ,,
Total loss = 3·836 ,,

All-day efficiency on this 10 per cent load-factor $= \frac{15{\cdot}000}{18{\cdot}836} = 74{\cdot}3$ per cent.

Table III.

C^2R losses in the primary cable on the assumption that four 6,000-watt transformers are placed at the end of one mile run of double primary cable, each single cable having a copper section equal to 7/16 and a total go and return resistance of 4 ohms.

Primary pressure at transformer terminals = 2,400 volts. Total volts lost on primary cable at full load = 40, or under 2 per cent. Load diagram as in Tables I. and II.

A.—Four 6,000-Watt "Hedgehog" Transformers.

Energy loss in cable in watt-hours.
11 × (1·194 × 4)² × 4 = 1,003
5 × (1·228 × 4)² × 4 = 482
4 × (1·270 × 4)² × 4 = 413
3 × (1·410 × 4)² × 4 = 381
1 × (2·436 × 4)² × 4 = 380
Total = 2·659 B.T.U.

B.—Four 6,000-Watt Mordey Transformers.

Energy loss in cable in watt-hours.
11 × (0·076 × 4)² × 4 = 41
5 × (0·323 × 4)² × 4 = 33
4 × (0·387 × 4)² × 4 = 38
3 × (0·692 × 4)² × 4 = 92
1 × (1·980 × 4)² × 4 = 250
Total = 0·454 B.T.U.

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primary line, in the case of the four "Hedgehog" transformers, was 2·659 B.T.U., while in the case of the four closed-circuit transformers it was only 0·454 B.T.U.; the difference was therefore 2·205, and this was the difference which had to be supplied in order to reduce the losses in the line to the value which they would have with good closed-circuit transformers at the other end. There would also be a slight reduction in the case of the copper losses of the transformer, but as these together only amount to one-quarter of a unit in the 24 hours, they saw by a comparison of the figures that if the condenser dissipated 2·4 B.T.U., and the utmost amount that it could save on this 10 per cent. load diagram was something like 2·3 B.T.U., or rather less than 2·4 B.T.U., the addition of the condenser to the line was merely robbing Peter to pay Paul—it put on, on the whole, rather more than it took off from the energy balance-sheet—hence, although it was very easy to talk about adding condensers to save magnetising energy and copper losses in the line, unless an actual condenser could be produced which was absolutely free from dielectric hysteresis, it merely changed the place of the waste of energy. It was obvious that at less load-factors the condenser was a source of waste. It was perfectly clear, to his mind, that a condenser, therefore, did not necessarily effect the saving which Mr. Swinburne thought it did. Dr. Fleming then referred to Mr. Swinburne's criticism of his method of measuring the drop of the secondary volts, and of his explanation that the "Hedgehog" loss was due to eddy currents in the copper. There was one drastic remedy that Mr. Swinburne might apply without hesitation, and that was to return to the kind of "Hedgehog" transformer that was first devised by Mr. Cromwell Varley in 1856. Mr. Swinburne's "Hedgehog" transformer had its "Hedgehog" ends very little projecting beyond the coils. Mr. Varley made a transformer in 1856, in which he left the ends of the wires at both ends long enough to be folded back and joined together round the body of the transformer. By returning to Mr. Varley's type of transformer, and making a closed magnetic circuit, Mr. Swinburne would get rid at one blow of all his difficulties.

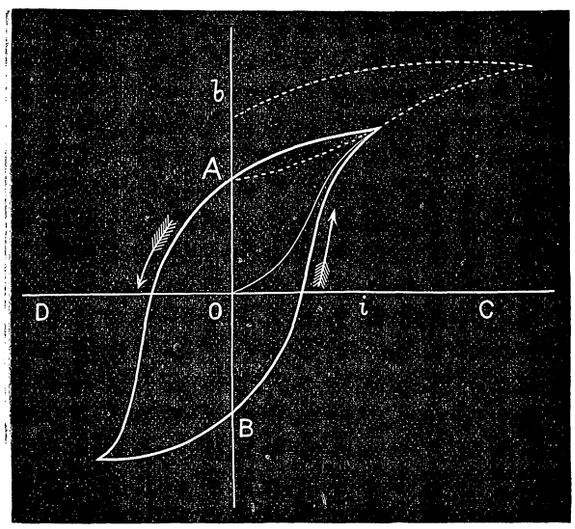

FIG. 1.

Coming to Prof. Forbes' remarks upon the importance of designing transformers especially for their work, he (Dr. Fleming) feared they had been too much urged to admire mere high efficiency at full load without regard to the nature of the work to be done. The advent of large schemes for power transmission would show the necessity of designing transformers specially with regard to their character of work, and of adopting probably a much lower frequency than was now employed in the majority of transformers used for electric lighting. In connection with the Westinghouse transformer, no one seemed to have called further attention to the fact which he had pointed out, that the core of the Westinghouse transformer tested by him was made of mild steel. He knew the great difficulties which manufacturers of transformers had to contend with in procuring identical qualities of iron on all occasions; and it seems to him that the only way out of that condition of things would be for some enterprising persons to turn their attention seriously to the production of electrolytic iron of definite chemical purity, and which could be made on the same manufacturing scale as electrolytic copper was at the present time. Referring to what Mr. Evershed had said in admiration of Prof. Ryan's work, yet that work left, said Dr. Fleming, many points still unsettled. The chief value of Prof. Ryan's work was in showing clearly the relative phases of the current and electromotive force in the actual working transformer, which, up to that time, had been entirely a matter of guesswork. It was, however, satisfactory to have touched the bottom at last, and to have established as a combined result of many workers' experiments, the fact that the iron losses in a transformer were, for all practical purposes, constant at all loads, and that the hysteresis losses were practically independent of the speed. Mr. Evershed concluded his remarks by expressing his regret that some of our live professors had not come in contact with a live transformer some years ago, and concludes by rejoicing over one who had done so at the eleventh hour. Perhaps it was only permissible to remind Mr. Evershed of the fact that the evolution of knowledge was to a large extent a matter of money. It often cost very little to propound a theory, it sometimes cost a good deal of money to arrive at a fact. It had become the fashion lately to cavil at the supposed tendency in scientific teachers to supply too much theory and too few facts. The manufacturers had the remedy largely in their own hands. Let them see that teachers who had the means and training to conduct experimental research were not starved in apparatus and the means of testing in practical work the theories they evolved. Some of the work of which Mr. Evershed had spoken in admiration was carried out by means of a complete alternator and transformer plant given by the Westinghouse Company to an American college. Could anyone point to an English college which had a similar gift made to it by an English firm? Moreover, they did not, however, find as a general rule that manufacturers were specially anxious to provide professors with results of experiments, by which alone they could test their theories. He was not saying that they ought to do so, because he was sufficiently in contact with practical work to know that manufacturers were not likely to give away the results of experiments, which may have cost them hundreds of pounds; but, at any rate, until they were prepared to do so, and to furnish their quota towards the progress of public information, it would, probably, only be bare justice for them to withhold destructive criticism on those who, at any rate, had furnished them freely with the best that they had at their disposal. Mr. Mordey had given the results of a number of exceedingly careful experiments, upon the sudden rush into transformers, which might occur at the moment of connecting them to the primary circuit.

He wished to correct a view which he put forward in the Paper that the rush into the transformer was an alternating rush. His present opinion was that the whole effect was over in less than one period. Without dogmatising at all on what might require further elucidation, the following suggestions had occurred to him as a possible explanation of the whole of the observed effects. If they considered a single magnetic cycle, which was being traversed in the direction of the arrows by the iron (Fig. 1), let them suppose that when the current finally ceased the magnetism left in the iron was represented by OA. When they closed the circuit and started the current again it must either begin to increase positively, that was towards OC, or negatively, that was towards OD. If the latter, the magnetic cycle was picked up at the point where it was left, and continued in the proper direction and the proper back electromotive force due

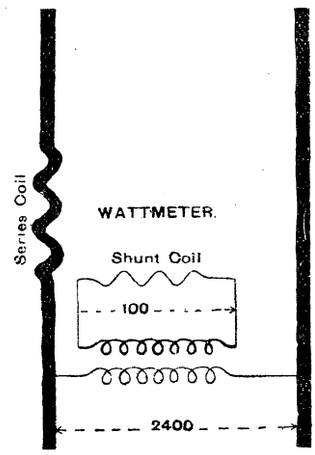

FIG. 2.

to rate of change of induction obtained at each instant. If, however, the current began again to increase positively, then the true permanent magnetic cycle was not picked up at once, but a loop shown by the dotted line was formed on the magnetic cycle curve. This loop started off at first nearly horizontally; in other words, the rate of change of induction with magnetising force, or $\frac{d\,B}{d\,i}$ was nearly or quite zero. Hence the back electromotive force of self-induction was nearly or quite zero, and there being nothing to keep back the current, it came in with a rush until the reversal of the electromotive force restored things to their normal state. If the current were broken slowly, so as to cause the magnetism of the iron to be entirely destroyed, then, on beginning again, they had to do as it were with virgin iron, and under those circumstances the value of the rate of change of induction with magnetising force, or $\frac{d\,B}{d\,i}$, was not zero. Hence there could be no very great rush.

Dr. Sumpner naturally put in a claim for his own method of testing transformers. As a matter of fact, it was not generally, outside a factory, most convenient to test transformers in pairs. He had recently modified his dynamometer method, and got rid of the large non-inductive resistance in the shunt coil, making use of a transformer instead to supply the current for the shunt coil of the wattmeter (*see* Fig. 2). For that purpose he placed a small tranformer across the primary mains, and connected the low-resistance shunt coil of the wattmeter through one incandescent lamp to the secondary terminals of the transformer. It was easily seen that since the secondary current in a transformer was in exact opposition as regards phase with the terminal primary electromotive force, this arrangement would give a current through the shunt coil of the wattmeter which was in synchronism with the primary impressed electromotive force. The arrangement did not involve nearly so much power expenditure as when non-inductive shunt resistances were employed as in the method described in the Paper. The really important point in Dr. Sumpner's speech was his investigation of the cause of error in the Swinburne wattmeter, and he

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(Dr. Fleming) did not think it possible to resist the logic of Dr. Sumpner's experiments and conclusions.

He now came to Mr. Crompton's remarks and those which fell from Mr. Wright. Some of Mr. Crompton's conclusions could not be allowed to pass without challenge. In some respects Mr. Wright was even a more formidable opponent than Mr. Crompton, for, if anybody in this world understood the design of transformers, and what they would do, it was Mr. Arthur Wright; and since he had also had wide experience in the practical management of low-pressure stations, his endorsement of Mr. Crompton's contention, that there was no room for an alternating current station inside of a radius of a mile and a quarter, was one which, if allowed to pass unmet, would leave the impression that the matter was beyond dispute. However, so far from there being no room for an alternating current station inside a radius of a mile and a quarter, it was simply a matter of fact that a low pressure feeder of a mile long supplying on the usual load-factor, cost more to lay down and cost more to maintain than the high pressure transformer feeder of the same capacity. That was the proposition that he proposed to maintain. He would assume that the load diagram of the supply was 10 per cent., that was to say, that it was a supply of the following nature: eleven hours no supply, five hours one-tenth of full supply, four hours one-eighth of full supply, three hours quarter of full supply, and one hour three-quarters of full supply. This diagram was equal to 2½ hours at full load, or to a load factor of very nearly 10 per cent. No one could assert that this load factor was an exceptional one. Having assumed this, he proposed to demonstrate that if they took two feeders, each of 24 kilowatts maximum capacity and a mile long, one a low pressure three-wire feeder supplying at the business end at 200 volts across the outer mains, and the other a high pressure feeder worked at 2,000 volts at the dynamo and supplying a 24 kilowatt transformer at the business end to reduce to 100 volts, that the high pressure feeder would cost a less annual sum to maintain than the low pressure feeder. He should take it that the cost of the unit generated at the dynamo terminals was the same in both cases. First let them consider the three-wire feeder. He had taken three cases as to the drop of pressure in that feeder, and in Table IV. had calculated out the diurnal losses in the feeder on the 10 per cent. diagram on the assumption of a 40 per cent. drop, a 30 per cent. drop, and a 20 per cent. drop respectively, the full load current in each outer main being 120 amperes, and the sizes of the mains required to give these drops being calculated from the maximum current. In case A (40 per cent. drop) the feeder loss in the 24 hours was 8·28 B.T.U., and the feeder delivery in the 24 hours was 60 B.T.U., or an all-day efficiency of 87 per cent. In Table V. he calculated the diurnal losses in the high-pressure feeder consisting of a mile of double 7/16 cable and a 24-kilowatt transformer, and on the assumptions made, the diurnal loss was 9 B.T.U. in the cable and transformer, and the delivery 60 B.T.U., or an all-day efficiency of 87 per cent. In Table VI. he had calculated in the same way the high-pressure feeder efficiency on the assumption that the single transformer was replaced by two 12-kilowatt transformers, and they would see from the table that the total loss in the transformer and cable on the 10 per cent. load diagram was 8·049 B.T.U., or an all-day efficiency of 88 per cent. Accordingly, at the distance of one mile on this load diagram, a transformer feeder of the kind supposed was equivalent, as far as regards energy losses, to the low-pressure feeder and both of them might be taken to waste 8 units per day in delivering 60 units on the 10 per cent. load diagram. The next thing that remained to be done was to estimate the relative capital outlay on the two feeders, and to fix figures for depreciation and interest. In doing this, he had not relied on his own estimates, but he had gone to responsible people and asked them to furnish him with figures at which they would be prepared to carry out the work of laying the respective feeders. The specification for the high pressure feeders was as follows: The primary cable to be concentric, each conductor having a section equal to 7/16, the resistance of the go and return, namely, 2 miles, being 4 ohms. Vulcanised india rubber to be used as insulation, taped and braided cable to be drawn into a wrought iron pipe, provided with 20 draw-boxes—a pit at the business end for the transformer, which was to be a 24-kilowatt transformer with a loss on open circuit of 1·35 per cent., and a loss on full load of 3 per cent., which gave an efficiency of 86 per cent. at 1/10th full load, and 96 per cent. at full load. The estimate for that work complete, laid in the ground, but exclusive of the cost of opening and making good the road, was £465. For the low-pressure feeder the specification was as follows: Low pressure feeder to consist of three cables, each one mile in length, respectively 37/16, 19/15, and 37/16, giving a drop of 40 per cent., when 120 amperes were flowing, and when 200 volts were maintained at the business end between the outer cables. The cables to consist of Callender's bitumen lead-covered and steel-armoured cable, laid in the ground direct. Total cost of laying one mile of three-wire feeder exclusive of cost of opening and making good the road, £925. He had checked the figures and compared them with those-

Table IV.—*All-Day Efficiency of Three-Wire Feeder one mile long, giving a maximum supply of 24 kilowatts at 200 volts constant pressure at the business end.*

Let the diurnal load diagram be as above, viz.:—

11 hours no supply
5 „ 1-10th full load
4 „ 1-8th „ „
3 „ 1-4th „ „
1 „ 3-4th „ „
} = 10 per cent. load-factor.

Case A.—40 per cent. drop at full load. Full current = 120 amperes in each main; resistance of each outer main = 0·33 ohm; cables, 37/16, 19/15, 37/16.

Feeder Loss in Watt-Hours.	Feeder Delivery in Watt-Hours.
$11 \times 0 \times \frac{2}{3} = 0$	
$5 \times (12)^2 \times \frac{2}{3} = 480$	$5 \times 12 \times 200 = 12{,}000$
$4 \times (15)^2 \times \frac{2}{3} = 600$	$4 \times 15 \times 200 = 12{,}000$
$3 \times (30)^2 \times \frac{2}{3} = 1{,}800$	$3 \times 30 \times 200 = 18{,}000$
$1 \times (90)^2 \times \frac{2}{3} = 5{,}400$	$1 \times 90 \times 200 = 18{,}000$
Total = 8·28 B.T.U.	Total = 60·000 B.T.U.

$$\text{All-day efficiency} = \frac{60}{68{\cdot}28} = \text{per cent.}$$

Case B.—30 per cent. drop at full load. Full current = 120 amperes in each main; resistance of each outer main = 0·25 ohm; cables, 37/14, 19/14, 37/14.

Feeder loss in watt-hours.	Feeder delivery in watt-hours.
$11 \times 0 \times \frac{1}{2} = 0$	
$5 \times (12)^2 \times \frac{1}{2} = 360$	$5 \times 12 \times 200 = 12{,}000$
$4 \times (15)^2 \times \frac{1}{2} = 450$	$4 \times 15 \times 200 = 12{,}000$
$3 \times (30)^2 \times \frac{1}{2} = 1{,}350$	$3 \times 30 \times 200 = 18{,}000$
$1 \times (90)^2 \times \frac{1}{2} = 4{,}050$	$1 \times 90 \times 200 = 18{,}000$
Total = 6·310 B.T.U.	Total = 60·000 B.T.U.

$$\text{All-day efficiency} = \frac{60}{66{\cdot}31} = 90 \text{ per cent.}$$

Case C.—20 per cent. drop at full load. Resistance of each outer main = 0·165 ohm; cables, 37/13, 19/13, 37/13.

Feeder loss in watt-hours.	Feeder delivery in watt-hours.
$11 \times 0 \times \frac{1}{3} = 0$	
$5 \times (12)^2 \times \frac{1}{3} = 240$	$5 \times 12 \times 200 = 12{,}000$
$4 \times (15)^2 \times \frac{1}{3} = 300$	$4 \times 15 \times 200 = 12{,}000$
$3 \times (30)^2 \times \frac{1}{3} = 900$	$3 \times 30 \times 200 = 18{,}000$
$1 \times (90)^2 \times \frac{1}{3} = 2{,}700$	$1 \times 90 \times 200 = 18{,}000$
Total = 4·14 B.T.U.	Total = 60·000 B.T.U.

$$\text{All-day efficiency} = \frac{60}{64{\cdot}14} = 93 \text{ per cent.}$$

Table V.—*All-day efficiency of 24-kilowatt transformer on 10 per cent. load diagram, and losses in double 7/16 primary cable one mile long feeding the same.*

Let the transformer have 1·35 per cent. loss on open secondary circuit, and 1·35 + 1·60 per cent. loss at full load. This gives an open-circuit loss of 324 watts, and an efficiency of 86 per cent. at one-tenth full load, and 96 per cent. at full load.

The energy balance-sheet for the transformer on the above load diagram is:—

Energy in watt-hours given to primary circuit.	Energy in watt-hours taken from secondary circuit.
11 × 324 = 3,564	11 × 0 = 0
5 × 2,762 = 13,810	5 × 2,400 = 12,000
4 × 3,372 = 13,488	4 × 3,000 = 12,000
3 × 6,420 = 19,260	3 × 6,000 = 18,000
1 × 18,612 = 18,612	1 × 18,000 = 18,000
Total = 68·734 B.T.U.	Total = 60·000 B.T.U.

The primary cable losses ($C^2 R$) on same load in watt-hours are—

$11 \times 4 \times (\frac{1}{8})^2 =$	1
$5 \times 4 \times (1)^2 =$	20
$4 \times 4 \times (1\frac{1}{4})^2 =$	25
$3 \times 4 \times (2\frac{1}{2})^2 =$	75
$1 \times 4 \times (7\frac{1}{2})^2 =$	225
Total = 0·346 B.T.U.	

Total loss in 24 hours in cable and transformer = 8·734 + 0·346 = 9·08 B.T.U.

All-day efficiency = 87 per cent.

Table VI.—*All-Day Efficiency of Pair of 12-Kilowatt Transformers on a 10 per cent. Load Diagram, and also Energy Losses in a Double 7/16 Primary Cable one mile long feeding the same.*

The energy balance-sheet of the transformers (Ferranti), as taken from tables of observation, is as follows:—

Energy in watt-hours given to primary circuit.	Energy in watt-hours taken from secondary circuit.
11 × 2 × 149 = 3,278	11 × 2 × 0 = 0
5 × 2 × 1,189 = 11,890	5 × 2 × 1,055 = 10,350
4 × 2 × 1,580 = 12,640	4 × 2 × 1,422 = 11,376
3 × 2 × 3,064 = 18,384	3 × 2 × 2,903 = 17,418
1 × 2 × 8,932 = 17,864	1 × 2 × 8,614 = 17,228
Total = 64·056 B.T.U.	Total = 56·372 B.T.U.

The primary cable losses ($C^2 R$) on the same load in watt-hours are—

$11 \times (0{\cdot}076 \times 2)^2 \times 4 =$	1
$5 \times (0{\cdot}503 \times 2)^2 \times 4 =$	20
$4 \times (0{\cdot}675 \times 2)^2 \times 4 =$	29
$3 \times (1{\cdot}265 \times 2)^2 \times 4 =$	77
$1 \times (3{\cdot}713 \times 2)^2 \times 4 =$	237
Total = 0·364 B.T.U.	

Total loss in 24 hours in cable and transformers = 7·684 + 0·364 = 8·048 B.T.U.

All-day efficiency = 88 per cent.

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of a number of other makes of cables and transformers. He would, therefore, take it as a perfectly certain fact that the cost of the low-pressure feeder, apart from the opening and making good of the ground, would cost £1,000 per mile; that the transformer feeder would cost not far from £500, £400 for cable and £100 for transformer and pit. They then had to compare the annual expenditure on the two feeders respectively; assuming that the 10 per cent. diagram represented the every-day diagram throughout the year. Since the loss on both cases was the same, namely, 8 units per diem; if they took the manufacturing cost of the unit as 3d., it would give a total annual cost for power wasted in the two cases of £36. 10s. To this must be added 5 per cent. on the capital outlay for interest, which, taking the capital outlay on the low-pressure feeder as £1,000, and the capital outlay on the transformer feeder as £500, amounting respectively to £50 and £25. The next question was the depreciation to be placed respectively against the several items. Here they would find great differences of opinion. He would take the depreciation on the transformer at 15 per cent., at which he knew many makers of transformers would exclaim, as putting the transformer on an equality with a secondary battery. Placing, then, the cost of the transformer at £100, this amounted to £15. On the high-pressure cable he would take a depreciation of 5 per cent. on £400, making £20 per annum. On the low-pressure cable he would take the depreciation at the exceedingly moderate amount of 2½ per cent. No doubt manufacturers of high-pressure cables would consider that he was doing them an injustice, but he wished to put his case first in a manner which would render it impossible for the supporters of low pressure to refute it. They then had the following comparative annual costs :—

	Low-pressure feeder.	High-pressure feeder.
Annual cost of energy wasted in both cases at 3d. per unit	£36 10 0	£36 10 0
Interest on capital outlay at 5 per cent	50 0 0	25 0 0
Depreciation, 2½ per cent. on the low-pressure feeder	25 0 0	— — —
Five per cent. on the high-pressure feeder	— — —	20 0 0
Fifteen per cent. on transformer	— — —	15 0 0
Total	£111 10 0	£96 10 0

As long as they kept within the limits of practical experience, they would find it to be demonstrated without possibility of refutation, that the annual cost of the high-pressure feeder of one mile in length, delivering 24 kilowatts as a maxium load, was considerably less than the annual cost of maintenance of the low-pressure feeder, and in particular, that the capital outlay for the low pressure feeder was about double that of the high-pressure feeder. Taking lower percentage voltage drops the case became decidedly favourable to high-pressure. The figures, which he had endeavoured in every way to subject to test, did not in the least degree confirm the statements of Mr. Wright and Mr. Crompton, that there was no room inside a radius of a mile and a quarter for an alternating current station; on the other hand, they showed most decidedly that there was no room outside a radius of one mile for a continuous current station. His firm conclusion was that the economical radius of supply by three wire direct current systems was reached at distances when the feeders had an average length of somewhat less than one mile with load diagrams of 10 per cent. The case became much more unfavourable to the low pressure supply, if they supposed the load diagram to improve, they did not build stations with the object or hope of remaining permanently with load factors of 10 per cent. No one was making greater efforts than Mr. Crompton to increase those abnormally low load-factors. The result of improving the load-factor must, therefore, be to diminish the efficiency of the low-pressure feeder. This was clearly obvious, because, if the load-factor rose to 100 per cent., the efficiency of the feeder with the 40 per cent. drop would only become something like 70 per cent., and this was the limit towards which the efficiency or distribution of the low-pressure system tended, as the load-factors were progressively increased when secondary batteries were not used. Who was to say what it fell to when secondary batteries (whatever their additional advantages) were employed? On the other hand, it was a matter of simple demonstration that, in proportion as the load-factors increased, the efficiency of distribution of the high-pressure feeder must tend as a limit towards 95 per cent.—2 per cent. being the drop in the line, and 3 per cent. the loss in the transformer. In all the above he had altogether left out of account the capital outlay on the generating plant. To supply a maximum of 100 kilowatts at the business end of a high-pressure feeder they had only to put down a generating plant capable of supplying, at the maximum, 105 kilowatts at the dynamo end, because the losses at full load were only 5 per cent.; but if, with a low-pressure feeder to do the same work, they had to put down generating plant with a capacity of 140 kilowatts as its maximum output, because the maximum waste of 40 per cent. occurred in the low-pressure feeder at the very hour of maximum demand at the business end. That, of course, very seriously affected not only the whole capital outlay in generating plant, but the whole annual cost of the system and opened up a view of the case which must not be lost sight of in considering all these questions. In fact, the enthusiastic advocates of low-pressure working had done their utmost to draw the attention of the world to the losses occurring in transformers, but they had judiciously kept exceedingly silent on the equally important matter of the losses in low-pressure feeders. With regard to Prof. Kennedy's interesting remarks, it was impossible to deny that the system of house transformers was one in which the all-day losses were exceedingly large, butnone of them who at any time advocated alternating current systems had ever looked upon that house-to-house system as anything more than necessary in initial stages of supply. Where the alternating current stations had been, or were being, laid out with knowledge and skill and experience from the beginning, nothing but a system of transformer feeders and low-pressure secondary networks was being adopted, and when they came to collate the results of sufficient experience of the working of that system with the results of working of low-pressure systems there was no reason to believe that the balance of advantage would be found on the side of the continuous current system. There was one other point, and that was that even when they were dealing with the same percentage load-factor, there might be a great difference between the efficiency of distribution by a feeder when the diagram-form altered in shape, even if it still included the same area. Let them consider a load-diagram of the following kind :—Nine hours at no load, eight hours at one-eighth of full load, three hours at one-fourth of full load, two hours at one-half of full load, and two hours at three-fourths of full load. That was equivalent in area to 4¼ hours at full load or to an 18 per cent. load-factor. If they took the low-pressure three-wire feeder in the case A, and calculated the feeder loss and feeder delivery in 24 hours, they would find them to be 18·6 units and 102 units respectively on this 18 per cent. diagram, or a feeder efficiency of 84·5 per cent. If, however, they took the same percentage load-factor and considered it as made up by 4¼ hours at full load and 19¾ hours at no load then, on calculating the feeder loss and feeder delivery they would find them to be 40·8 units and 102 units. Hence with the same percentage load-factor the efficiency of distribution had fallen to 70 per cent. On the contrary a transformer feeder would have benefited in efficiency by the concentration of the load. One of the most remarkable qualities of a low-pressure feeder was the degree to which a very moderate duration of full load depressed the efficiency of distribution. If, however, they considered the alternating current feeder the above facts were conversely illustrated. The higher or more concentrated the load-factor the better the efficiency of distribution.

Lord Bacon said that "truth emerges more easily from error than from confusion," and if the outcome of his work and the discussion which had taken place on it was in any degree helpful in furthering their knowledge of the subject of transformer working, and dispelling illusions or confusions with which it might be surrounded it would not prove a disadvantage for them to have so fully discussed the Paper they had done him the honour to receive.

THE BRISTOL LAMPS AND BATTERIES.

Some time ago the London General Omnibus Company decided to try the experiment of introducing electric lamps into the leading routes of omnibuses owned by them, and, after negotiations, entered into an arrangement with the Bristol Electric Safety Lamp Works to supply 140 omnibuses with small incandescent lamps worked by their patent battery. Fig. 1 shows lamp and battery and contact plates, and Fig. 2 shows the interior of an omnibus and the position of the battery and lamp with connections.

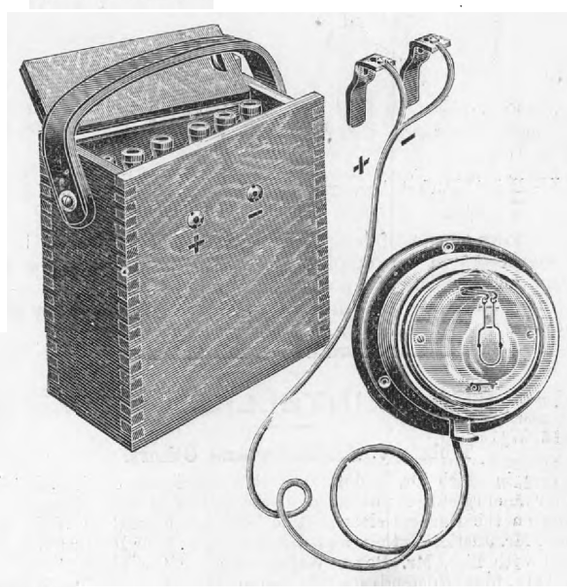

FIG. 1.—The Bristol Lamp and Battery.

The battery selected for this service weighs about 8lb., and is placed as shown in a wooden box under one of the seats. The box is provided with two brass spring terminals, which make automatic contact with the battery when it is let down into the box. The lamp is of a special design, and is made as shallow as possible, to allow of its being placed in the centre of the roof, it being found that this arrangement distributes the light most satisfactorily all over the carriage. The lamp design is covered by Mr. L. Bristöl's patents, and offers great advantages for omnibus work, since breakage of filaments from the shaking of the carriages is avoided. Ordinary bottom loop lamps are used, and two wire hooks, which expand sideways, clasp these loops firmly. A wire spring, which catches the top of the incandescent lamp, forces it against the wire hooks and increases the clutch of the hooks.

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The batteries are charged at Victoria, seven in series, from the Westminster Electric Supply Corporation's mains, small incandescent lamps being used as resistances. The batteries have, we understand, stood the test in a very satisfactory way, and the severe shaking to which they are necessarily subjected while in use has had no effect upon the plates.

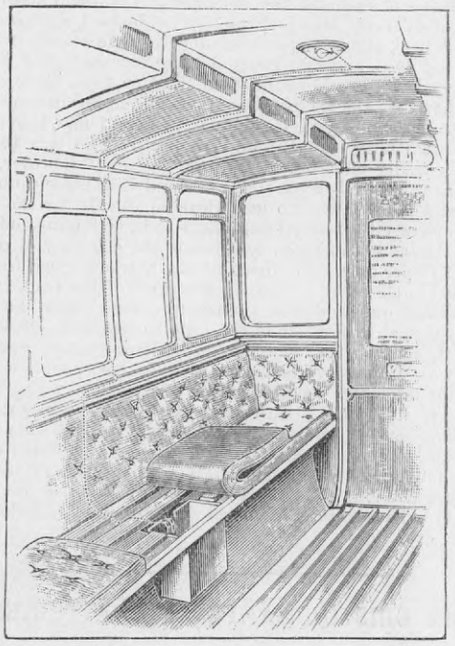

FIG. 2.—Interior of Omnibus, showing Lamp, Battery and Connections.

The installation has been very successful, the only difficulty experienced being to get time enough to charge the batteries for the whole night's run, as the lamps are delivered between the hours of 9 and 12 a.m., and the serving out commences about half-past 2, but a sufficient number of spare batteries now provided will overcome this difficulty.

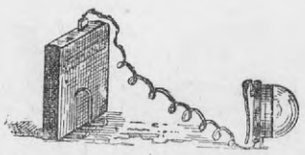

FIG. 3.—Bristöl Pocket Accumulator and Button-hole Reading Lamp.

Fig. 3 shows a type of lamp and battery which is used by the ticket inspectors in the employ of the London General Omnibus Company, and consists of a pocket accumulator and a button-hole lamp. This lamp has been in use for the past year, and has given satisfaction.

LEGAL INTELLIGENCE.

Tibbits v. Alabaster and Others.

This case, in which Dr. Tibbits sues the proprietors of the *Electrical Review* for an alleged libel published in the course of some comments on his report on the Harness electropathic belt, was opened on Wednesday last before Mr. Justice Mathew and a special jury. Sir Richard Webster, Q.C., and with him, Mr. Roger Wallace, was for the plaintiff, and Mr. Walton, Q.C., for the defendants. In opening the case Sir Richard Webster read the alleged libel, which attributed ignorance of electrical laws to the plaintiff, and suggested that the report he made on Harness's belts called for action on the part of the medical authorities. The plaintiff gave evidence to the effect that the report was an honest one, made after a careful testing of the belts, and said that they would generate electricity. A number of scientific and medical witnesses, who had also tested the belts, expressed the view that the belts generated electricity, and that the current would pass through the body of the wearer. All the witnesses in cross-examination admitted that if the two poles of the belts were not coupled, there would be no current. At this stage the Court adjourned until Thursday.

On Thursday morning Mr. Walton, Q.C., opened the case for the defendants, and called evidence, both electrical and medical, including Lord Kelvin, to show that the belts when unconnected would not produce a current, and that when connected the current was so small as to be almost inappreciable. In summing up the case for the defendants, Mr. Walton held that the article was a fair comment, and that his evidence had shown that competent men drew from the pamphlet the inference that the writer knew little of electricity. He appealed to the jury not to give Mr. Harness, who put Dr. Tibbits forward, an advertisement by their verdict. The Court then adjourned until to-day. A fuller report of these proceedings will appear in our next issue.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Feb.* 3, 1893.

The Incandescent Lamp Question.—The electric lamp situation continues to be the absorbing topic in electrical circles. In conformance with the ruling of the Court, as announced in a previous letter, both the complainants and the defendants in the suit of the General Electric Company *v.* The Beacon Vacuum Pump and Electric Company, presented on Wednesday last their printed arguments. In addition to this the defence asked leave to introduce new evidence. Mr. Fish, counsel for the plaintiff company, appeared to oppose the introduction of this new evidence, and the question was argued in Chambers before Judge Colt. The result of this argument was that the judge decided to admit the new evidence presented, which seems to be another point gained by the defence. On the part of the latter the chief additional evidence was another exhibit of a Goebel lamp, which has platinum leading-in wires. Additional affidavits were also presented on both sides, and the case, as now in hand, has been taken into consideration. The Westinghouse Company seems to be the only organisation in this country who will not be affected in one way or another whatever the outcome of this present suit. They claim that their new separable lamp leaves them really master of the situation, and profess to be entirely unconcerned as to the result. The feeling among the outside manufacturers, who are accused of infringing the Edison patents, seems to be one of growing confidence; while they will not say that they expect an injunction will be denied in this action, still they feel that every moment of time gained strengthens their side of the case and think that they will be able eventually to procure evidence sufficiently strong to enable them to continue the manufacture of lamps.

Referring again to the lamp situation, the Chicago Edison Company, the local licensee for the sale of Edison lamps, having declined to sell lamps to parties not using the General Electric Company's machinery, the National Electric Construction Company brought the matter to the notice of the Courts that it had been unable to procure lamps for its circuits. The trial consumed the greater portion of last week, and resulted in the judge ruling that the Chicago Edison Company, as the agent of the General Electric Company, would be obliged to furnish the National Electric Construction Company with all the lamps necessary to supply its customers, and at a price not to exceed 42 cents. per lamp. This is the only relief thus far granted to outside companies against what now appears to be the declared policy of the General Electric Company of closing up all competitors, or forcing them to use their machinery. But since the General Electric Company are unable to supply the whole demand for lamps, it will be seen that this relief will be totally inadequate if the policy is continued to the end.

The Green Trolley Patent.—Another feature in the electrical field has been brought into prominence during the past week by the reported sale of the Green trolley patents to the General Electric Company. It seems that Geo. F. Green, of Kalamazoo, Michigan, received two patents, Nos. 465,407 and 465,432, on December 15, 1891, which are claimed to be fundamental, covering the use of the trolley for electric street car propulsion. These patents were originally filed September 15, 1879; being somewhat indefinitely stated, it appears possible to interpret them as covering the whole field. The application as originally filed was promptly rejected, such action being taken on September 20, 1879. In August, 1881, a substitute set of drawings, including five new figures, were filed, but these new features were afterwards struck out. Again substitute specifications

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and drawings were filed, and after various amendments had been insisted upon, the Patent Office wrote to Green as follows: "The amendment filed January 2, 1882, overcomes the objections urged, but future action in the case will be suspended until after the determination of a pending interference involving the invention claimed by an applicant, when a new interference will be declared between this application and that of the successful party." As a result of this suspension of his case, Green's application lay dormant in the Patent Office until the spring of 1885, when the interference referred to in the letter, between Stephen D. Field, E. Werner Siemens, and Thomas A. Edison was decided in favour of the first-named. Meanwhile, other applications besides Green's were waiting to be put in interference with the successful party, and when Field, unable to get his patent, in spite of his victory over Siemens and Edison, petitioned the Commissioner that the Examiner be directed to send his application to issue, the Chief Examiner entertained the petition with permission to Green and the other interested parties to be heard. On this occasion Green formally requested that Field's patent be denied, and after much interchange of letters between the Patent Office and the applicant, the latter had remodelled his claims very materially. Green's attorneys then carried his case to the Supreme Court of the District of Columbia, where a decision was given in favour of the majority of Green's claims, and the Patent Office was forced to pass the case and to issue the patents, as it did in December, 1891. Should the patents of Green be upheld by the Courts of Last Resort, the General Electric Company will be in the same position in regard to electric railways employing the trolley as it is now *de jure* in regard to the incandescent lamp. What with the incandescent lamp litigation and that which may result from the Green patents, and from the claims of Dr. Wellington Adams, of St. Louis, who claims fundamental patents on the suspension of motors beneath the car body, the electrical industry is certainly in an unfortunate situation in this country.

CORRESPONDENCE.

MR. JUSTICE KEKEWICH'S JUDGMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the Author's preface in chapter lxiii. of "Tristram Shandy," there occurs the following:—

"But in answer to this, Didius, the great . . . lawyer, doth maintain, and make fully appear that an illustration is no argument; nor do I maintain the wiping of a looking-glass clean to be a syllogism; but you all, may it please your worships, see the better for it; so that the main good these things do, is only to clarify the understanding previous to the application of the argument itself, in order to free it from any little motes, or specks of opacular matter, which if left swimming therein might hinder a conception and spoil all."

There was once upon a time a common, a real common, with public rights of way, and pasturage, etc., for the common advantage of the whole community, and no two individual commoners could in any way pretend to apply any principle "on the basis of their being absolute owners" of it.

Among the more important of the animals recently introduced and nurtured for its profit by this community, there were two, which while differing widely in all other qualities and adjuncts, had this in common, that they were both graminivorous—one of these was a sort of cart horse, but bigger; the other was a sort of carrier-pigeon, but much smaller. Now the pigeons being delicate fastidious little beasts, it was soon noticed that their stomachs were upset by the cart horses, who were decidedly coarse feeders; and besides they sometimes got "the jumps" from fright at seeing the cart horses so close. So the pigeon farmers said to the carters, "Go and take your big brutes away, they are spoiling the grass for our pigeons."

"Why no," said the carters, "we have as much right to the common as you have, and it is not only our big cart horses which they complain of, but that herd of bright bays; and even eating the same grass with their own bigger cousins, the real carrier pigeons, seems to disagree with them. It is you who should keep *them* to *themselves*; and besides our cart horses at most stray a little way on either side of our beaten tracks." "Your beaten tracks," screamed the little pigeons, "we have as much right to the roads as you have."

"Why, no," said the carters, "the roads are for traffic and draught, which we do; that is their *raison d'être*, and if you find the noises disturb your nerves it is not a hardship to you to avoid them; but if you must come, provide perches where wanted, which will keep you quite secure." "Perches be hanged!" said the carriers, "we will force you to fence your big brutes in, and then only we shall feel secure."

"Be reasonable," said the carters, "the little bit of the common you want for yourselves is one billion times less* than what we should have to fence, and even if we did, the complication of gates and drawbridges would so greatly interfere with our doing the cartage for the community as to practically stop it."

But the pigeon farmers would not listen to reason.—Yours, &c., FRANK WYNNE.

13, Ashley Gardens, S.W., Feb. 14, 1893.

A METHOD OF MEASURING DYNAMO EFFICIENCY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following method of testing the efficiency of dynamos I venture to send to you, as, from its simplicity, it may prove of use where other methods are not applicable.

The electrical power produced is found in the usual way by the formula E C. To find the mechanical power supplied the formula $\frac{1}{2} I 4 \pi^2 n^2$ is made use of where I = moment of inertia of the armature V N = revolutions per minute. If the driving power be suddenly cut off whilst the dynamo is running the rate at which the speed begins to diminish will be some function of the power the dynamo was absorbing. The dynamo is therefore run at a maximum speed, and the ratio at which speed diminishes is ascertained (by a speed counter and timepiece) for different velocities of rotation. A curve may be then plotted, showing the relation of rate of change of speed for any given speed. Hence $4 \pi^2 I n \times$ (rate of change of speed) will measure the power absorbed by the dynamo at speed "n."

It remains to find the moment of inertia of the armature. It will probably be impossible to get this by calculation, but it may be found by experiment. A disc flywheel may be attached to the armature, and the rate of loss of speed (when the power is cut off) compared with that of armature without flywheel. If the moment of inertia of the flywheel is known, then that of the armature may be calculated.

Variations of this method might be used to find the separate losses of power occurring in the various parts of the dynamo, if a current to excite the field-magnets or armature separately were available.

To obtain, however, the commercial efficiency of a dynamo by the above method, good time and speed measurers are the only requisites.—Yours, &c., J. R. A.

February 8, 1893.

[The experiment described by our correspondent is interesting, but it can hardly be relied upon for measuring the efficiency of a dynamo.—ED. *E.*]

"THAT BLESSED WORD, 'INSTALLATION'"!

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You struck a sympathetic chord in my heart lately, and I wish you every success in your crusade against that "affected and pompous term." I have not used it for years. A householder *puts in* gas, or *lays on* water, or *fits* electric bells, or *runs* telephone wires, and *fixes* instruments; but when

* Professor P. G. Tait has calculated that the current which works the telephone is about a thousand million times less than the current used in ordinary telegraphic work.—FLEEMING JENKIN.

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it comes to lighting the place he chokes himself! Can you help me to put down "accumulators"? I mean the word—not the cells themselves.—Yours, &c., W. H. MASSEY.

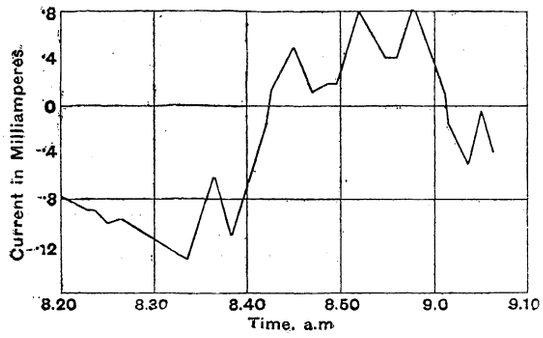
Twyford, R.S.O., Berks, February 12, 1893.

EARTH CURRENT DISTURBANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On the morning of the 5th inst., I observed on the Java-Australian cables an earth current disturbance, the nature of which may be seen from the accompanying diagram. Though the disturbance, as observed here, is not great, it may, however, be of interest when compared with particulars from other localities, should the disturbance have extended over a considerable area, as in the case of the two last magnetic storms recorded by you.

In testing by direct deflection the insulation resistance of one of the cables, I had what is probably a unique experience in cable insulation testing. The battery, consisting of 10 Higgins cells, was well insulated. The deflection was so unsteady with zinc current to line as to render the test worthless; with the copper current to line the deflection was still more unsteady, and after the current had been on for four minutes it was overcome by a current from the cable



Earth Current Disturbance observed on the Java-Australian Cables during morning, December 5, 1892. The Current is considered Positive or Negative as the Direction is Incoming or Outgoing with reference to this Station; and based on the Direction of a Positive Current from Battery through the Galvanometer. C.R. of Cable = 12,300 ω.

which gave a large deflection on the other side of zero. I then had the distant end of the cable earthed and observed the earth current for some time. The greatest strength of earth current observed coincides with that obtained here during the disturbances of May and July, and is from five to six times the normal earth current at that hour. I am unable to say how long the disturbance continued, as, the cable being required for other purposes, observations came to an end. One point I have noticed in these disturbances may have been observed by some of your readers, viz., that the rise and fall of current strength partake of the nature of a succession of impulses of variable period, occupying in this case about five minutes on an average.—Yours, &c.,

J. KENNEDY GIBSON.

Eastern Extension Telegraph Company,
Port Darwin, South Australia, December 14, 1892.

USEFUL FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following rules are easy to remember and apply:—

(1.) To reduce centimetres to inches:—Multiply by ·4, and *deduct* 1in. in 5ft. from the result.

Note.—This rule gives 999·047in. in place of 1,000in.: *i.e.*, the error is 1in. in 1,000in., or in 83⅓ft., or in 28 yards, *in defect*: therefore, *add* 1in. in 1,000in.

(2.) To reduce metres to yards:—Add one-tenth; deduct one-tenth (*i.e.*, of the correction); add one-third (*i.e.*, of the last correction.)

Note.—This rule gives an error of 1·06 yards in 4,000 yards, *in defect*: therefore, *add* 1 yard in 4,000 yards.

(3.) To reduce kilometres to miles:—Multiply by ·6, and *add* 1 mile in 30 miles to the result.

Note.—This rule gives an error of 2·215 miles in 1,000 miles, *in defect*: therefore, *add* 2 miles in 1,000 miles.—Yours, &c., J. W. SHARPE.

Woodroffe, Bournemouth, February 11, 1893.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following is a simple rule for ascertaining velocities in miles per hour:—

Take any convenient distance in yards, and take the time required to traverse that distance in seconds.

Then $\frac{\text{yards} \times 2}{\text{seconds}}$ = miles per hour nearly.

To be more exact add $\frac{1}{40}$

Thus, 440 yards traversed in 15 seconds

$= \frac{440 \times 2}{15} =$ 58·66 miles per hour.

add $\frac{1}{40}$ 1·46

60·12 the true value being 60.

Again, say 20 yards traversed in 5 seconds;

then $\frac{20 \times 2}{5} = 8$ miles per hour approximately.

In most cases it is unnecessary to add the one-fortieth, because the error of observation would probably exceed that amount.—Yours, &c., HENRY LEA.

38, Bennett's-hill, Birmingham,
February 10, 1893.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—I hasten to make a correction in my letter of the 8th. For "sectional area in inches" please read "diameter (in inches) squared." So that the weight of water (in pounds) contained in one yard run of any pipe may be represented roughly by the diameter (in inches) squared, or, more accurately, by the diameter squared × 1·02.—Yours, &c.,

N. G. THOMPSON.

PRICE OF ELECTRIC SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I hasten to point out that owing apparently to the awkward composition of the circular I sent you, you have fallen into a rather serious error by assuming that the basis of the reduction is on the number of lamps fixed, whereas the reduced charge comes in after *the maximum number of lamps used at one time* have been burning for two hours.

The distinction between this and the circular, as you understood it, will be obvious when you consider the case of private houses and hotels.

I agree with you that any consumer who uses the light between sunset and 8 p.m. only, will not derive any benefit from the reduction. These, however, are the most expensive customers to supply.

Your remark that the St. James' and Pall Mall Companies' revenue per lamp was 13s. 11d., evidently applies to the number of lamps fixed.

We find that about 22 per cent. of our clients will be benefited, more or less, by the reduced charge.—Yours, &c.,

ARTHUR WRIGHT.

The Brighton Corporation Electricity Works,
February 15, 1893.

BOOKS, &c., RECEIVED.

"The Local Government Annual." 1893. (London: *The Local Government Journal* Office.) Crown 8vo. Price 1s. 6d.

"University College (Nottingham) Calendar. 1892-3." (Nottingham: John Sands.)

"Professional Papers of the Corps of Royal Engineers." Edited by Captain W. A. Gale, R.E. (Chatham: Royal Engineers Institute.)

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This useful book contains over 1,000 pages, and several new and handy features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

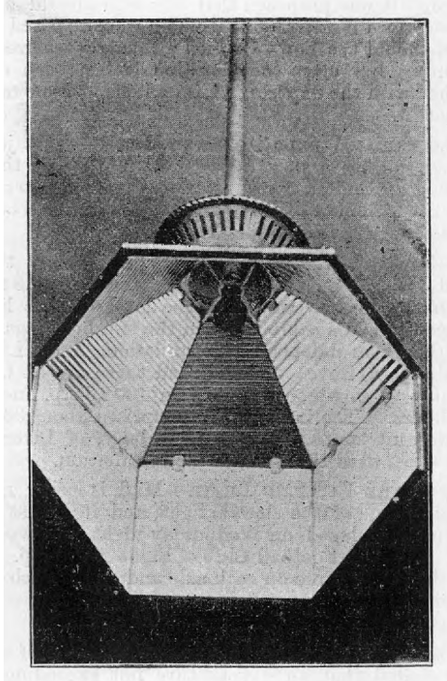
TENDERS ACCEPTED.—The tender of Messrs. J. Allen and Son has been accepted for the ornamental cast-iron electric light lamp-posts for the Promenade at Blackpool, subject to a sample post being approved by a Lighting Committee of the Town Council.

SALE BY AUCTION.—Messrs. Wheatley Kirk, Price, and Goulty announce in our advertisement columns that they will sell by auction, early in March, the entire contents of the Plashet Hall Works, Forest Gate, E., comprising six electric motor tram cars, dynamos, engines, machine tools, electrical fittings, &c.

APPOINTMENT.—Mr. T. P. Wilmshurst, electrician-in-charge of the Exeter Electric Light Company (Limited), has been appointed electrical engineer to the Halifax Corporation.

PRESENTATION.—Mr. James Brown, general foreman in connection with Messrs. Julius Sax and Co.'s electric installation at the Smithfield Markets, has been presented by the men working under him with a chronograph watch bearing a suitable inscription.

MESSRS. J. F. CLARKE AND SONS (MOORGATE-STREET, E.C.).—This firm have recently manufactured for Messrs. Julius Sax and Co. (who have the contract for the electric lighting of the Smithfield Markets for the Corporation of London) a number



of lamps and fittings from special designs for use in lighting the market shops and avenues. Messrs. Sax and Co. are joint owners with Messrs. Clarke and Sons of these registered designs, of which the latter are the sole manufacturers. The lamps are provided with fluted glass reflectors. The illustration shows the interior view of one of the designs used for shop lighting, which have proved eminently satisfactory. We understand that in order to give a mellow tint to the light, the reflectors are in some cases gilded instead of silvered.

MESSRS. A. MACLEOD AND COMPANY.—This firm have recently supplied the fittings for the extensive installation of the electric light of Messrs. Hunter and Company's large premises at Well Gate, Dundee, the installation includes both arcs and incandescents. The same firm have secured the contract for the electric lighting of Altyre House, Forres, the residence of Sir W. Gordon Cumming, Bart.

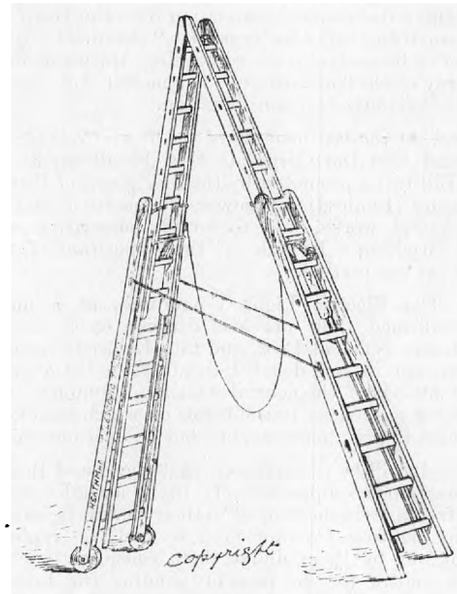
MESSRS. CAMPE AND CO. (SEYDELSTRASSE, BERLIN).—This firm send us a copy of their new catalogue in parallel columns of French and English text. The thirty-six large folio pages contain an extensive variety of globes and shades for the electric light, and many of the designs are very choice. The list includes a number of protector shades and lampscreen globes in various designs, as well as a large number of white iron and brass reflectors and shade holders. The catalogue is chiefly devoted to illustrations of globes, shades, and reflectors for incandescent lighting, but there are also several handsome designs in arc lamp globes.

MICANITE.—The Mica Insulator Company of New York send us a copy of their new price list of micanite plates, commutator segments, rings, washers, tubes, troughs, cloth, and paint, which they claim is used as an insulator by many of the largest electrical machinery manufacturers in the United States. This material consists of mica with lapped joints cemented together under pressure.

CROMPTON AND CO.'S DYNAMO AND MOTOR PRICE LIST.—We have received a price list containing prices of dynamos and motors made by Messrs. Crompton and Co., together with descriptions of their construction, diagrams showing general dimensions, notes on the selection of dynamos, particulars required when ordering dynamos or motors, information on steam consumption and direct driven dynamos coupled to high-speed engines. Full price lists are given, together with prices of sundries and a telegraph code. The illustrations and printing are excellent, but the best part of the list is the useful information and data.

"GOEHRING."—We have received from Messrs. J. M. Bennett and Sons, of Manchester, a very elaborate and finely-illustrated catalogue, relating chiefly to wooden mouldings cut by machinery. The feature of this material (which is pronounced "gearing") is the sinuous and interlacing of the mouldings, thus giving a large variety of waved and diaper patterns. Casing for electric wiring is made with ornamental covers. This waved moulding presents a variety of complicated patterns when mitred, and should be very useful for decorations in hotels, &c.

HEATHMAN'S LADDERS.—Messrs. J. H. Heathman, of Endell-street, London, W.C., send in some illustrated particulars of their telescopic adjustable ladders, suitable for use in cleaning and



attending to public lamps. The advantage of these ladders is, that although only 10ft. high when closed, they can be extended to 18ft. and can be stopped at any intermediate height. They are mounted on a pair of rubber tyre wheels, so that one man can readily move them about and use them. Several leading companies have them in use for trimming public and private lamps.

EDISON-SWAN COMPANY.—This Company have just issued their catalogue, Section IV., being a price-list of wires, cables, casings, and electrical sundries, the frontispiece to which is a bird's eye view of the extensive works at Ponder's End. The list comprises tables of the various descriptions of Ediswan electric light wires and cables.

GÜNTHER TURBINES.—Mr. W. Günther, of the Central Engineering Works, Oldham, forwards us a copy of his new illustrated catalogue and price list of turbines and general hydraulic machinery manufactured by him. The catalogue is prefaced by very full

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descriptions of the "Jonval" and "Girard" turbine systems, and the illustrations accompanying the particulars given include views of the turbines for high, low, and medium falls. A section is also devoted to a description of the Pelton wheels with Mr. Günther's improvements. At a time when enquiries are frequent respecting the use of water power for electric lighting the information upon this subject, given in the catalogue, will be read with interest. A list of nearly 120 turbine installations for a large variety of commercial purposes is given.

TOOL-MAKING MACHINERY.—Mr. H. F. L. Orcutt sends us advanced sheets of machine tool lists of presses, drilling, planing, and grinding machines, manufactured by Messrs. Loewe and Co., of Berlin, for whom Mr. Orcutt is agent in this country. The lists are very fully illustrated, and include measurements and weights of the various machines described.

SCREWS, TERMINALS AND CONNECTIONS.—The Automatic Standard Screw Company (Limited) forward us samples of screws, terminals and connections, for the manufacture of which they possess patent machinery capable of executing orders of any magnitude in this special branch of trade. The samples sent show excellent workmanship and finish, and engineers will be well advised in asking for prices from the Company when requiring supplies. Among the samples are brass binding screws with screwed shanks of steel.

ENGRAVING BY ELECTRICITY.—A paragraph is going the round of the papers with reference to a process which is described as likely to seriously interfere with working engravers. There is nothing new in the process, particulars of which will be found on page 305 of *The Electrician* for July 25, 1890.

ELECTRIC ORGANS.—At a cost of £1,370 the Liverpool School for the Blind have ordered from the Hope-Jones Electric Organ Company a new four-manual organ, to contain 35 speaking stops, 2,024 pipes, and 22 coupling movements. Messrs. Jardine, of Manchester, have the contract for the construction of the instrument.

BELFAST.—The Police Committee of the Corporation have decided to light the new Chief Fire Brigade Station by electricity, and the work has been entrusted to Mr. Greenhill.

BOURNEMOUTH.—The Bournemouth and District Electric Supply Company (Limited) are asking permission from the Town Council to substitute a small number of underground "chambers" in lieu of the large number of boxes now used containing apparatus for controlling the supply of electric current. The matter has been referred to the Roads Committee for consideration.

BRIGHTON.—At the last meeting of the Town Council, Alderman Reeves moved that the Corporate Seal be affixed to a petition against the Bill being promoted by the Brighton and Hove Electric Light Company (Limited) for powers to construct and maintain electric lines and works, and to supply electricity within the Borough of Brighton. In spite of the opposition of Councillor Dell the motion was carried.

BRISTOL.—The Electric Light Committee, at a meeting on Saturday, confirmed their previous decision as to accepting the tender of Messrs. Siemens Bros. and Co. (Limited) instead of the lowest tender sent in, and decided to advertise for a switchboard and internal fittings of the central station to complete the plant. Some discussion ensued as to the terms on which the electric light will be supplied to private consumers, but no decision was come to.

BROMLEY.—It will be remembered that the Local Board endeavoured to ascertain the support likely to be accorded by the principal public frontages in the district to their electric lighting scheme. The Electric Lighting Committee have had the replies to the circular sent out by them under their consideration, but have deferred the matter for the present, pending the Local Government Board inquiry as to the acquisition of the proposed site for a central station.

BURY.—A long discussion took place at the last meeting of the Town Council on the subject of the electric lighting of the town, in the course of which complaint was made that the progress made in the discussion of the subject was not satisfactory. It was ultimately agreed that a committee, consisting of Aldermen Maxwell and Brierley and Messrs. Byrom and Hopkinson, be appointed.

BURGLARY AND THE TELEPHONE.—A daring attempt at burglary was made on Wednesday on the premises of Messrs. Walter Cross and Co., jewellers, of Holywell-street. The thief having obtained entry to the premises attempted to open one of the show cases which was connected up to a number of burglar alarms which were only fitted a day or two previously, these commenced ringing and the sound was communicated by telephone to the second place of business of Messrs. Cross in High-street, Bloomsbury; the thief hearing the ringing of the bells cut the telephone wires, but the telephone communication and the noise made by the ringing of the bells had aroused a dog in the Bloomsbury establishment, which succeeded in awakening one of the members of the firm, who hastily made his way to Holywell-street, accompanied by the police. The burglar had, however, taken alarm at the ringing of the bells, and had effected his escape, leaving behind him the implements of his profession and some wearing apparel which may assist in his capture.

CARDIFF.—The *Western Mail* of the 11th February contains an account of an interview with Mr. Massey and Mr. Harpur, and sets out in detail these gentlemen's views on the subject of the utilization of water-power for the Cardiff lighting.

DEWSBURY.—The Lighting and Water Committee ecommended at a meeting of the Town Council on Thursday that the site of the old gas works be utilised for the new central electric light station, which, after some discussion, was agreed to.

DOLCOATH.—The *Mining Journal* states that the electric lighting of Dolcoath will soon be accomplished. Engines are being fixed and the plant is nearly ready for placing. The Cornish miners are represented as being very friendly to the light.

DOLGELLY.—The Local Board, having recently received a communication asking for the sole right of supplying electric light within the Board's district for a term of 21 years, have replied that they could not entertain the proposal.

DORSET.—Mr. E. Dale, of Sherborne, Dorset, writes to say that it is contemplated supplying the Dorset County Police with electric lamps to be attached to the policemen's belts. Mr. Dale further states that by means of an improved primary battery, these lamps are to be charged by the police themselves.

DUNDEE.—In reference to a note in our last issue stating that the tender of Messrs. Lowdon Bros., had been accepted for the lighting of the Town House and offices by electricity, we are asked to state that this is incorrect, and that Messrs. James Maxwell and Son, of King's-road, Dundee, are the contractors. The number of lamps is to be 109 16-c.p. and 3 200-c.p., the contract price being £140.

EDINBURGH.—It was proposed that circulars should be sent out in order to ascertain how many consumers were disposed to use the electric light, should the Town Council ultimately resolve to undertake the lighting, but after consideration it has been decided to consult further with the experts, whose advice is to be taken upon the whole matter.

"THE ELECTRICAL WORLD" OF NEW YORK.—This journal, in its last issue, notifies a new departure. Following the lead of several engineering and electrical journals in this country, it is proposed to add a "Review of Reviews" corner in the *World*, under the supervision of Mr. Carl Hering.

EXETER.—Mr. J. H. Stanbury, Proprietor of the Royal Clarence and Half Moon Hotels, which have for some time been supplied with the electric current by the local electric light company, has recently laid a cable between the two buildings, and they are now lighted by an independent installation. A 17-H.P. Tangye gas engine drives a Royce dynamo, and there are 54 Crompton-Howell accumulators, which will sustain 100 16-c.p. incandescent lamps for 8 hours. The installation comprises about 300 Edison-Swan incandescent lamps. Mr. A. Stanbury, of Liverpool, has plannedand supervised the work of the installation.

FOOTBALL BY THE ELECTRIC LIGHT.—Hull is losing no time in taking full advantage of the electric light, and its latest departure is a football match, played on Wednesday night last week in the enclosure of the Hull Football Club. Eight 1,000-c.p. arc lamps surrounded the field—three on each side and one at each end. The players found that rather more light would have been advantageous, but the affair altogether was a distinct success.

HAMMERSMITH.—The Electric Lighting Committee of the Vestry have recommended that an expenditure not exceeding £100 be made for the purpose of making experiments for utilising the dust and house refuse for producing power for electric lighting purposes.

HARROGATE.—The Town Council have requested the Board of Trade to grant them an extension of time to consider the question of working their Provisional Electric Lighting Order.

HENLEY.—The Town Council at their last meeting received the report of the Lighting Committee, which recommended the Council to apply to the Gas Committee for a reduction in the price at present paid for gas. The report also recommends: "That the Town Clerk be directed to make enquiries as to the probable cost of obtaining a provisional order for electric lighting." In moving the adoption of this report, Alderman Watts stated that the Committee had had under their consideration the application by numerous local bodies throughout the Kingdom for provisional electric lighting orders, and he thought that Henley offered sufficient inducements in the way of probable consumption to justify them in taking the matter into earnest consideration.

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HECKMONDWIKE.—The result of the poll of the ratepayers for and against the proposed introduction of the electric light into Heckmondwike by the Local Board has been declared—against 725, for 694; majority against 31. The number of papers returned unfilled up was 523, showing that nearly one-fourth of the electors took no interest in the question either way.

HERTFORD.—The Lighting Committee reported at the last meeting of the Town Council that they had visited several central electric light stations for the purpose of obtaining practical information upon the subject, and hoped at an early date to present to the Corporation a report that would enable them to come to a definite conclusion with regard to the matter.

ISLINGTON.—A letter to the Vestry from the Holloway Electricity Supply Company (Limited), asking for the Vestry's consent to an application for an Electric Lighting Order, has been referred to the Electric Lighting Committee.

LECTURES.—Recent lectures include a Cambridge University Extension series on "Electricity and Magnetism," by Mr. Knowles, at Stockport; and a course at Leeds, by Dr. Stroud, of Yorkshire College.

LIVERPOOL.—It will be remembered that the City Council have refused the Liverpool Electric Supply Company the powers asked for to lay two surface mains across Sefton Park. The matter again came up for discussion at the last meeting of the Parks, Gardens, and Improvement Committee, and it was ultimately agreed to refer the matter back to the committee for reconsideration. There seems a disposition on the part of the members of the committee to meet the Company on condition that certain stipulations are inserted in the agreement.

LIVERPOOL OVERHEAD RAILWAY.—Messrs. Maunsell Mercier and Co., of Deansgate, Manchester, have supplied the whole of the station-to-station electric bell signals, and the electric bell communications in the cars for the Liverpool Overhead Railway Company.

LLANGOLLEN.—The Local Board has formed itself into a committee to consider the question of the lighting of the town of Llangollen by electricity.

"THE LOCAL GOVERNMENT ANNUAL."—We have received a copy of the Local Government Annual for 1893, which will be found of service to those contracting firms desiring to communicate with Local Authorities throughout the country. The book is published at the offices of the *Local Government Journal*, Dorset House, Salisbury-square, Fleet-street, E.C., price 1s. 6d.

"LONDON."—This is the title of a new paper, published chiefly with the object of reporting the proceedings of the London County Council, and to aid the advancement of civic and social progress. The first number is well printed, and can be safely commended to those of our readers interested in London municipal matters. The price of the journal is 1d.

PORTRUSH.—On the proposal of Capt. Watt, the Town Commissioners have decided to advertise for tenders for the lighting of the town by electricity.

THE PRESS AND ELECTRIC LIGHTING.—As evidence of the continued interest in the subject of the introduction of the electric light throughout the country, we have recently called attention to various series of articles in the principal provincial journals. The *Yorkshire Weekly Post* is inserting a series of articles on this subject, popularly written, and similar in character to those to which we have previously referred.

ST. JAMES'S VESTRY, LONDON, W.—The recommendation of the Lighting Committee "that each member of the Vestry be furnished with a copy of the report issued by the Electricity Department of the St. Pancras Vestry, showing the result of the first year's work of that Vestry's electric supply undertaking," was adopted at the last meetng.

ST. OLAVE'S, SOUTHWARK.—The Vestry have decided to continue their opposition to the City and South London (Islington Extension) Electric Railway Bill.

SHIP ELECTRIC LIGHTING.—The Liverpool Salvage Association's new wreckage steamer "Ranger" has recently left Liverpool for the purpose of rendering assistance to the stranded steamer "Cuban." The "Ranger" has a most complete electric light installation on board, including a search-light of 22,000 candle power fitted at the foremast, arc lamps of 5,000 candle power at each masthead for the working of cargo, and a number of submarine electric lamps.

SUNDERLAND.—The Highways Committee have resolved to recommend the Town Council to request Prof. A. B. W. Kennedy to draw up a scheme with a view to carrying out their Provisional Order.

SUTTON.—The Local Board had before them at their last meeting an inquiry whether they would transfer their powers under their Provisional Order to a company, provided the expense incurred in obtaining the Order were paid, and after some discussion a special committee was appointed to go into the question. The Sutton Gas Company asked if the Board would assist them in obtaining the necessary powers to supply electricity, and the letter was referred to the General Purposes Committee.

TELEPHONIC COMMUNICATION.—The St. Albans County Police Office has been placed in telephonic communication with Hatfield, Watford, and Rickmansworth, and can also communicate with the private residence of the inspector in charge and the Clerk of the Peace for the district. Hertford will shortly be connected up on the system.

TIVERTON.—A local journal of the 11th instant contained an account of the draft scheme for the proposed electric lighting of Tiverton, from which it would appear that the total cost of the proposed premises, plant, and installation would be £17,000. The scheme was laid before Mr. de Ferranti, whose opinion, the journal in question states, has been received. The *Western Times*, however, states that the draft scheme is unauthorised.

TUNBRIDGE WELLS.—The Town Council have had under discussion Mr. Preece's report on the best manner of exercising the powers conferred by the Electric Lighting Provisional Order of 1891. The Electric Lighting Committee of the Council recommended the adoption of the report and the approval of the plans prepared by Mr. Preece for the purpose of establishing electric lighting works, and also on application to the Local Government Board for sanction to borrow £13,000 for the purposes of the order. The motion that the recommendations be adopted was carried, and the debate on the subject of the report was adjourned for a month.

MR. MCWHIRTER.—A complete mining installation for lighting, hauling, and pumping has been completed at the Loganlea Colliery, West Calder, by Mr. McWhirter, of The Faraday Electrical Works, Govan, Scotland. The work comprises a 70 H.P. Faraday compound wound dynamo and two motors of the same type, three 2,000 c.p. arcs, and a large number of incandescents. The haulage plant is capable of dealing with 200 tons per day, and owing to the satisfaction this plant has given, a considerable extension is now being made. It is claimed for this colliery that it is one of the most completely equipped in the East of Scotland.

ROCHDALE.—Mr. J. K. Grindrod has recently installed the electric light in the extensive corn mills of Messrs. Cunliffe and Swyre, and Messrs. C. A. Parsons and Co. have supplied a powerful search light for the mill of Messrs. Kelsall and Kempe, the latter also installing the electric light in the mill, about 500 incandescent lamps being used.

RUNCORN.—It has been proposed that Messrs. A. Hall and Co., of Liverpool, be instructed to prepare a complete report, specification, and estimate of the proposed electric lighting for the public streets, and a Special Committee of the Board of Commissioners has been appointed to deal with the matter. This Committee have been authorised to obtain information from other Local Authorities who have had practical experience of the working and cost of the electric light prior to the firm of engineers being engaged to make the report referred to.

WALSALL.—The Town Council have resolved to give a fee of £350 to Mr. F. Brown, of Birmingham and Walsall, as consultant in the new electric light scheme, which it is contemplated will cost between £15,000 and £20,000. It was stated that the works would be completed in a little over twelve months, and that for three months after the completion Mr. Brown's service would be retained.

WESTON-SUPER-MARE.—The Electric Lighting Inspection Committee having received a letter from the Brush Electrical Engineering Company (Limited) offering to submit a proposal for the transfer of the Commissioners' Provisional Order to a local company to be formed by them, the clerk was instructed to reply to the Brush Company to the effect that the Board were open to consider such a proposal, but that the proposition for the payment for goodwill at a valuation on the expiration of the term fixed would not be entertained.

WHITEHAVEN.—At the last meeting of the Town Trust the minutes of the Electric Lighting Committee came up for discussion, which included a lengthy correspondence with the contractors for laying the mains. Considerable progress has been made with the works at the central station.

WREXHAM.—The Wrexham Electric Lighting Company has given up the Wilderness Mill part of their electric lighting scheme, and are confining their attention to the lighting of the borough. The Company are, we understand, prepared to negotiate with the Corporation for the purchase of the undertaking. A letter to this effect was referred to the Lighting Committee of the Town Council.

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 10, 1893.

538. W. MITCHELL. Birmingham. Electro-magnetically heated receptacles and articles.*

552. W. T. GOOLDEN and S. EVERSHED. London. Improvements in electric measuring instruments.

January 11, 1893.

583. A. WRIGHT. Brighton. Improvements in self-recording electric apparatus.

585. A. E. MUIRHEAD. Glasgow. System for suspending electrical conductors (without the use of poles) by means of wires.

601. J. R. HUGHES. London. Improvements in and relating to the manufacture of electric incandescent lamps.

605. R. KENNEDY. Glasgow. Improvements in and relating to the measuring of electricity and in meters therefor.

628. H. FARADAY. London. Improvements in brackets, standards and other electric light fittings.

660. A. F. KIRKPATRICK-PICARD and H. THAME. London. An improved method of manufacture of elements or plates for secondary batteries.

January 12, 1893.

694. R. ATKINSON. Shipley, Yorks. Air tight electric lighting wire casings.

724. F. R. POPE. London. Improvements in filaments for incandescent electric lamps.*

736. J. C. RICHARDSON. London. Improvements in the manufacture of white lead and other compounds electrolytically, and apparatus therefor.

January 13, 1893.

757. H. T. BARNETT. London. Improvements in platinised electrodes.

758. H. T. BARNETT. London. Improvements in connection with carbon electrodes.

775. E. CONRADY. KEIGHLEY. Improvements in electric arc lamps.

791. J. H. TUCKER. Birmingham. Improvements in devices for opening and closing electrical circuits.

813. C. POLLAK. London. Improvements in or connected with the manufacture of electrodes for electric accumulators.

814. F. J. JUDSON and W. J. WOODWARD. London. Improvements in dynamo or motor brushes or collectors.

January 14, 1893.

841. SIR D. L. SALOMONS, Bart. Tunbridge Wells. Improvements in the electric illumination of clocks.

869. H. NEHMER. London. Improvements in electric belts.

January 16, 1893.

933. W. A. LAUDER. Dublin. Improvements in electrical arc lamps.

January 17, 1893.

1,005. C. M. ANDERSON. Manchester. An improved method of electrically controlling railway signal and point levers.

1,035. M. L. BOSSIÉRE (Widow of A. Bossiére) and P. P. BARBRY. London. Improvements in electrical indicating apparatus chiefly designed for indicating the position of a ship's rudder.

1,057. H. H. LAKE. London. Improvements in and relating to electric railways. (Thomas Harris, United States.)

1,077. W. P. THOMPSON. Liverpool. Improvements in electric telephone switch apparatus. (Carl Christian Ernst, Lesenburg, Germany.*)

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

22,640. SAYERS Electric arc lamps.

22,686. ANGELL. Electric forges.

22,687. ANGELL. Heating metals by electricity.

1892.

1,243. STEWARD. Magnetic compasses.

1,656. JOHNSON (De Bovet). Electric brakes.

2,162. CROMPTON and POCHIN. Automatic arc lamps.

2,312. DRAKE and others. Electric lamps.

2,365. MABON. Electrical communicating apparatus.

2,981. CRAVEN. Electro-medical appliances.

3,120. BERTRAND. Galvano plastics or electro deposition of metals.

3,366. HEMMING. Dynamo-electric machines.

3,538. CHARLETON and WALKER. Electric currents in mines &c.

3,801. WINNALL, L. W. and W. H. Electric bells.

COMPANIES' MEETINGS & REPORTS.

Kensington and Knightsbridge Electric Lighting Company.

The sixth ordinary general meeting of this Company took place yesterday at No. 1, Great George-street, Westminster, Mr. Granville R. Ryder presiding.

The CHAIRMAN, in proposing the adoption of the report and accounts, thought they would agree with him in considering that substantial and steady progress was shown by the statement submitted. With reference to the houses and shops taking the light, the number had increased from 436, at the end of 1891, to 550 in the past year, the 8-c.p. lamps had risen from 38,408 to 47,441, and the output of units had jumped from 385,051 to 535,343. The gross earnings for 1891 were £12,266, whereas last year they amounted to £16,628, an increase of £4,361; and the net profits had risen from £4,381 to £6,828. A satisfactory point in these figures was that the ratio of profit to the gross receipts had considerably increased—from 36 per cent. in 1891 to 42 per cent. in 1892. That point might be further elaborated by this fact also—that the increase in the net profit of £2,446 might be put against the advance of £4,361 in the gross earnings; and in that case the increase would stand at about 56 per cent. of profits as against gross earnings. The capital expenditure during the year had been £12,800, of which £4,441 had been on mains and £3,764 on plant. He afterwards dealt with the revenue account, and expressed gratification at the first item on the expenditure side—manufacturing electricity, coal, oil, water, waste, wages, and sundries. This item stood at £3,746, compared with £4,067 in the previous statement, so that with an increase of output of very nearly one-third, the expense of producing the expense of producing the electricity had been about £300 less. He also referred with satisfaction to the acquisition by the Company of a district which formerly belonged to the Chelsea Company, and said that on the purchase price they expected to obtain a return of 10 or 12 per cent.

Mr. G. H. HOPKINSON seconded the motion, which was adopted, and resolutions were also passed declaring a dividend of 4 per cent. per annum on the ordinary shares, voting the Directors £350 remuneration for their services for the past year, and re-electing the retiring Directors and auditors.

[*We shall publish a full report of this meeting in our next issue.*]

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

The twenty-ninth ordinary general meeting of this Company was held at the City Terminus Hotel, on Tuesday, under the presidency of Mr. S. William Silver.

The SECRETARY (Mr. William J. Tyler) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: The report is a very brief one, but I hope you will agree with me that it is satisfactory, as it confirms the hopes expressed when we last had the pleasure of meeting. The result of the year's transactions—after carrying to reserve all the premium on the new capital issued, with a portion of the profit made—justifies our recommending the same dividend as heretofore, with a bonus, carrying forward an amount fully as large as we did a year ago. The additional capital has been well employed. It has enabled us from time to time to lay in large stocks of raw material under favourable circumstances, and thus to compete successfully in the hard-fought battle of trade, finding remunerative employment for our works, which, I am happy to say, are in a highly efficient condition. We have manufactured over 3,000 miles of submarine telegraph cable, and, I am glad to say, without a fault, and well within the contract time. The same may be said of our French factories, which have been doing good work. With the sinews of war, in the form of ample capital, and the masterful mind of my friend the Managing Director in command, I have no fear as to the future of this undertaking. I have much pleasure in recommending for your approval the following resolution:—

"*That the report and accounts now presented be received and adopted, and that a dividend of 5 per cent. and a bonus of 2½ per cent., together 15s. a share, free of income-tax, payable on the 15th inst., be now declared.*"

Mr. ROBERT HENDERSON seconded the motion.

The CHAIRMAN said he would be very happy to hear any remarks that any shareholder might have to make; but there being no discussion he put the motion in the usual way, and it was carried unanimously.

The MANAGING DIRECTOR (Mr. Matthew Gray) proposed the re-election of Mr. Silver and the Hon. Henry Marsham to their seats at the Board.

Mr. ABRAHAM SCOTT expressed his pleasure in seconding the motion, and said that both gentlemen worked so well and so ably that he would be very sorry if they were not both re-appointed.

The resolution was carried unanimously.

The CHAIRMAN: In our joint names I thank you for this renewal of your confidence. I need hardly say that it will stimulate us to fresh exertions; and I hope that we shall meet under as favourable circumstances on the next occasion.

On the motion of Mr. MARTINDALE, seconded by Mr. COCHRAN, Mr. J. F. Clarke, of the firm of Messrs. Turquand, Youngs, Weise, Bishop, and Clarke, was elected auditor of the Company.

Mr. GEORGE HANBURY then proposed a vote of thanks to the Chairman and the Directors for the admirable way in which they had managed the Company's affairs. He had been a shareholder for many years, and although there had been some slight variations in the dividend, yet he was sure that

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everyone would agree that it was a very steady and excellent investment and it seemed likely to continue so. He believed that while they had the same management of Mr. Gray, Mr. Silver, and the other members of the Board the same prosperity would attend the Company.

Mr. TREBLE seconded the motion, which was carried by acclamation.

The CHAIRMAN: It only remains for me to thank you for this fresh proof of your confidence. In doing so I think I ought to remind you of the stake which we have on this side of the table in the Company, and that our interests are identical with yours.

The proceedings then terminated.

City and South London Railway Company.

Pursuant to the Standing Orders of Parliament a special general meeting of the proprietors of this Company was held at the offices of the Company, 46, King William-street, on Thursday, February 16th, for the purpose of considering, and if thought fit, of approving a Bill now pending in Parliament, intituled—"A Bill to extend the time for the purchase of lands for and for the completion of the Subway or Underground Railway, authorised by the City and South London Railway Act, 1890." Mr. Sampson Hanbury presided.

Mr. W. F. KNIGHT (the Secretary) read the notice calling the meeting.

The CHAIRMAN: Gentlemen, in the absence of the regular Chairman of the Company, Mr. C. Grey Mott, I have been requested to take the chair at this Wharncliffe meeting, and I call upon the solicitor to explain the provisions of the Bill.

The SOLICITOR: The only practical provisions in the Bill are that the time for acquiring the land is extended to July 25, 1895, and the time for the completion of the works is extended to July 25, 1898. The other part of the Bill is only formal.

The CHAIRMAN invited discussion upon the proposal, and there being no remarks, he moved the approval of the above Bill, subject to such additions, alterations, and variations as Parliament may think fit to make therein.

Mr. TATE seconded the motion, which was carried; and a vote of thanks to the Chairman closed the meeting.

Liverpool Overhead Railway Company.

The half-yearly meeting of the shareholders of this Company was held at the Law Association Rooms, Cook-street, Liverpool, on Tuesday, Sir William B. Forwood, Chairman of Directors, presiding.

The CHAIRMAN, in moving the adoption of the report (which appeared in the last issue of *The Electrician*), stated that the Directors had met the shareholders so recently that he need not detain them with any lengthened remarks. The railway was now practically completed, and, as they knew, the formal opening took place on the 4th inst. The function was in every sense a great success, and he hoped that the eloquent and very encouraging words spoken by Lord Salisbury on that occasion would be remembered by all the shareholders, for the noble marquis spoke not only merely as an eminent statesman, but as one of the most able electrical experts in the country. Lord Salisbury had written him a letter, in which he stated, "I thank you heartily for a very interesting evening and day at the end of last week. It was one of the most interesting twenty-four hours I ever passed." The Directors were now busily engaged in completing the electric signals of the railway, the whole of which would be completed and connected by Thursday. They were also exercising the staff in their duties, and were that day running a five-minute service of trains. Of course they were carrying no passengers, because the railway had not been passed by the Board of Trade. They had made their preliminary examination, and when the electric signals were completed they were coming down to make their final examination. He thought he might say that the railway would be opened to the public on March 1st, and he hoped before that day they would be able to give an opportunity to the shareholders of having a private inspection of the railway, so that they might be able to make a test for themselves. The trials up to the present had been in every way satisfactory, both as to smoothness of running, perfect control over the trains, economy in the electric energy employed, the rapidity with which they could get up speed, and the high rate of speed attained. In all these cases the trials had exceeded their most sanguine expectations. It was also satisfactory to know that at the opening function they had almost all the leading experts of the country present, and it was the unanimous verdict of all those gentlemen that the work of the railway had been very well done, the ironwork of the main structure and the machinery in the generating station being all the subject of praise. That reflected very great credit upon their engineers, their contractors, and sub-contractors. Referring to reports in the newspapers, he assured them that the electric conductor could not and would not be a source of danger to any passenger. It was entirely out of the reach of the passengers, and if a passenger chose to stand upon it would simply give him a slight shock which would be rather beneficial than otherwise. The railway was constructed upon a corrugated floor, and it was stated in one of the newspapers that they were paying a heavy royalty to an *employé* of the engineers for the use of that form of structure. It was quite true that the chief of the staff in the employment of the engineers did patent the corrugated floor—and it was a very valuable patent—but the Directors had not had to pay a penny piece of royalty. There were a great many reports put out in reference to the railway, but they must not believe one of them. The railway was a thorough success from beginning to end. The only trouble they ever had had been a little delay in fixing the electric signalling, and he could now say they were promised that the signals would be in full working order by Thursday. Everything they had seen in connection with the railway led them to the belief that it would be a thorough success. The trains would be rapid, well under control at all times, and he was quite sure the service they would give to the public would be thoroughly appreciated.

Mr. JAMES BARROW seconded the motion.

In reply to questions, the CHAIRMAN said that the contractor had informed the Directors that it would take three months to complete the northern extension, but they had put it down at six months. The Directors had given instructions that day to the engineers to prepare the plans, so that the shareholders might take it that the work would be completed in six months from that day. In regard to a supposed difficulty as to the trains passing each other when meeting the Chairman said that their line was a full gauge one; they had six feet space between the rails, precisely as had the London and North-Western and every other company, and their carriages also were precisely the same width as the Pulman cars on the London and North-Western Railway; so that the statement which had been made was absolutely untrue. As to a platform being erected outside the lines, plans which had been before the Board of Trade and passed provided for a parapet on both sides of the lines. That was a considerable expense to the Company, but the Board of Trade put it upon them. It was part of the original plan and original contract, so that there had been no additional expense, and the Board of Trade had already passed the main structure.

The report was adopted unanimously.

Sir Wm. Forwood and Mr. Harold Brocklebank were re-elected Directors and Mr. J. S. Harmood Banner was reappointed auditor, and the proceedings closed with a vote of thanks to the Chairman.

General Electric Power and Traction Company (Ltd.)

The second ordinary general meeting of this Company was held on Tuesday last at Winchester House, Old Broad-street, the Right Hon. the Earl of Albemarle presiding.

The SECRETARY (Mr. J. Payne) read the notice convening the meeting, the report of the Directors and statement of accounts being taken as read.

The CHAIRMAN: Gentlemen, I am not going to make a great many remarks. I regret that it has been necessary to postpone this meeting so often, but it is well known to all of you, I think, that very great and serious changes have been made in our staff, and that many of those who take the liveliest possible interest in your affairs have been compelled to absent themselves through illnesss. One of our Directors, Lord Egerton of Tatton, whom we all highly esteem, is at this moment at Biarritz, suffering greatly in health, and I have received a telegram from him to-day, stating his full concurrence in the course that we are to pursue. I myself have been suffering for two years from a very severe illness, and have not been able to give recently the same attention to electric traction which has occupied my attention for many years past, as I used to do. The balance-sheet, together with the auditors' report, give such very full information in regard to the accounts of the Company that it is not necessary for me to say very much about them, but I am desirous of taking this opportunity of again pointing out to the shareholders that the large loss shown has not been entirely incurred by the operations of the year—more apparent than real. It will be observed that a sum of nearly £60,000 has been written off to capital account in respect of depreciation on plant and for the Barking undertaking, and that the patents and goodwill have been written down by £20,000. These are losses which the Directors think it well should be plainly recognised by the shareholders, but they are losses not in any way due to the management of the business. The trading account, it is true, shows a loss of £4,000, but this has arisen largely from exceptional causes, and the Directors hope that they will not recur. The expenses of the management may also appear high, but the greater portion of these items were incurred in the earlier part of the year, and latterly very considerable economies have been introduced. The Board have made an arrangement with the Electric Construction Corporation (Limited) by which that Corporation will for one year undertake the management of the Company for a fixed sum, which represents less than one-tenth of the amount charged for the management expenses for the past year. The Electric Construction Corporation (Limited), as a result of the changes which they are making in their own organisation, will be able, the Directors hope, to arrange for the efficient conduct of this Company's business, and the Directors will, in consultation with them devise a plan of action for the future, which the Directors hope will be beneficial in its results. The Electric Construction Corporation (Limited) are large shareholders in the Company, and have, therefore, every interest to improve the value of your property. But little progress has been made with electric traction, and although we are confident the systems we advocate would be of the greatest possible benefit to the shareholders, they are at the present moment practically in abeyance. We are bound to admit that the hopes we entertained in connection with this branch of our business have not been fulfilled. We have had promises from various quarters, and we have incurred considerable expense to demonstrate the advantages of electric traction as compared with the present system. We have seen no reason to change our opinions. Whether it is want of confidence, want of enterprise, want of capital, or the influence of vested interests which is so all powerful we cannot say. We do not feel justified in continuing to demonstrate at our own cost what should be obvious, and no doubt is obvious, to those entrusted with the management of our tramway systems. We had come to an arrangement with the North Metropolitan Company which would have enabled us to work even that small installation at Barking of five cars without loss, and possibly at a profit, but having had occasion to remonstrate with that Company on the disgraceful state of the permanent way, that Company withdrew from the arrangement, and the cars are at present stored at Millwall. That our complaints were justified is evidenced by the fact that before they could resume horse traction the whole of the roads had to be thoroughly overhauled. We con-

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sider that the principle of runing cars at a mileage rate is altogether unfair to the electrical contractor, the greater the success the greater the loss to those who have to provide the electrical energy. It was notorious that the cars at Barking were constantly overloaded, but, of course, in such a case as this the police are not required to interfere. We have, in the course of this experiment gained some valuable experience, and I am advised that given an installation of, say, a dozen cars, with average gross receipts of, say, 11d. per car mile, which is much less than the receipts at Barking, the installation can be run at a profit to all parties concerned, and is certainly superior to horse traction. We must bear in mind that the vested interests involved must naturally tend to retard the introduction of electric traction, but time and the constant pressure of shareholders on the tramway companies will surely lead to the adoption of electric traction throughout the country. When that time comes we hope to get our share of the benefit. There is no doubt that in anticipation of a greater demand for machinery than has been experienced, our late Manager produced more stock than was strictly prudent; this we hope to realise, but meanwhile, acting on the advice of our auditors, and in accordance with our own views, we have thought it prudent to write it down to what may be considered an excessively low figure. The expenses in every branch have been cut down as low as possible. The losses on the year have been materially reduced. At the present moment our attention is devoted to the completion of the Copper Works at Millwall. Mr. Thomas Parker has joined the Board, and if properly worked there is every reason to hope the deposition of copper will form a most important branch of our business. If we should eventually determine to turn this copper into wire we do not anticipate any difficulty in placing all we can manufacture. The Kentish Town Works will be transferred to Millwall, and a considerable saving will be effected in rent alone. I beg to move the adoption of the report and accounts.

Mr. JAMES PENDER seconded the motion.

Mr. DUNN thought everything pointed to the fact that the property was taken over at too high a valuation, and said that the report should not be adopted until the capital was written down.

Sir HENRY C. MANCE said that such a course was rather premature, but no doubt it would eventually be adopted.

Mr. DUNN moved an amendment in effect to appoint a committee of shareholders to confer with the Board with regard to the reorganisation of the Company.

Mr. THOMAS seconded the amendment, and asked whether under the present circumstances of the Company it was the intention of the Board of Directors to forego their fees for the last eighteen months.

Sir HENRY MANCE explained that their late manager was somewhat sanguine in overestimating the value of the plant and machinery, and the Directors had acted conscientiously in appraising them at what was considered to be their true value. As to the fees of the Directors, those fees had been reduced, and even on the reduced scale they had not been taken. With regard to the suggestion as to a conference of shareholders with the Directors, he could only say that in the case of no other company had there ever been given a fairer explanation of all the items in the balance-sheet sent out to the shareholders. There was no information which he could give which was not clearly set forth in the report. They had strengthened the Board by electing to a seat Mr. Thomas Parker, who would no doubt materially aid them.

Mr. JAMES W. BARCLAY, while agreeing with the observations of Mr. Dunn, pointed out that the writing down of the capital and the reconstruction of the Company were expensive operations, and might be left over for another year.

The CHAIRMAN, in reply to a shareholder, said that the launch business on the Thames was likely to be a successful branch of the Company's business.

The amendment for the appointment of a committee of investigation was put and lost.

The original motion was then agreed to.

Mr. MORITZ IMMISCH proposed, and Sir HENRY C. MANCE seconded, the re-election of Lord Albemarle to his seat at the Board.

The motion was adopted unanimously.

Mr. J. PENDER next proposed and Mr. IMMISCH seconded, the re-election of Lord Egerton of Tatton, the other retiring Director.

The motion was agreed to *nem. con.*

The auditors (Messrs. Ward and Wilding) having been re-appointed, a vote of thanks to the Chairman and Directors brought the proceedings to a close.

Newcastle and District Electric Lighting Company (Limited).

The sixth ordinary general meeting of this Company was held on Monday at 57, Westgate-road, Newcastle. Mr. John D. Milburn in the chair.

The following report of the Directors was taken as read :—

"The Directors have pleasure in reporting that the supply of current continues to give satisfaction to the Company's consumers, and, although the present depression in trade has had the effect of somewhat crippling progress, the prospects of the Company continue satisfactory. The installations connected to the Company's mains during the year are equal to 3,500 10-c.p. lamps, bringing the total up to about 14,500, and 290,469 units of electrical energy have been supplied, as against 206,017 units supplied in 1891. During the past year 3,012 yards of main and branch piping have been laid, together with 6,146 yards of main and branch cable. A tunnel has now been completed from the Company's works to the river Tyne, and condensing plant is being erected to which water will be circulated direct from the river; it is expected that this plant will be in operation next month, and your Directors anticipate a considerable saving of both fuel and water. It is anticipated that there will be a great fall in the price of lamps during this year, which will greatly tend to further the interests of the Company. The gross earnings during the year amount to £2,139. 15s. 1d., and after paying interest and making provision for reserve fund, and writing off £59. 7s. 7d. from formation expenses, your Directors are able to recommend a dividend at the rate of 3 per cent. for the half-year ended December 31st (less income tax), which, together with the interim dividend paid in July last, makes the dividend 5½ per cent. for the year. Sir Benjamin C. Browne retires by rotation, but is eligible, and offers himself for re-election as a Director. The auditors, Messrs. Strachan and Co., also offer themselves for re-election."

The CHAIRMAN then said: The leading feature of the year's work is the payment of a little more dividend. This increase in the earning power is trifling, but it marks progress. The following figures will prove the steady progress we are making: Units sold, 1891, 206,017; in 1892, 290,469—increase, 84,452. Increase of output, 41 per cent.; increase in receipts, 23 per cent. Selling price, 1891, 5·309; selling price, 1892, 4·650—difference per unit, 0·659. Cost price, 1891, 3·420; cost price, 1892, 3·113—difference per unit, 0·307. You will see, therefore, that whilst our average price has been gradually reduced, the cost has likewise been reduced, and, by the introduction of the shaft and tunnelling to the Tyne and the new condensing plant, the cost of fuel is expected to come down to nearly one-half. This is a great economy, but nothing like the saving which will ensue by doubling the production of the current. Cheapness begets demand, and demand begets cheapness of production. In the summer months, when our output is only about 11,000 units per month, the cost of production is about 4½d. per unit. In mid-winter, when the output is 50,000 units, the price per unit comes down to 2d. It is obvious, therefore, that when we shall be able to supply 50,000 units per month, the average cost will be enormously reduced; and we hope at no distant date to be able to produce electric current at a net cost of 1d. to 1½d. It is, however, impossible to attain this end by hoping to sell the current for illuminative purposes alone, and we must look to other sources of demand, such as motive power, ventilation, &c. Electric cooking is now an established fact, and the method can be seen at the Victoria Hotel, where are introduced the best electric cooking appliances in the market. Sixpence per unit electricity, with a properly proportional installation, is equal to about 5s. per 1,000ft. of gas. The gas companies have not much to fear in the way of competition so long as the price of electric lighting stands at 5d. to 6d. What, however, we want to be at is to be able, profitably, to supply electricity for lighting purposes at 3d. per unit, equal to only 2s. 6d. per 1,000ft. of gas. This, as I think I have shown you, can only be done by increased demand for electric current and steady economy in working expenses. A great stimulus will undoubtedly be given to electric lighting by the termination in November next of the patents of the Swan-Edison lamps. In reference to the report recently made to the Watch Committee of this city by Mr. Lamb, the inspector of lamps, I have to say on behalf of this Company that we are prepared to prove that the right system has been adopted by this Company for public lighting, and that in no place in England have the lamps given greater satisfaction. We trust that the Watch Committee will soon make up its mind to take their electric lighting question into consideration.

Sir B. C. BROWNE, in seconding the motion, said they had considered very carefully before they increased their dividend, but they were fully justified in making that step forward.

The Directors' fees were increased from £105 to £210 per annum, the retiring Director and auditors were re-elected, and the proceedings closed with the usual vote of thanks to the Chairman.

Westminster Electric Supply Corporation (Limited).

The following report is issued by the Directors of this Company, and will be presented to the ordinary general meeting of shareholders to be held on Wednesday, the 22nd inst., at the offices, Eccleston-place, Belgravia, S.W., at 11 o'clock:—

The Directors are gratified in being able to state that the business of the Corporation continues to make steady and satisfactory progress. After very careful consideration, they decided, from the 1st July, 1892, to reduce the price of current from 8d. to 7d. per unit. The policy of reducing the standard charge which this Corporation initiated, has been fully justified by the increased consumption of current. On the 31st December, 1891, electric energy was being supplied from the Corporation's mains to the equivalent of 62,820 lamps of 8-c.p., and the supply increased to 98,686 on the 31st December, 1892. At the present time there are on circuit the equivalent of 102,743 lamps of 8-c.p., and applications have been received for a further 8,229.

The total length of roadway along which mains have been laid exceeds 33 miles, making about 130 miles of ways into which upwards of 97 miles of copper (strip and cable) have been drawn. The plant and machinery have been working satisfactorily throughout the year.

Since the last meeting of shareholders the building at Davies-street has been completed, the frontage having been finished as shops and chambers. In September last the chief office was transferred to Eccleston-place on the completion of the buildings there. Great convenience has been experienced by the concentration of the general staff under one roof.

As promised at the last meeting, the Directors offered £40,600 in £100 4½ per cent. mortgage debentures to the shareholders, by whom the issue was immediately taken up. The Directors were pleased to be able to pay a first dividend at the rate of 3 per cent. for the half-year ending 30th June last. The accounts now show a balance of £7,324. 8s. 9d. to the credit of net revenue and they recommend the payment of a dividend

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at the rate of 4 per cent. for the past half-year, carrying forward a balance of £1,324. 8s. 9d.

In accordance with the Articles of Association two of the Directors, Messrs. J. Browne Martin and R. W. Wallace retire, but, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers and Co., also retire, but, being eligible, offer themselves for re-election.

Electricity Supply Corporation (Limited).

The following is the report of the Directors of this Corporation for the year ended December 31st last, to be presented at the general meeting to be held at the Town Hall, St. Martin's-lane, London, W.C., to-day (Friday), at two o'clock :—

The Corporation are now supplying energy to 29,000 8-c.p. lamps, an addition of 7,000 since May last, or an increase at the rate of or about 32 per cent. on the number then supplied. Applications have been received and negotiations are pending for a substantial addition to this number. Additional mains to the extent of about two miles have been laid, making a total of upwards of eighteen miles of mains now laid.

Out of the available profits the Directors, after providing for the interim dividend up to June 30, 1892, and writing off the debit balance brought forward for 1891, propose to declare a dividend for the year up to December 31, 1892, at the rate of 5 per cent. on the capital from time to time paid up, and to carry forward the balance.

The Directors have every reason to be satisfied with the progress and future prospects of the Company.

The Directors retiring by rotation are Mr. George Henry Brougham Glasier and Mr. Isaac Percy Mendoza, who, being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire and offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

GEORGE MORITZ (LIMITED).—This Company was registered on the 9th inst., with a capital of £5,000 in £1 shares. The objects are to acquire the goodwill of the business of an electrical engineer, dealer in electrical appliances, fittings, and instruments, &c., now carried on by George Moritz, under the style or firm of "The Manchester and Liverpool Electric Engineering Company," at Manchester, Liverpool, and elsewhere ; and to carry on in all or any of its branches the business of electrical and mechanical engineers, electricians, suppliers of electricity, and manufacturers of and dealers in electric, magnetic, telegraphic, telephonic, and other appliances and apparatus, and of steam, hydraulic, pneumatic, or other engines, machines, appliances, and apparatus.

JAMES SMYTH AND SONS (LIMITED).—This Company was registered on January 31st, with a capital of £25,000, in £50 shares, to carry on the business of general and electrical engineers, at Peasenhall, Suffolk.

OVERTON, BANGOR AND DISTRICT GAS COMPANY (LIMITED).—This Company was registered on the 3rd inst., with a capital of £1,000, in £1 shares, to light with gas, electricity, oil, or other illuminating power, the roads, buildings, &c., in the parishes of Overton and Bangor, and to manufacture, work, buy, sell, let on hire, and deal in lamps, fittings, instruments, and other apparatus relating to or connected with the generation, supply, distribution, accumulation, and utilisation of gas and electricity.

ROLLASON AND SLATER (LIMITED).—This Company has been registered, with a capital of £30,000, in £10 shares, to carry on business as iron and brass founders, boiler makers, iron and steel plate manufacturers, mechanical and electrical engineers, wire drawers, &c., at Birmingham and Wombridge.

SILMAN BROTHERS (LIMITED).—This Company was registered on the 6th inst., with a capital of £1,000, in £1 shares, to carry on business as mechanical and electrical engineers at Moseley-street, Birmingham.

SOUTHERN CONCESSIONS SYNDICATE (LIMITED).—This Company includes among its objects the financing of electrical, telegraphic, and telephonic undertakings and companies. Capital, £120, in £1 shares.

WALLIS AND STEEVENS (LIMITED).—This Company was registered on the 6th inst., with a capital of £60,000, in 440 Preference shares of £100 each, and 1,600 Ordinary shares of £10 each, to carry on the business of mechanical, consulting, electrical, and general engineers, at North Hants Iron Works, Basingstoke.

BRITISH ELECTRICAL INSTALLATION CONTRACTORS (LIMITED).—At meetings of this Company, held on January 14th and February 4th, it was resolved and confirmed that the Company be voluntarily wound-up, and that Mr. W. J. Hill, 50, Foregate-street, Worcester, be the liquidator.

J. E. H. GORDON AND CO. (LIMITED).—A petition for the compulsory winding-up of this Company (in voluntary liquidation) was presented on the 8th inst. by Messrs. John Tullis and Sons, of Glasgow, and is down for hearing at the Royal Courts of Justice, London, on Monday next, the 20th inst.

LANCASHIRE AND YORKSHIRE ELECTRIC LIGHTING COMPANY (LTD.).—The annual return of this Company, made up to July 12, 1892, was filed on January 30, 1893. Out of a capital of £100,000, divided into 20,000 shares of £5 each, 127 shares have been taken up, and a call of £2. 10s. per share made, resulting in the payment of £315, and leaving £2. 10s. in arrears.

LAURENCE, SCOTT AND CO. (LIMITED).—The annual return of this Company, made up to December 23, 1892, was filed on January 12. The Company was registered in August, 1888, with a capital of £30,000, in £10 shares. At the time of making up, 1,406 shares had been taken up, of which 500 had been issued as fully paid. Upon the remaining 906 shares, the full amounts have been called, and all calls (£9,060) paid.

MULHOLLAND, MAUGHAM, AND CO. (LIMITED).—The annual return of this Company, made up to November 22, 1892, was filed on December 7th following. The Company was registered on July 29, 1890, with a capital of £5,000, divided into 120 founders' and 380 ordinary shares of £10 each. At the time of making up, 120 founders' and 1,678 ordinary shares were taken up, and upon the founders' shares the full amounts have been called, while upon the ordinary shares £5 per share has been called, resulting in the total of £2,035.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to February 2nd, was filed on the 7th, out of a capital of £50,000 in £5 shares, 6,104 shares have been taken up, of which 43 shares have been issued as fully-paid. Upon the remaining 6,061 shares a call of £4 per share has been made, resulting in the payment of £25,984, which includes a sum of £1,340 paid in advance of calls.

PERU TELEPHONE COMPANY (LIMITED).—The annual return of the above-named Company, made up to January 14th, has been filed. Out of a total capital of £100,000, divided into 20,000 shares of £5 each, only seven shares have been taken up, no calls made, and nothing paid, the original signatories to the Memorandum of Association being the only shareholders.

POOLE AND WHITE (LIMITED).—Mr. Edwin Wilding, Bloomsbury Mansions, Hart-street, Bloomsbury, has been appointed liquidator in the winding-up of the Company.

QUEEN ANNE'S MANSIONS LIGHTING AND HEATING COMPANY (LIMITED).—The annual return of the above-named Company, made up to December 28, 1892, has been filed. At the time of making up, all the shares had been taken up and all issued as fully paid.

ST. LUKE, CHELSEA, ELECTRIC LIGHTING COMPANY (LIMITED).—By an agreement made November 24, 1892, and filed on December 9th, it was agreed that this Company shall purchase from the Cadogan Electric Light Company (Limited) and its liquidator the lease of the premises at 91, Manor-street, Chelsea, S.W., and the powers granted by the Vestry of Chelsea, for the erection and maintenance of electric lines and works, and those granted by the Vestry of St. George, Hanover-square, for the construction and maintenance of a main under footway in part of Belgrave-square, and also the business, goodwill, plant, cables, machinery, stock in trade, book and other debts, &c., of the old Company. The consideration for the said sale is the payment of £4,250 in cash, and the allotment of 455 fully paid £10 shares, Nos. 1 to 455 inclusive, in such manner as the liquidator may direct. The annual return of the St. Luke, Chelsea, Electric Lighting Company, made up to January 11th, has been filed. At the time of making up the seven signatories' shares were the only ones taken up, and no calls have as yet been made. The above agreement, therefore, had not been put into effect at the time of making up the return.

VARLEY'S ELECTRIC PATENTS PROPRIETORY (LIMITED).—A meeting is to be held at 527, Mansion House-chambers, E.C., on March 14th, at 12, to receive an account of the winding-up.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended February 12th were £952, as against £881 for the corresponding period of last year, being an increase of £71. The total receipts for half-year amount to £5,862, against £5,033 in the corresponding period of 1892, being an increase of £829.

COMPAGNIE L'INDUSTRIE ELECTRIQUE DE GENEVE.—The receipts of this Company for 1892 were 177,586fr., and the expenses 87,816fr., or a balance of 89,770fr., which is 17,447fr. more than the previous year's balance.

CRYSTAL PALACE COMPANY.—In the course of his address to the shareholders of this Company, at their meeting last week, Mr. George Rait stated that, from a scientific point of view, the Directors considered the Electrical Exhibition held at the Palace in 1892 had been an enormous success, but from a financial point of view it had been an enormous failure ; besides which the Exhibition had blocked up the space, and they had, therefore, been unable to hold other shows.

MUNTZ'S METAL COMPANY (LIMITED).—For the past year a dividend of 10 per cent. per annum is proposed, leaving £15,781 to be carried forward.

PHOSPHOR-BRONZE COMPANY (LIMITED).—After placing £1,000 to the credit of the contingency fund, the Directors, in their annual report, recommend a dividend of 1¼ per cent., carrying over a balance of £134.

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SOCIETE CENTRALE D'ELECTRICITE.—A Company has been formed with a capital of 120,000fr. for the creation and exploiting of electrical works in the towns of the departments of the Rhône, the Loire Haute Loire, Saône-et-Loire, Ain, Jura, Isère, and Ardèche. The offices are at Lyons.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended February 10, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,616.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 8.	Price Wednesday, Feb. 15.	Rate per Cent. Yielded.	Dividend Due.	Business done during week ending Feb. 15. Highest	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	17/6	Anglo-American xd	53½ 54½	53½ 54½	4 11 9	Jan., Apr., July, Oct.	54½	..
£2,876,140	Stock	35/0	Do. Preferred xd	96 97	95 96	5 9 5	" "	96	93⅝
£2,876,140	Stock	5/0	Do. Deferred	12½ 13	13 13½	..	" "	13¼	12⅞
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11¼ 11⅜	11½ 11⅝	5 10 8	Mar., June, Oct., Dec.	11⅝	11½
£68,200	£100	6%	Do. 5 per Cent. Bonds	99 102	100 103	4 17 1	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	104 108	104 108	4 12 7	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175 180	175 180	3 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12 13	12 13	6 3 1	February and August	12½	..
6,000	10	10%	Do. Preference 10%	18 19	18 19	5 5 3	" "	18½	18½
12,931	5	1/7½	Direct Spanish (£4 paid)	2 3	2½ 3½	4 11 5	April and October..	3	2⅞
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	9	..
60,710	20	3/6	Direct United States	11⅜ 12	11⅜ 12	5 16 8	Jan., Apr., July, Oct.	12	11⅛
400,000	10	2/6	Eastern	14¾ 15	14¾ 15⅛	4 5 11	" "	15⅛	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15½ 16½	15½ 16	3 15 0	" "	15¾	15¼
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	111 114	112 115	3 9 7	May and November	114	112½
105,900	100	5%	Do. 5 per Cent. Debentures 1899	106 109	106 109	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension	14⅞ 15¼	15¼ 15⅝	4 11 1	Jan., Apr., July, Oct.	15¼	15
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	109 112	3 11 5	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103 106	103 106	4 14 4	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor Deb. 1900	102 105	102 105	4 15 3	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101 104	101 104	3 16 11	February & August	101½	..
180,227	10	1/3	Globe Telegraph and Trust	9⅝ 9⅞	9⅝ 9⅞	5 1 4	Jan., Apr., July, Oct.	9¾	9½
180,042	10	6%	Do. 6 per Cent. Preference	15 15¼	15⅛ 15⅜	3 18 1	" "	15⅜	15⅛
150,000	10	5/0	Great Northern	18¾ 19¼	19 19½	4 7 8	Jan., April, and July	19⅜	19
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	105 108	4 12 7	March & September	107⅞	..
17,000	25	12/6	Indo-European	43 45	43 45	5 11 1	May and November	44	..
88,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108 111	108 111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October...	..	..
3,381	£100 Cert.	30.0	Submarine Cables Trust 6% *	119 124	119 124	4 16 9	" "	..	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	102 105	102 105	4 15 3	March & September	102½	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	102 106	102 106	7 10 11	June and December	..	..
88,321	10	6d.	West India and Panama	1½ 1¾	1½ 1¾	..	" "	1½	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½ 11	10½ 11	5 9 1	May and November	11	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref	8½ 9½	9 10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 19.7	105 108	106 109	4 11 9	June and December	..	..
64,242	15	3/0	Western and Brazilian	7⅜ 8½	7⅜ 8½	5 9 1	" "	8	7⅞
33,129	7½	3.0	Do 5 per Cent. Cumulative Preferred	5¾ 6½	5¾ 6½	6 0 1	" "	6⅛	6
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾ 2½	1¾ 2½	..	" "	..	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104 107	104 107	5 12 2	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104 107	104 107	5 12 2	" "	1 6	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	121⅝	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	103 106	103 106	5 13 2	March & September	—	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
224,850	1s/0	1½d.	Consolidated Telephone Const. & Maintenance	7/8 15/16	7/8 15/16	7 16 5	May and November	..	..
220,000	£1	4½d.	Oriental (11s. paid)	¼ ½	¼ ½	7 18 2	Yearly	..	..
454,747	5	2/6	National	5¼ 5½	5½ 6½	5 9 1	June and December	5 15/16	5 15/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14⅜ 15½	14½ 15½	3 17 6	" "	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref	13¾ 14½	13¾ 14½	4 4 3	" "	14 1/16	14
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref (£3 paid)	4⅜ 4⅝	4⅜ 4⅝	..	..	4 9/16	4¼
726 477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112 115	1 2 115	3 18 3	January and July ..	114⅜	114½
48,000	£10	..	New Telephone, Limited (£4 paid)	.. ..	.. ..	..	..	..	..
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	—	City of London Electric Lighting (fully paid)	12½ 13	12½ 13	—	—	13¼	12½
20,000	£10	..	Do. 6 per Cent. Preference	7¾ 8¼	8 8½	2 18 2	..	8 1/16	8⅛
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	—	..	..
£160,000	£5	..	Electricity Supply Company Ordinary	5 5¼	5 5¼	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	1½ 2¼	1½ 2¼	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5½	5 5½	..	—	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	6 6½	6 6½	..	..	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	4 4¼	4¼ 4½	..	January and July ..	..	..
10,000	£5	4½% '91	Do. (fully paid)	5¾ 6	6 6½	..	March	..	..
111,000	5	..	London Electric Supply	½ 1	⅝ ⅞	..	March	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	—	..	..
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	104	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5½ 6½	5½ 6⅜	—	—	..	..
18,680	£5	9½%	St. James' and Pall Mall	7¾ 8¼	8 8½	..	—	8 1/16	8
7,900	£5	7%	Do. 7% Preference	8 8¼	8 8¼	4 2 4	—	8 1/16	8⅛
42,853	5	3%	Westminster Electric Supply (fully paid)	1¾ 6¼	5½ 6	2 10 0	—	6⅛	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/93	Brush Electrical Engineering	3⅛ 3⅜	3⅛ 3⅜	..	—	3 1/16	3
69,996	2	6%	Do. 6 per Cent. Preference	2⅜ 2⅝	2¼ 2½	4 16 0	—	2 1/16	2
£125,000	Stock	..	Do. 4½ per Cent. Debentures	104 106	104 106	..	—	10 1/2	10
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July ..	..	..
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	1¾ 2¼	1¾ 2¼	..	—	..	..
45,000	10	12/0	Electric Construction	2½ 3	3½ 4	..	—	..	..
70,000	2	10/0	Elmore's Patent Copper Depositing	⅝ ¾	⅝ ¾	..	—	3 1/16	3
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	..	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	22½ 23½	22½ 23¼	5 6 4	February & August	23¼	22 13/16
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	103 105	103 105	4 5 9	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0 6/0	5/0 6/0	..	..	..	..
78,949	5	4/2⅞	Swan United (£3. 10s. paid)	3 3¼	3 3¼	10 0 0	May and November	3⅜	3 3/16
37,350	12	12/0	Telegraph Construction and Maintenance	38 42	38 42	5 14 3	March and July....	40	37
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July .	..	..
..	£5	15%	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	..	—	..	..
..	£5	8%	Do. Preference (fully paid)	¾ 1¼	¾ 1¼	—	—	..	..
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	.. ..	.. ..	..	—	..	..
600,000	Stock	5%	Do. Stock xd	37 39	37 39	1 5 7	May and November	38	..

* 30s. balance of Coupon October 15, 1892.

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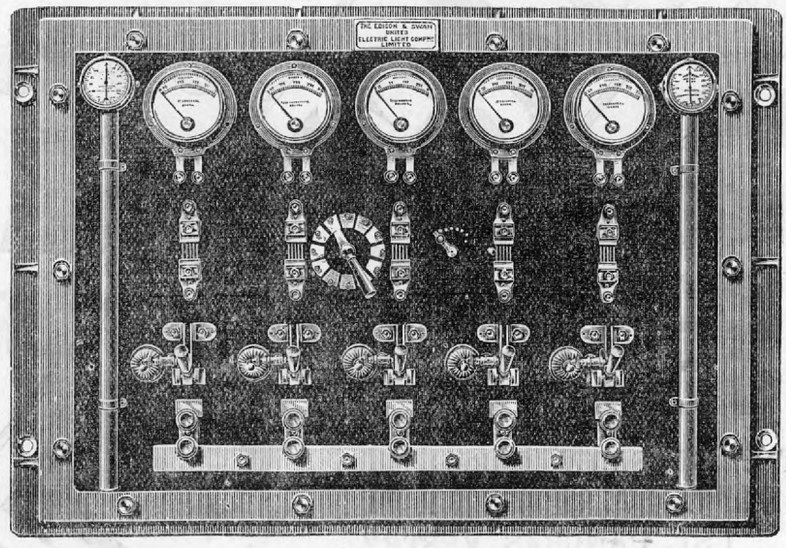

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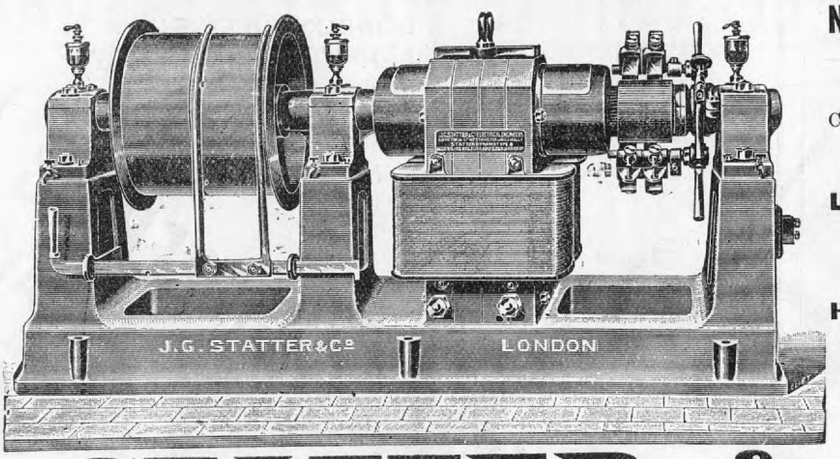

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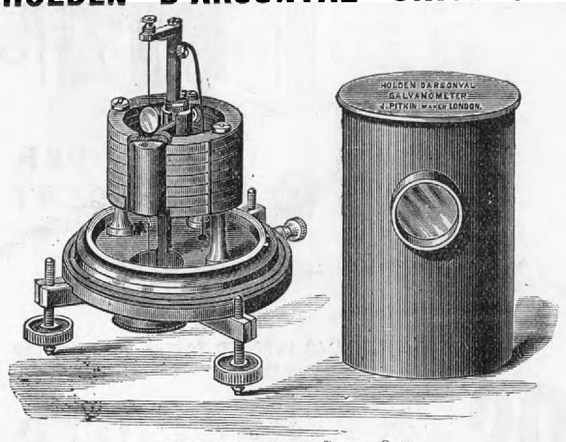

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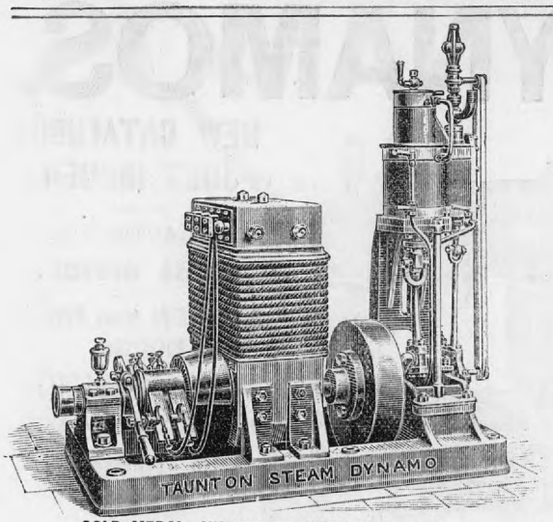

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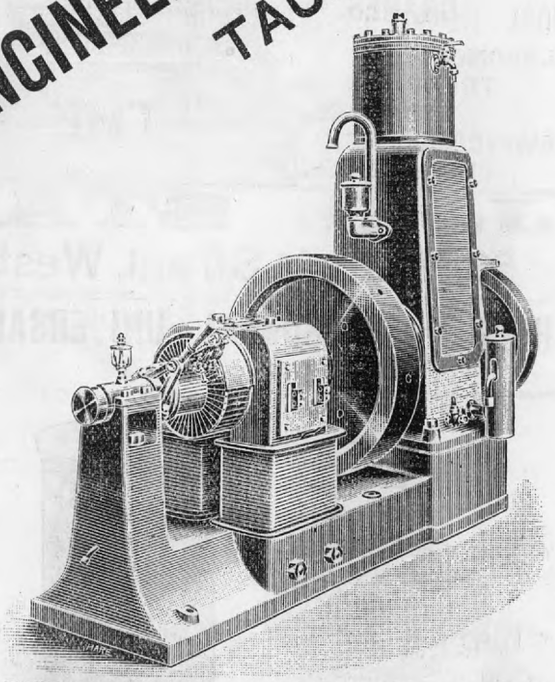

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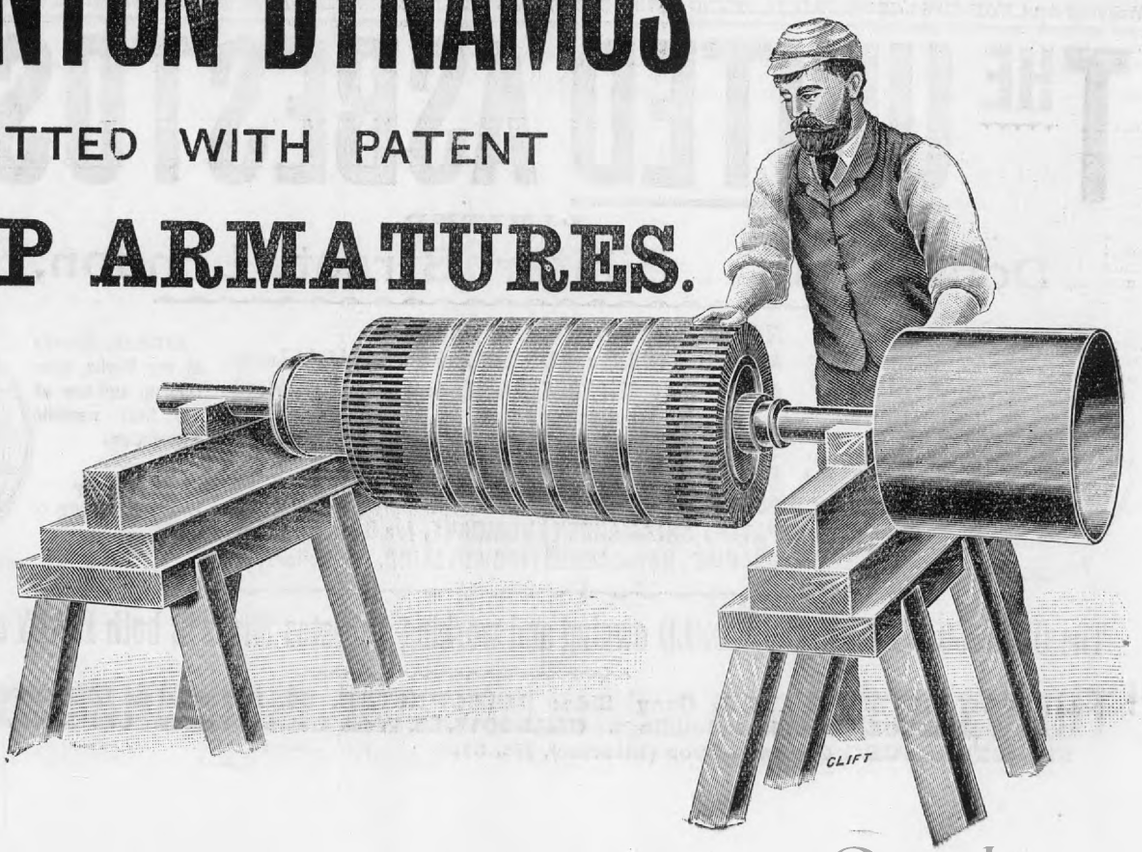

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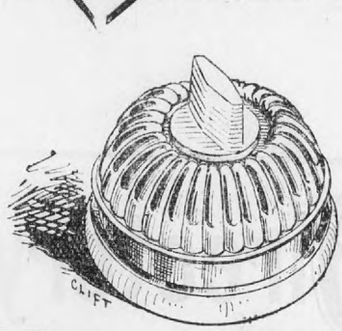

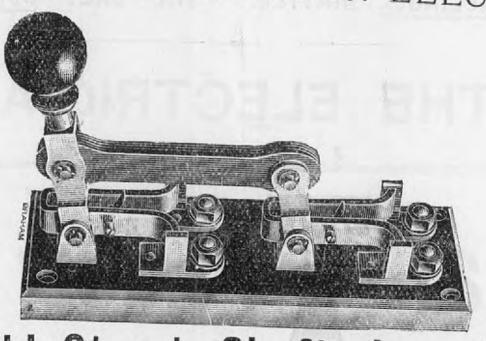

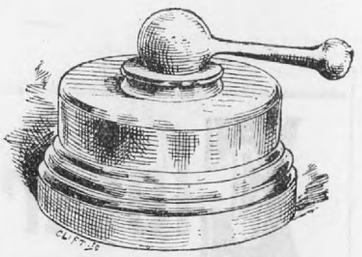

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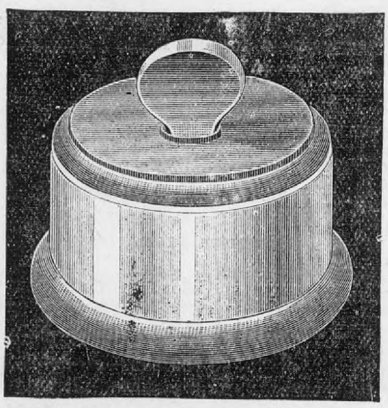

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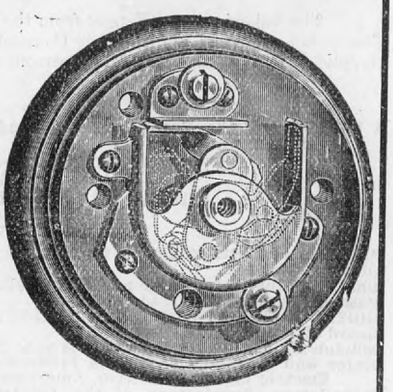

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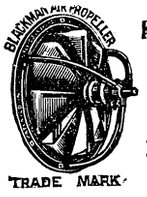

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Tenders must be made on the prescribed Forms, and delivered at the Offices of the Authority, 51, Prince-street, Bristol, by WEDNESDAY, the 15th of March, 1893, endorsed "Tender for Switchboards."

The lowest or any Tender will not necessarily be accepted.

The Specification, Plans, and Form of Tender may be obtained at the Offices of the Sanitary Authority, on payment of £2, which will be returned on receipt of a bona fide Tender.

D. TRAVERS BURGES, Town Clerk.

51, Prince-street, Bristol, February, 1893.

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Samples and sealed Tenders to be forwarded to Mr. A. B. MOUNTAIN, Borough Electrical Engineer, Gasworks-street, Huddersfield, not later than WEDNESDAY, the 15th March, 1893, and the tenders must be endorsed "Main Switches, &c."

By Order,

H. BARBER, Town Clerk.

Town Hall, Huddersfield, 15th February, 1893.

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ASSISTANT TELEGRAPH SUPERINTENDENT WANTED for India. Must be thoroughly trained in both out-door and mechanical shopwork and capable of undertaking the duties of the Superintendent when required. Candidates should state their age and experience.—Applications must be made in writing to Mr. GEORGE BERKLEY, 57, Charing Cross, London, S.W., from whom particulars as to terms and engagement may be obtained.

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By order,

E. DICKENS, Secretary.

30, Old Broad-street, London, E.C.,
February 17, 1893.

THE LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).

NOTICE is Hereby Given, that the HALF-YEARLY COUPONS, which fall due on the 1st March, 1893, of the £100,000 SIX PER CENT. DEBENTURES of the Company will be paid by Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, London, E.C., on and after that date. The coupons must be left with the Bankers three clear days for examination.

By order,

(Signed) R. M. CUNNINGHAM, Secretary.

19, Great Winchester-street, London, E.C.,
15th February, 1893.

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Winchester House, 50, Old Broad-Street,
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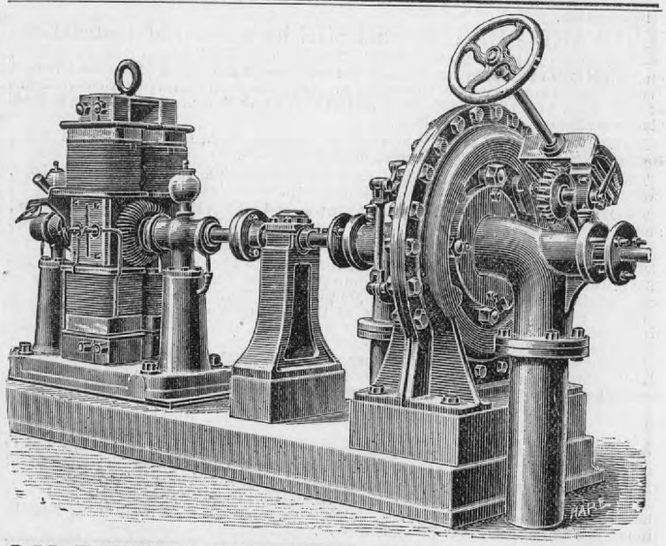

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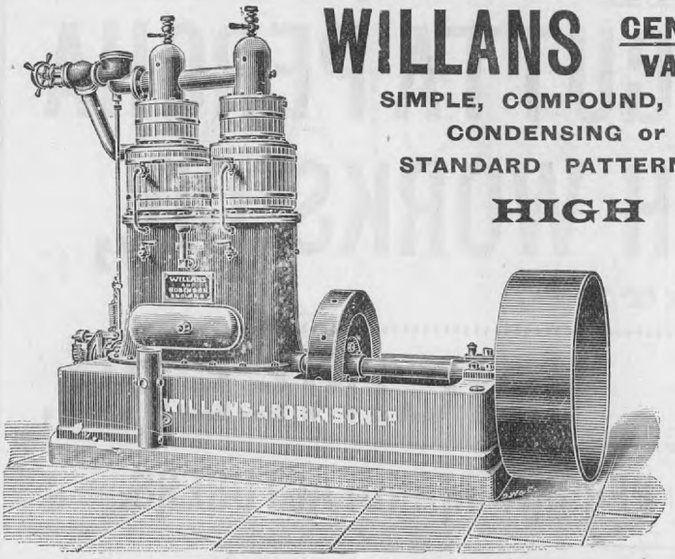

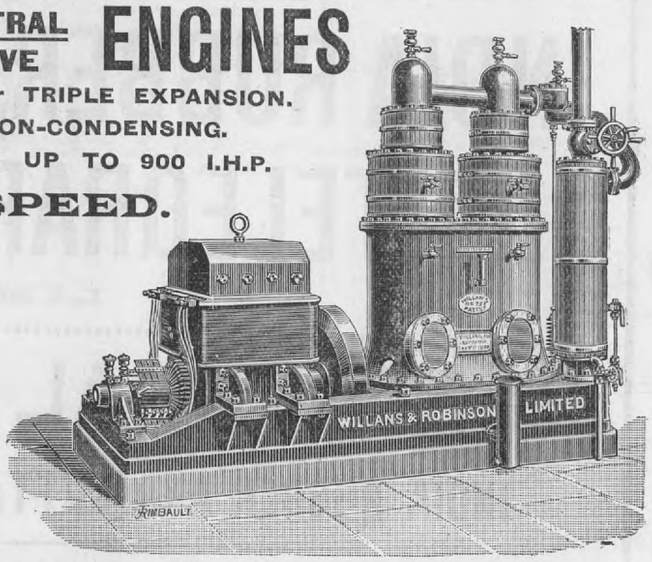

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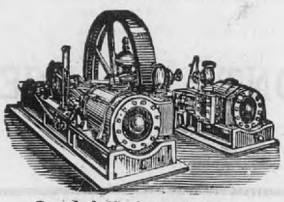

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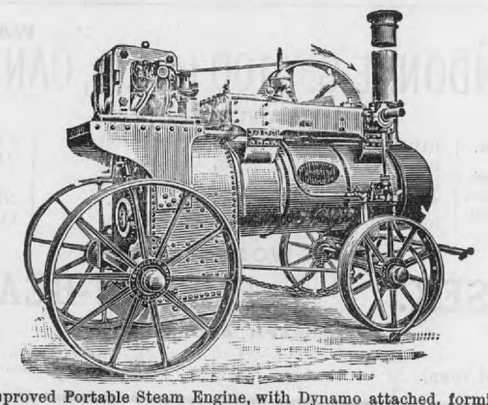

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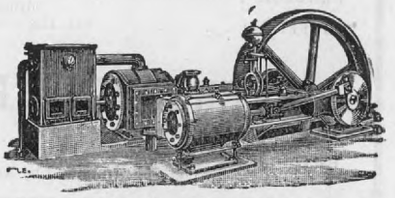

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 771.—Vol. XXX. FRIDAY, FEBRUARY 24, 1893. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

We heartily congratulate the *Electrical Review* upon the result of the libel case heard last week. Being an action brought by Mr. Harness against his critics in the name of an unfortunate medical man the case was unsatisfactory, but still more unsatisfactory was it as an attack by these critics upon the Harness belt, backed though they were by scientific men of every standing. The onus of exposing medical quacks ought not to be thrown on electrical journals; theirs is the sufficiently serious responsibility of checkmating charlatans connected with the electrical industry, and action should long ago have been taken by the Medical Association or some other wealthy medical body. To fight a man like Mr. Harness must be an expensive matter, and a difficult one, when only indirect thrusts are possible. It appears that the costs in this case cannot be recovered, since Dr. Tibbits, whom none could see without a feeling of pity, is a man of straw; Mr. Harness was financing the case, but cannot be called upon for costs. When Mr. Bankes, for the defence, clearly stated that it was his intention to prove that the whole system was a fraud, the learned counsel for the plaintiff were placed in a most awkward position, for they were merely appearing for Dr. Tibbits in a prosecution for libel. The scientific evidence given in this case will be available for use in the civil proceedings which are being instituted against Mr. Harness, but, as we remarked on the occasion of the County Court case of misrepresentation by the Medical Battery Company, the vendors of Harness belts, we hope that the subject of these impostures may lead to a successful Treasury prosecution.

The three companies to the accounts of which we referred last week have since held their meetings, but nothing of particular importance transpired. At the Kensington and Knightsbridge gathering a shareholder thought he ought to get a better dividend and the Company a better district; at the other meetings the voice of the critic was pitched in a minor key. Three interesting items of information were supplied by the chairman of the Kensington and Knightsbridge Company. The gross earnings per lamp have fallen from 7s. 8d. to 7s. 7d.; the ratio Profit/Gross Income has risen from 0·36 to 0·42, and the Lane-Fox case cost the defendants £6,000.

When the rough balance-sheet of the St. Pancras Vestry's electricity supply venture was first published some weeks ago, we pointed out that the figures neither proved nor disproved the case for the municipalisation of such undertakings. The detailed accounts which are now before us confirm this view. It would be unfair to compare St. Pancras with St. James; on the other hand the Chelsea Company and the St. Pancras concern have one or two points in common. Both supply districts which though dissimilar in character have an equal degree of desirability—or undesirability if one prefers to express the matter in negative terms; and although the St. Pancras area is nominally much larger it is actually much the same size as that covered by the Chelsea Company. Again, whilst the Chelsea Company has expended £81,000, St. Pancras has spent nearly £89,000 of the ratepayers' money; the gross revenues are also much the same being, respectively, £11,000 and £12,500. It was upon "management expenses" and "wages," however, that partisans fastened. The advocates of municipalisation alleged that there would be a considerable saving under the first heading, and opponents retorted that such a saving, if made, would be wiped out by increase under the second heading. So far as the two ventures under consideration are concerned, both prophecies have been partially verified, but the net result favours the municipal vaticination.

In connection with the new Kelvin wattmeter, which is described in another column, it is of interest to consider the suggestion made by Dr. Fleming to supply the current for the shunt coil by means of a little transformer, the primary of which is placed across the mains. When the power to be measured is supplied at a high-pressure, this device seems useful, as it not only saves the expense of a large non-inductive resistance, but also reduces the waste of energy occurring in the instrument. If, for instance, the Kelvin wattmeter described in this issue were employed for measuring the power sent out at 2,000 volts from a central station, it would have to be used in conjunction with a non-inductive resistance of 40,000 ohms, wasting over an eighth of a horse-power. In such cases Dr. Fleming's device could be adopted with advantage. When, however, power is being delivered at low-pressures, it does not seem at all advisable to use a subsidiary transformer in this way, for, although the waste in the instrument could be reduced, the time constant of the circuit containing the shunt coil of the wattmeter would be increased, and the wattmeter would cease to read correctly.

Among the interesting novelties shown by Dr. Fleming at his recent Cantor Lectures before the Society of Arts, were

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some resistances which promise to be of great value. They were made at his request, by well-known manufacturers of plumbago crucibles, from a mixture of plumbago and Stourbridge clay. The compound was moulded into the form of rods, about a quarter of an inch in diameter and five or six inches in length, and was baked as in the manufacture of crucibles. By using different proportions of clay and of plumbago, the specific resistance can be altered. Very high resistances can be thus obtained without the use of fine and expensive wire, while the temperature coefficient may be reduced to almost nothing, or may be made negative. The curious behaviour of mixed powders noticed by M. Branly and others is said to be absent in these resistances, and they cannot, of course, short circuit by fusion. A half-and-half mixture of plumbago and clay has a resistance more than 4,000 times that of German silver, and such rods will dissipate about 1 watt per square inch.

Cheap and reliable resistances of several hundred ohms would be convenient for a purpose which we venture to suggest with some hesitation. They might be used on ordinary electric supply circuits, instead of Leclanché batteries, for ringing electric bells. The chief advantage would be that they would require no attention, and the serious drawback to electric bells, namely, the drying up or exhaustion of the batteries, would be avoided. Our reluctance in making this suggestion is due to our regret lest, by it, the trade in batteries might suffer; and the thought that few, if any, meters could register the current used for ringing an electric bell. The current, such as it is, would not be used for electric lighting, and would, therefore, come under the cheap rate for power. In the "Hopkinson" system of charging, where a fairly large sum is paid every quarter for the privilege of having 100 volts at disposal at any moment, no compunction need be felt in making such use of the electric mains; but on a plain meter basis, it really seems almost like stealing. And yet when asked to supply light, the companies say: "No, we supply electricity and you can do what you like with it." It is to be feared that our suggestion, if of any value, will be useful only to the consumer, and will be bad for trade. The least we can do, is, by publishing the suggestion, to prevent a patent for the combination of a central station, an electric bell and a high resistance for the purpose hereinbefore set forth, and substantially as herein specified and described.

Royal Institution.—Lord Rayleigh will be unable to deliver his lecture next Saturday afternoon on "Sound and Vibrations" in consequence of illness.

Maidstone.—The Town Council has resolved to obtain information as to the terms upon which a company will carry out their Electric Lighting Order.

Junior Engineering Society.—We are requested to state that the visit of the members of this society on March 2nd is unavoidably postponed to March 9th.

Advance in Mexican Telegraph Rates.—Owing to the continuance of a high rate of exchange, the Mexican Telegraph Company has, states the *Mexican Financier*, of January 28th, advanced its rates, the increased tariff to date from February 1st.

Hammersmith Vestry.—At the last meeting of this Vestry permission was given to the Electric Light Committee to expend £100 in making experiments for the purpose of utilizing the dust and house refuse to produce heat for electric lighting purposes.

The Barry Island Electric Railway.—In deference to a most pronounced expression of public opinion in the district, the Parliamentary Committee of the Barry and Cadoxton Local Board have determined not to offer any opposition to the Barry Railway Company's Bill for an electric railway.

Telegraphic Communication between Germany and the Cameroons.—Dr. Stephan, the German Postmaster-General, on Tuesday received a telegram from Sir John Pender, G.C.M.G., M.P., congratulating him on the establishment of telegraphic communication between Germany and the Cameroons.

Personal.—Sir Henry Trueman Wood, the Secretary of the Royal Commission for the Chicago Exhibition, sailed on Wednesday for America by the "City of Paris," to take charge of the British Section at Chicago. Mr. H. D. Wilkinson, Chief Engineer to the Section, was also a passenger by that vessel.

Society of Engineers.—The first ordinary meeting of this Society was held on February 6, when the premiums awarded for Papers read during the year were presented by the retiring president. A "Society's Premium" was presented to Mr. S. Sellon for his Paper on "Electrical Traction and its Financial Aspects."

The Antwerp Hydro-Electric Scheme.—The Directors of the Compagnie Hydro-Electrique Anversoise announce that notwithstanding the loss the Company has suffered by the death of M. van Rysselberghe, the hydro-electric scheme will go forward under the direction of the best possible technical advisers.

The Groper Microphone.—The Groper Microphone is provided with two diaphragms, one of mica 0·04mm. thick and the other of carbon, a layer of air separating the two. At the back of the carbon disc are several sloping tiers on which are ranged balls of carbon, the front row of each tier resting against the carbon disc.

Electricity in Mines.—The Vicoigne Mines in the Pas-de-Calais are asking for tenders for a somewhat extensive electric mining plant. From a central station, $2\frac{1}{2}$ miles from the mine, current must be supplied to a number of 5-H.P. pumps at the bottom of the mine, to five 6-15 H.P. winding machines, to 12-H.P. hauling machines, and to arc and incandescent lamps.

Cape Town.—The electric lighting of Cape Town, as we have already announced, has fallen into the hands of Messrs. Siemens and Halske. The scheme for street lighting will provide for 30 arc lamps and 400 incandescent lamps, and for private houses about 10,000 lamps of 8 c p. Power will be supplied by water from a specially constructed high level reservoir. Distribution will take place on the 5-wire system with accumulators.

An Electric Acidimeter.—An ingenious apparatus for indicating the progress of fermentation has, says *Industries*, been brought out by Messrs. R. and A. Collette, of Paris. It consists of a pair of battery plates inserted in the fermenting liquid, with a galvanometer connected to them by a pair of wires. As the liquid becomes acid, the deflection of the galvanometer needle increases rapidly. An alarm bell can be worked in connection with the apparatus by a suitable relay.

Train Lighting.—At the last meeting of the Owen's College Engineering Society, Mr. Harry Pollitt, of the Manchester, Sheffield, and Lincolnshire Railway, contributed a Paper on "Train Lighting." Mr. Pollitt referred to the various systems of train lighting by electricity and oil gas, holding that as yet the latter was the best system, as, by only a slight addition to the weight of the carriage, the lamps could be fed for 24 to 36 hours without recharging.

Cable Interruptions.—

	Date of interruption.
Cayenne-Vizeu	September 24, 1892.
St. Thome-Loanda*	February 17, 1893.
Gibraltar-Tangier	February 18, 1893.
Aden-Zanzibar*	February 20, 1893.

* The simultaneous interruption of these cables causes a total stoppage of telegraphic communication with South Africa; the repair of the Aden-Zanzibar Cable is, however, expected within two or three days.

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Paper for Photometer Screens.—M. Aimé Witz is of opinion, says the *Gas World*, that in photometry the best paper is the French "papier écolier," a soft, dull-surfaced, but smooth and slightly porous, scribbling-paper, and the best stain a spot of olive-oil which has had time to grow old upon the paper, but has neither become yellow or gathered dust. He also remarks that machine-made paper is never the same on both sides, and that it is therefore necessary to have the means of turning the paper round through two right angles, and of examining it on both sides alternately.

The Westinghouse Exhibit at the Chicago Exhibition.—"The Westinghouse plant at the World's Fair promises," says the *Western Electrician*, "to be one of the most attractive features of the exposition, owing to the great size of the engines and dynamos, and the thorough manner in which the work of installation is being done. The great 2,000 H.P. Allis engine, with its fly-wheel 30ft. in diameter, from which will be driven two 10,000 light dynamos in tandem, will occupy a prominent position in the machinery hall, and *is sure to be ever the cynosure of an admiring throng.*"

Glasgow Street Lighting.—At an early hour on Wednesday morning the street arc lamps were switched on for the purpose of testing. As arranged at present, the official inauguration is to take place on Saturday evening. Some 108 arc lamps are to be used; but of these, only 72 have as yet been erected. They are placed alternately on each side of the street at a distance of 160ft. from each other. The lamps are of the Brush Company's make, and are arranged 36 in series, so that the total pressure is about 2,000 volts. When all the lamps are up, the voltage will be 3,000 on each circuit. The iron columns are 17ft. in height; both pillars and lanterns being similar to those used in the City of London.

The St. Louis-Chicago Electric Railway.—According to the *Electrical World* of February 11th, 20 miles of the roadbed of this line have been completed, and contracts for the remainder have been let. The contractors are Bagnall Brothers, of St. Louis, and Givens Brothers, of Memphis, Tenn. Both of these firms are well known and have laid more than 1,800 miles of railroad track for various Western and Southern roads. The contract price is $5,500,000, of which $2,750,000 is to be taken in bonds of the company at par. The time limit of the contract is one year, but it is thought probable that the roadbed will be completed by the autumn, as it is proposed to start work immediately at several different points, and work in both directions.

Power and Lighting Charges at the Chicago Exhibition.—Special illumination can be had at the Chicago Exhibition for 32s. per 16-c.p. light from May 1st to October 31st. The rate for steam power is £8 per horse-power. Those who only require occasional power will be charged 2d. per horse-power per hour. The charges for electric power, exclusive of a fee of £2 or £3 for making connections, will be:—For ¼ H.P. and less, £4; ¼ to ½ H.P., £8; ½ to 1 H.P., £15; 1 to 2 H.P., £14 (per H.P.); 2 to 3 H.P., £12 (per H.P.); more than 3 H.P., £10 (per H.P.). The maximum charge of £4 for ¼ H.P. for six months is at the rate of £32 per H.P. per annum. The minimum charge, £10 per horse power, is at the rate of £20 per horse-power per annum.

The Ventilation of the New York Electric Subways.—It is not, we believe, generally known that the constant explosions which occurred during 1887-1889 in the New York electric subways led to the adoption of a pressure system of ventilation. The plan adopted is to provide by blowers and pipes a pressure in the manholes and ducts greater than the gas pressures in the surrounding earth, and sufficient to renew and change the air in the subways at least once an hour, the subways being kept as air-tight as possible, and the air forced into them being compelled to make its exit through the walls of the manholes or through the walls of the ducts. This system necessitated establishing "blower" stations at different parts of the subways, and there are now in operation twelve Roots blowers in nine different stations.

Aix-la-Chapelle.—Messrs. Schuckert and Co., of Nuremberg, have lately completed the central station at Aix-la-Chapelle. The plant is capable of lighting 20,000 incandescent lamps of 8 c.p. each. There are three Cornish boilers of 1,500 square feet heating surface, by the firm of J. Piedbœuf, of Aix-la-Chapelle. The engines, of which at present two sets are fixed, run at 120 revolutions per minute. They are triple-expansion condensing engines, by C. Kuhn, of Stuttgart; and the dynamos are by Schuckert. There are 140 Tudor cells, with a capacity of 1,610 ampere hours, and capable of discharging at a maximum rate of 483 amperes. There is room left in the building for extension. The cables, manufactured by Messrs. Felten and Guilleaume, of Mülheim-on-Rhine, have a total length of about 40 miles; they are double lead covered and armoured.

Electric Light Box Explosion.—On Wednesday last in the Lord Mayor's Court an action was brought against the Gas Light and Coke Company to recover damages for injuries alleged to have been caused through an explosion of gas. The plaintiff, a warehouseman, said that on October 14th he was in Great Tower-street, standing on a "box" in the pavement which was used for the electric light, when an explosion of gas occurred. The negligence alleged was that there was an escape of gas from the main, and that workmen in digging struck some stones, which emitted sparks, and thus ignited the gas. The defence was that the electric light box became filled with gas, and that the electric light ignited it. It was further stated that the electric light boxes were sources of great danger to the public, because they became receptacles of leakage gas. The jury found for the plaintiff for £40.

M. Moissan's Electric Furnace.—In our issue of December 23, 1892, p. 214, we gave a brief description of a laboratory electric furnace devised by M. Henri Moissan; we gave at the same time a summary of the results obtained by him with this apparatus. Since then M. Moissan has succeeded in making transparent carbon crystals, commonly called diamonds, and as some of our readers may possibly like to try their hand at this fascinating pursuit we give M. Moissan's recipe:—Place about 200 grammes of a mixture of cast-iron and carbonized sugar in a crucible. The crucible should be of carbon and should rest on a bed of magnesia, the whole being contained in a block of lime. After five or six minutes the current is stopped and the crucible and its contents are quickly plunged into cold water. The metal solidifies superficially and the interior mass expanding as it cools becomes subjected to a high pressure, under which the liquid carbon solidifies. On dissolving the nugget with acid a number of microscopic diamond crystals are found.

Earthing Electric Light Circuits.—In an article in *La Lumière Electrique* of February 18th, M. Frank Géraldy discusses the question of "earthing." Theory, he says, indicates that if we wish to earth a conductor it is preferable to earth the negative. With this arrangement, if there is a steady leak, and consequent electrolysis in the vicinity of the electric light circuit, its effects are focussed upon that circuit, whilst in the reverse case water and gas pipes may be attacked, and serious troubles may arise. In either case there is damage and expense, but "it is better to pay one's own little bills than those of other people, who make more fuss and charge more highly." To the contention that since faults are inevitable it is better to frankly ground the system, and thus ensure that incipient faults shall be rapidly developed and localised by blown-out fuses, M. Géraldy replies that accidents seem a rather costly mode of repairing defects of the kind. M Géraldy's advice is that all electrical engineers, whether telegraph, telephone, lighting or traction engineers, should give up the use of earth, as a game not worth the candle.

The Westinghouse Company and the Three-Wire Patent.—At the last meeting of the Brighton Town Council the Lighting Committee reported that, in reply to a letter written on behalf of the Westinghouse Company, they had resolved "that Messrs. Faithfull and Owen be informed that the Corporation have never used and are not using any three-wire system, and that the system they contemplate adopting does not involve the use of two dynamos in series, is thus essentially dissimilar to that of the St. James' and Pall Mall Electric Lighting Company, and is not in any way an infringement of Dr. Hopkinson's Patent." The resolution which immediately succeeded this on the Lighting Committee's proceedings was:—"That the expense incurred in changing over the Pavilion installation from the two-wire to the three-wire system be borne by this

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Committee." The report was agreed to.—It is understood that there is a probability of an arrangement being come to between he Corporation and the Brighton and Hove Electric Lighting Company, by which the Corporation will be left in undisturbed possession of the electric lighting business in Brighton.

The Westinghouse Separable Lamp.—In a letter to *The Engineer*, Mr. Hiram S. Maxim relates that in the spring of 1881 a consultation was held by the officers and mechanical experts of the United States Electric Lighting Company at New York. The Edison patents were carefully gone into, and Mr. Maxim gave it as his opinion that if the Edison patents were ever sustained it would be on the narrowest kind of a claim, such, for example, as the combination of a slender carbon mounted in a high vacuum, platinum conductors melted into the glass, and with the globe all in one piece. It was decided that Mr. Maxim should make some specimen lamps, and have them ready in case the Edison patents should be eventually sustained on these grounds. He accordingly made some lamps in two pieces exactly, he says, after the manner of the new separable lamp. The specific lamp referred to as the *new* separable lamp was patented by Mr. Maxim in the United States, September 13, 1881, the application being filed April 25, 1881.—Mr. Francis Jehl writes us that in a work by A. Merling (1882), p. 393, it will be found that a glass blower by the name of Böhm describes a lamp similar to the "separable" lamp.

The Liverpool Overhead Railway Electric Signals.—The expenditure of electric energy in working these signals is very small. Each station comprises four signals, each worked with a lowering current of 5 amperes at 40 volts, and with a holding down current of 0·25 amperes at 40 volts. With a three-minutes' service for 20 hours a day, each signal will be lowered 400 times, requiring $400 \times 1 \times 5 = 2000$ ampere-seconds, or (say) 0·5 ampere-hours per signal per day. The entire station with its four signals, each working at 40 volts, would, therefore, require $0{\cdot}5 \times 4 \times 40 = 80$ watt-hours per day, and the total system 1,040 watt-hours, or approximately 1½ H.P. hours per day. This, however, does not include the holding down currents. Assuming each signal to be held down 1½ minutes, it will be down 600 minutes per day, requiring 150 ampere-minutes, or 2·5 ampere-hours, or five times as much as for lowering, that is to say, a total of about 7½ H.P. hours per diem for all the signals. The total expenditure over the whole railway for the whole day, therefore, amounts to about 6¼ kilowatt-hours, which at 8d. per kilowatt-hour costs 4s. 2d., or the cost of a single signalman's wages for the day. Since the kilowatt-hour can be *produced* for much less than 8d., that figure may, perhaps, be taken to include interest, depreciation, &c., about which no mention is made by our contemporary *Engineering*, to whom we are indebted for most of these figures.

Bradford.—The following figures with reference to the working of this station, in addition to those given last week, will be of interest:—The electricity accounts show that the committee have sold electricity of the value of £4,548. 19s. 4d., which is somewhat over £1,000 more than was sold in the corresponding half. Taking the history of the working of the department since its commencement, it will be found that in 1889 there was a loss, including payments on account of sinking fund and interest, of £1,079; in the half-year to June 30, 1890, there was a loss of £732; in the December half a loss of £315; and in the first half of 1891 a loss of £30. For the second half of 1891 there was a profit of £970, for the first half of 1892 there was a profit of £387, and last half-year there was a profit of £1,089. So that from the commencement of the work of the department the whole of the loss resulting in the earlier stages has been extinguished, besides paying interest for sinking fund, and there is a net profit on the undertaking up to date of £289. 15s. 7d. The number of units sold in the last four half-years have been 85,103, and 154,258 in the first and second halves of 1891, and 141,622 and 224,232 in the first and second halves of last year. The numbers of pounds of coal used per unit in the same four periods have been:—16lb. and 12·58lb. for 1891, and 12·5lb. and 10·1lb. for 1892. The cost of coal per unit for the four periods referred to has been, respectively, 0·67d., 0·53d., 0·56d., and 0·42d.

Leicester.—At a special meeting of the Town Council on Monday last the report of the Gas Committee, with reference to electric lighting, came up for consideration. It stated that in July last the Committee had invited tenders; seventeen firms responded and twenty-five schemes were presented. The tender of the Brush Company for £26,977 for an alternate-current transformer sub-station system was recommended for acceptance, and it was suggested that borrowing powers for £50,000 should be sought. The Committee's Report was followed by one from the Gas Engineer, who stated that although the idea of using gas engines naturally presented itself to him he had found on closer investigation that the idea was impracticable, no gas engine being built large and steady enough. The Gas Engineer, in discussing the question of high versus low pressure, comes to the conclusion that the cost of generation is lower in the latter case, but points out that the former system is as a rule adopted in scattered districts bearing no comparison to those usually covered by low-pressure networks. The Gas Engineer is somewhat pessimistic as to the financial outlook of the proposed municipal electric lighting venture. He thinks it probable that the total cost of the unit will be 1s., so that during the first year, even if the maximum charge of 8d. per unit were made, the deficit would no doubt be somewhat heavy. Alderman Lennard in moving the adoption of the report explained the position of affairs at length, stating that the Committee were much impressed with what they saw in Germany, and in consequence it was proposed at Leicester to adopt slow speed compound horizontal direct-coupled engines. After a somewhat heated discussion further consideration of the matter was adjourned for a month, "contractors to be informed that any canvassing of members in the meantime would be a disqualification."

Electric Traction in Queensland.—The Brisbane Metropolitan Tramway Company have petitioned the Governor in Council to postpone the time limited by the Tramways Act for the compulsory purchase of the tramways by the Local Authority from 14 to 25 years. Under the eighty-fourth section of the Tramways Act of 1882 it is provided that 14 years after the completion of the tramway constructed under the provisions of the Act the Municipal Council may purchase the tramway with its appurtenances, subject to any mortgage existing thereon, on giving the company six months' notice of their intention to do so. It is in view of their intention to substitute electricity for horse-power that the Company have, under the 12th section of the Tramways Act of 1882 Amendment Act, presented a petition to the Governor in Council for an extension of time. The petition has been acceded to. Under Clause 3 of the Tramways Amending Act the Governor in Council has power to impose conditions with respect to the position of the wires of electric tramways so as not to interfere with the working of the telegraph and telephone wires. The following conditions, which are said to be based on those in force in the United States, have been recommended by the Postmaster-General, and have been approved:—1. Poles to be of suitable dimensions, and to be not less than 25ft. in height, and so placed as not to interfere with telegraph poles or wires. 2. Poles to be distant from one another not more than 130ft. 3. Supporting wires to be not less than 23ft. in height above the surface of the earth. 4. Conducting and trolley wires to be not less than 22ft. in height above the surface of the earth. 5. Conducting and trolley wires to be insulated in a suitable manner, to the satisfaction of the Postmaster-General, and so as to prevent the current being conveyed to the non-conducting poles or wires. 6. Proper precautions must be observed, to the satisfaction of the Postmaster-General, to prevent the falling of wires or cords; also for protecting the trolley wires by steel guard wires running parallel to them, not less than 6in. away, as a precaution against accident from the falling of telegraph, telephone, or other wires. 7. Special arrangements, approved by the Postmaster-General, to be made at crossings. 8. *A second or return wire to be provided instead of using the earth as a return circuit.* 9. The conducting wire to be carried at the opposite side of the respective streets or roads to that on which the telegraph or telephone lines are placed. 10. Each section to be provided with automatic devices for switching off at power stations.

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ELECTROMAGNETIC THEORY.—XLIV.

BY OLIVER HEAVISIDE.

(*Continued from page 353.*)

§ **185.** For this reason, a perfectly conducting mass exposed to electromagnetic radiation in ether cannot be heated thereby, for heating would imply the absorption of energy. If, then, the law (whose existence has long been suspected) that metals tend to become perfect conductors when their temperature is sufficiently lowered, were absolutely true, it would follow that a metal, if once brought to zero temperature, would remain there, provided its only source of heat-energy be electromagnetic vibrations. At the same time it is conceivable, and, indeed, inevitable, that it should receive energy from them to some extent in another way, viz., by the electromagnetic stress producing motion in bulk, even though the establishment of irregular molecular motions be prevented.

Similarly, we should expect that a metal which obeys the law approximately would show very small absorptive power for radiation at very low temperatures. This refers to the reception of the energy of true radiation in ether—that is, in vacuo. A body may become heated in other ways, by the impacts of air particles, for example, if air be present. Prof. Dewar's late experiments are suggestive in this respect, but it is too soon to draw conclusions from partially-published experiments.

But even as regards strongly absorptive bodies, the perfectly black body of the thermal philosophers, for example, we may expect a similar diminution of absorptive and emissive power with fall of temperature. Stefan's law of radiation asserts that the emissivity varies as the fourth power of the absolute temperature. Since, however, in deriving this law from electromagnetic principles, as has been recently done by B. Galitzine, we seemingly require to invoke the aid of reversible cycles and the second law of thermodynamics, whose range of application is sometimes open to question, we may well be excused from an overhasty acceptance of the law as the expression of absolute fact. The second law of thermodynamics itself needs to be established from electromagnetic principles, assisted by the laws of averages, so that we may come to see more clearly the validity of its application, and obtain more distinct notions of the inner meaning of temperature.

§ **186.** As before said, a perfectly conducting screen enclosing a dielectric region supporting electromagnetic disturbances, keeps in their energy, which remains in the electric and magnetic forms, and if there be no sources of energy present, the total energy remains constant. Some interesting questions arise regarding the subsequent history of the electromagnetic disturbances, when left to themselves, subject to the obstructing and reflecting action of the screen.

In certain cases the initial state will continue absolutely unchanged; for example, when it is the steady state due to electrification, or associated therewith. Similarly as regards an initially steady state of magnetic force, that, for instance, associated with a linear current (without resistance) in the enclosed region. Again, in other cases, although the subsequent history of an initial state may be one of constant change, yet there will be regular recurrence of a series of states; as when a periodic state of vibration persists without any tendency to degrade. It is sufficient to mention the very rudimentary case of a plane wave running to and fro between parallel plane reflecting boundaries, without the slightest tendency to change the type of the vibrations. We see from these examples, which may be multiplied, that there is no necessary tendency for the initial state, even when vibratory, to break up and fritter down into irregular vibrations. Nevertheless, there does appear to be a general tendency to this effect, when the initial states are not so artfully selected as to prevent it happening. Even when we start with some quite simple type of electromagnetic disturbance, the general effect of the repeated reflections from the boundary (especially when of irregular form) and the crossing of waves is to convert the initial simplicity into a highly complex and irregular state of vibration throughout the whole region. This cannot happen universally, as we have seen, and therefore a general proof of conversion from any initial state to irregularity cannot be given; but there can be little doubt as to the usual possibility of the phenomenon. Especially will this be the case if the initial state be itself of an irregular type, such as that due to ordinary radiation from matter, when it is tolerably clear that the irregularity will persist, and become more complete.

Let us, then, assume that we have got the medium within our screen into this state in its extreme form, without enquiry into the intermediate stages. Then the very irregularity gives rise to a regularity of a new kind, the regularity of averages. The total energy, which is a constant quantity, will be half electric and half magnetic, and will be uniformly spread throughout the enclosure, so that the energy density (or energy per unit volume) is constant. As regards the displacement and the induction, they take all directions in turn at any one spot, quite irregularly, but so that their time-averages show no directional preference. Similarly, the flux of energy, which is a definite quantity at a given moment at a fixed spot, is constantly changing in amount and direction. But in virtue of the constancy of the mean density and the preservation of the normal state by constant exchanges of energy, there is a definite mean energy flux to be obtained by averaging results. This mean flux expresses the flux of energy per second across a unit area anywhere situated within the enclosure.

To estimate its amount, let the mean density of the energy be U. This is to include both kinds. Now fix attention upon a unit area, A, fixed in position anywhere within the enclosure, and consider the flux of energy through it under different circumstances. First of all, if the energy all moved the same way at the same speed v (that of propagation), as in simple plane progressive waves, and the direction of its motion were perpendicular to the fixed unit area A, then the energy passing through it would belong to a ray (or bundle of rays) of unit section, and the energy flux would be Uv simply. This is the maximum. But this is impossible, because energy would accumulate on one side of A at the expense of the other. The next approximation, to prevent the accumulation, is to let half the energy go one way and half the other; still, however, in the same line. This brings us down to $\frac{1}{2}Uv$. To go further, we must take all possible directions of motion into account. The original ray conveying Uv must assume all directions in turn, and the mean value of the flux through A must be reckoned. Now, if the ray of unit section be turned round so as to make an angle θ with the normal to A, the effective section of the ray is reduced from 1 to $\cos\theta$; that is, $\cos\theta$ is the fractional part of the ray which sends its energy through A, through which the flux per second is therefore $Uv\cos\theta$, due to the ray at inclination θ. The true flux through the area A is therefore the mean value of $Uv\cos\theta$ for all directions in space assumed by the ray. Now the mean value of $\cos\theta$ for a complete sphere is zero, and therefore the mean flux through A is zero. This is right, as it asserts that as much goes through one way as the other. To obtain the amount going either way we must average over a hemisphere only. The mean value of $\cos\theta$ is then $\frac{1}{2}$. But we are only concerned with half the total energy, or $\frac{1}{2}U$, when we are confined to one hemisphere. Consequently we have

$$W = \tfrac{1}{4}Uv, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

to express the flux of energy W per second each way through any unit area in the enclosure.

Another way of getting this result, which is, however, essentially the same, is to divide the original ray of unit section along which the flux is Uv into a very great number n of equal rays of unit section, each conveying $1/n$ part of the same, and placed at such inclinations to the normal to A that no direction in space is favoured. This amounts to dividing the surface of a sphere whose centre is that of the area A into n equal parts, the centre of every one of which defines the position of one of the n rays. Any ray now sends $(Uv/n)\cos\theta$ through A per second. Now sum this up over the whole hemisphere and the result is W. In the limit, when n is infinitely great, we have

$$W = \int_0^{2\pi}\int_0^{\frac{\pi}{2}} \frac{Uv\cos\theta}{4\pi}\sin\theta\, d\phi d\theta = \tfrac{1}{4}Uv, \quad . \quad . \quad (5)$$

as before. The 4π divisor in the integral is not the unspeakable 4π of the B.A. units. It is the area of the sphere of unit

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radius, whilst the other factor $\sin\theta\, d\theta d\phi$ is the area of an element of the sphere.

As this is an important fundamental result in radiation, it is desirable to establish it as generally and simply, and with as much definiteness of meaning as possible. Bartoli made it only $\frac{1}{2}Uv$ (apart from electromagnetic considerations, which are, however, only accidentally involved). On the other hand Galitzine makes it $\frac{1}{4}Uv$ by considering a special case, viz., that of a cylindrical enclosure with flat ends, one of which is a radiant source (perfectly black) at constant temperature, whilst the other end and the round surface are perfectly reflecting. It would appear, however, from the above method, that the result is general, and is independent of sources of heat, and of the emissivity and temperature. Since we made no use of the screen after introducing it to keep in the radiation, it may be dispensed with, provided the stationary condition be still maintained. Thus, if a portion of the screen be made "perfectly black," maintained at constant temperature, the quantity W, which represents the amount of heat falling upon it per unit area per second, is completely absorbed by it. But this is perfectly compensated by the emission from the black surface of an equal amount of heat. So $\frac{1}{4}Uv$ measures the total emissivity under the circumstances.

§ 187. Another important fundamental quantity is the mean pressure of radiation. In a simple ray the electric and magnetic stresses unite to form a pressure U along the ray, with no pressure or tension in lines perpendicular to the ray, that is, in the plane of the wave, as described in § 86. But when the radiation is balanced as in the last paragraph, there is no directional preference, and the pressure is all ways in turn, and therefore on the average, simulates a hydrostatic pressure. Its value may be readily estimated in a manner similar to that employed above concerning the mean flux of energy. When we make the energy U go all one way in a ray of unit section through the area A situated anywhere, the pressure in the ray is U, and this is the pressure on A if the ray is perpendicular to A. But when the ray is inclined to the normal to A at an angle θ, only the fraction $\cos\theta$ of the ray is concerned in the action upon A. Furthermore, the line of pressure is inclined to the normal to A at an angle θ, so that the effective normal pressure is still further reduced by the factor $\cos\theta$ a second time. The pressure on A is therefore only $U\cos^2\theta$. This must now be averaged for all directions in space that we may give to the ray, without preference. Now the mean value of $\cos^2\theta$ for the complete sphere is $\frac{1}{3}$. So the pressure, say p, is given by

$$p = \tfrac{1}{3}U. \qquad (6)$$

Notice particularly that we take the mean for the complete sphere, not merely for the hemisphere as in the former calculation. The reason is that whether a ray goes through A from right to left or from left to right, the pressure is the same: so both ways have to be reckoned.

Or, we may divide the original ray in which the pressure is U into a great number n of rays also of unit section, in each of which the pressure is U/n. Let the axes of these rays be defined by the middle points of n small equal areas into which we may divide the surface of a sphere, and sum up the normal pressures on A. We obtain, in the limit,

$$p = \int_0^{2\pi}\int_0^{\pi} \frac{Uv\cos^2\theta}{4\pi}\sin\theta\, d\phi d\theta = \tfrac{1}{3}Uv \quad . \quad . \quad (7)$$

This result was given by Boltzmann some years ago, and Galitzine confirms it for the special case of his straight cylinder with a radiant surface at one end. By the above method we see that the result is general, resulting from the uniformity of radiation in all directions, as the previous formula for the mean flux of energy did.

§ 188. This pressure p is not only the mean pressure throughout the enclosure, but also the the pressure on its envelope, which exerts an equal back pressure. If it move, then work is done by or against the enclosed radiation through the agency of its pressure, and the enclosure loses or gains energy to an equal extent. Observe that the idea of temperature does not enter explicitly when the boundary of the enclosure is of ideal perfectly reflecting material. But when it, or a part of it, is made absorptive and emissive, the physics of the matter becomes far more difficult and to some extent dubious. The notion of temperature comes in, and with it the second law of thermodynamics. Assuming its full applicability, Stefan's law follows easily enough, as Galitzine has shown. Let the enclosure be a cylinder of unit section with two pistons A and B. Let A be fixed, and be a perfectly black body, whilst B is moveable to and from A and is a perfect reflector, as is also the round cylinder.

Now start with B close to A; the volume of the enclosure is then nil. Draw B very slowly away from A through the distance h, keeping A at constant temperature t all the time, and then stop it. During this operation the source A keeps the enclosure filled with energy to density U, and pressure p, corresponding to the temperature t at which A is maintained. The pressure p does the external work ph. Besides that, there is energy Uh in the enclosure at the end of the operation. Their sum is therefore the heat lost by A (excess of heat emitted by A into the enclosure over that returned to A). Say

$$H = (U+p)h \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Now we know p in terms of U, so that we have, by (6),

$$H = \tfrac{4}{3}Uh. \quad . \quad . \quad . \quad , \quad . \quad (9)$$

Now, B being fixed, let the cylinder cool down to zero temperature. The whole of the energy Uh in the enclosure goes out through A. Lastly, push B back to A without working, and then raise A to temperature t. A cycle is then completed. Applying the second law, we have

$$\frac{H}{t} = \int_0^t \frac{1}{t}\frac{dH}{dt}dt, \quad . \quad . \quad . \quad . \quad . \quad (10)$$

where H is as before, and dH is an element of the heat lost in the cooling process. On the left side put $(U+p)h$ or $\frac{4}{3}Uh$ for H, because external work was done in the first operation. On the right side leave out the p term, because during the cooling B was fixed. So we get

$$\frac{\frac{4}{3}U}{t} = \int_0^t \frac{1}{t}\frac{dU}{dt}\,dt, \quad . \quad . \quad . \quad . \quad (11)$$

by omitting the factor h. Differentiate with respect to t, and we get

$$\frac{dU}{dt} = \frac{4U}{t}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

from which we conclude that U, and, therefore, also p and W, vary as the fourth power of the temperature, the result above mentioned as applied to the emissivity W.

We tacitly assume that the ether is able to escape freely from the cylinder through its envelope, or else that it is freely compressible, without resistance. This difficulty in connexion with the ether is a very old one.

(To be continued.)

ON THE DETERMINATION OF THE INSULATION RESISTANCE AND OF FAULTS IN ELECTRICAL PLANTS DURING THE WORKING.

BY DR. O. FROELICH.

(Concluded from page 442.)

System of Two Conductors.—In this system only one bridge test can be taken. If a is connected to conductor 1, b to conductor 2, it follows:—

$$(7g.)\quad \frac{k_1}{K} = \frac{b}{a+b} \text{ and } \frac{k_2}{K} = \frac{a}{a+b}$$

In this system the single faults of the two conductors can also be determined by measuring the insulation of the whole system and the absolute potential of one conductor.

In general it is useful to take these tests during the day, because then the resistance m of the machines can be neglected in proportion to the resistance l of the lamps between two

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neighbouring conductors; then the formulas are the following simple ones:—

System of Five Conductors.—

$$(7h.)\quad k_1/K = 1/8(1 + 4\,\mu_{51} - 3\,\mu_{12}),$$
$$k_2/K = 1/8(2 + 3\,\mu_{12} - 3\,\mu_{34}),$$
$$k_3/K = 1/8(2 + 3\,\mu_{23} - 3\,\mu_{45},)$$
$$k_4/K = 1/8(2 + 3\,\mu_{34} - 3\,\mu_{45}),$$
$$k_5/K = 1/8(1 + 3\,\mu_{45} - 4\,\mu_{51}).$$

System of Three Conductors.—

$$(7i.)\quad k_1/K = 1/4(1 + 2\,\mu_{31} - \mu_{12}),$$
$$k_2/K = 1/4(2 + \mu_{12} - \mu_{23}),$$
$$k_3/K = 1/4(1 + \mu_{23} - 2\,\mu_{31}).$$

Determination of the Position of One Heavy Fault in a Central Station.

Method 8a. (Fig. 8a. Testing in the streets.)—When a heavy fault developes in a central station, the main conductor, to which the fault is attached, must be determined by methods 5 or 6; then, when, by any means, the region of the fault is known, we can determine its exact position in the following way. Between two neighbouring accessible points of the conductors two lines $l_1\,l_1$ and $l_2\,l_2$ are laid in the street and connected to the faulty conductor (see Fig. 8a); in l_1 a galvanometer or a telephone of low resistance is inserted, in l_2 a wire bridge $a\,b$; from the moveable contact a branch B containing a contact-breaker and some accumulators or resistance is connected to earth. The place of the contact is sought, for which

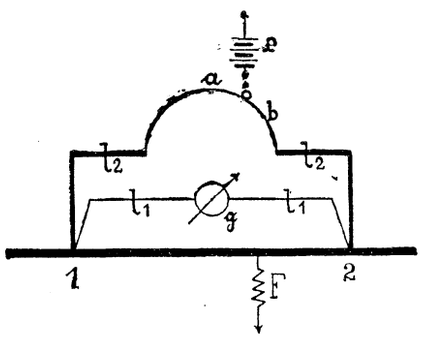

Fig. 8a.

the current in the galvanometer or the telephone does not change by opening and closing B. If the fault F lies between the points 1 and 2, we can measure and can determine the position of the fault by the known rule. If the fault lies to the left of 1, the place of the contact, which nearly gives a balance, is in the left corner; it is in the right corner, if the fault lies to the right of 1. Thus, if no determination can be made, remove the lines and instruments in the given direction, and take a new test between two other accessible points. The operation is repeated, until the determination is made; then the lamps on the faulty part of the main conductor are removed in order to take the last and exact test. Instead of the lines l_1 and l_2 we can use the small wires, which are usually laid by the main conductors for testing purposes (testing wires).

Method 8b. (Fig. 8b. Tests from the station.)—The method just described, and other ones, Messrs. Siemens and Halske, in April, 1892, proposed to patent. On September 30, 1892, Dr. Hiecke, of Vienna, described a method by which the localisation of a heavy fault could be obtained by tests from the station; for this method two feeding conductors must be taken off the machines. Between the feeders H_1 and H_2 insulated at the station, a low pressure machine, or a battery of accumulators with a contact breaker A is inserted; between the testing wires P_1 and P_2 the wire bridge $\alpha\,\beta$. A mirror galvanometer and a battery B for compensating purpose are placed between the moveable contact and earth. The battery is adjusted so that the galvanometer has no current. When the moveable contact has got the right place, the galvanometer must show no deflection when the contact breaker A is open or closed. This test is repeated with different feeding conductors; from the results the position of the fault is obtained by a special calculation.

If we compare this method to Method 8a, we see that the principle is the same. In 8b the diagonal branches of the bridge are interchanged, the current in the galvanometer is brought to zero and the telephone is not mentioned. The main difference of the two methods consists in that Dr. Hiecke takes the tests at the station by means of some changes in the main connections, and we test in the streets almost without change in the main connections.

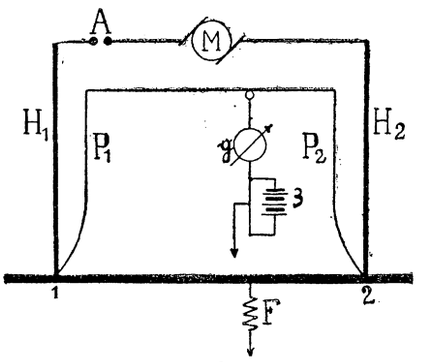

Fig. 8b.

If we adopt Dr. Hiecke's idea and adapt to Method 8a, we come to the Method 8c (Fig. 8c). The bridge wire lies between the detached feeders $H_1\,H_2$, the galvanometer or telephone between the testing wires $P_1\,P_2$, the accumulators with contact breaker between the moveable contact and earth. If the tele phone is used we close and break the contact by turning a suitable contact wheel by hand or by an electric motor.

Testing Arrangement for Central Stations.

The methods described above have been tried on a small system of three conductors, and several instruments have been constructed for the purpose. The instruments, which are partly necessary, partly useful, are a wire bridge, a bridge composed of bobbins, with a rotating handle, telephones of different resistances, a hand contact wheel, a contact wheel driven by an electric motor, a mirror galvanometer, which can easily be transported, put up and used in any place, voltmeters of higher accuracy than usual, but available in engine-rooms, different resistances. In the mirror galvanometer it is very useful to adopt the magnetic compensation mentioned above, and to put mirror, magnets, and suspension fibres into water, by which device a good damping is obtained; thus, a fixing

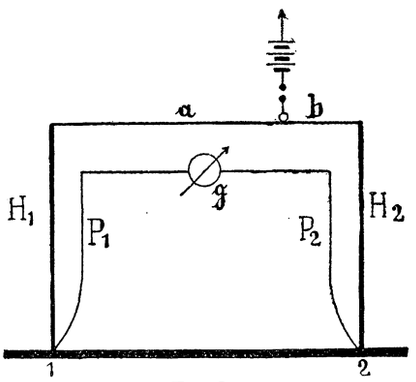

Fig. 8c.

arrangement for the transport can be omitted, and the putting up is so easy that screws for adjusting the level position are not necessary. The deflections are read as usual by aid of a petroleum lamp, but can be taken in full daylight; the box containing the galvanometer and its belongings is short and easily transportable.

Beside the described tests it is useful during the working of the plant to measure the potentials at as many points as possible of the same main conductor by a mirror galvanometer

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and testing wires from the station in the day and night; this is a good preparation for the appearance of a heavy fault. For, if the fault develops, the fault and its surroundings show low potentials. It is true, that other points of the same conductor can also have low potentials in consequence of an irregular distribution of the current; but the points of low potential of the latter sort change during the day and during the night, whereas the potential of the faulty place always remains low. So these tests will be useful for determining the region of the fault.

The tests which, in a central station, are partly necessary, partly useful, and can be taken during the working, are the following:—

(1) Continuous observation of the insulation (Method 3).

(2) Determination of the general insulation (Methods 1, 2, 3, and 4).

(3) Determination of the faulty main conductor (Methods 5 and 6).

(4) Determination of the fault of every main conductor (Method 7).

(5) Measurement of the pressure on the same main conductor with different loads (day and night).

(6) Determination of the place of a heavy fault by tests from the station (Methods 8b, 8c).

(7) Exact determination of the place of a heavy fault by tests in the street (Method 8a).

I suppose that the development of testing in central stations will take the same course as it was with deep-sea cables. At first, tests were despised as "scientific humbug" and quite omitted, then testing was introduced for determining heavy faults, and at last, when it became plain that testing was useful, it was made use of as much as possible. Most of the methods described are directly appliable to alternate currents; but I hope to treat of that in a special article.

LATITUDE AND THE LOAD-FACTOR.

BY E. TREMLETT CARTER, F.R.A.S.

When Greenland's icy mountains sparkle in electric light, and arc lamps are dotted along the rugged lines of India's coral strand, a comparison of a year's working would show that the load-factor of a supply station and the conditions of economical working are affected by the latitude and other astronomical functions of the area of supply. Owing to the inclination of the earth's axis to the plane of the ecliptic—which, by-the-bye, Milton tells us was produced as a punishment for man's sin—the distribution of darkness and sunlight over the face of the globe is by no means as simple as an electrical engineer might desire. This inclination causes the interval between sunset and sunrise to vary harmonically from day to day throughout the year; producing, for a plain man, the delights of season, and for the electrical engineer the harassing differences between the five per cent. load-factor of July and the 25 per cent. load-factor of December. Nor is this all; for the same inclination of the earth's axis produces a different distribution of day and night for each latitude. Away up within the Arctic Circle, or in its almost unexplored austral counterpart, there are periods of uninterrupted darkness surpassing the achievements of our best London fogs. At Hammerfest, in Norway, four degrees within the Circle, where there is a small electric light station driven by a mountain torrent, the yearly programme includes a night of 66 days duration and a "day" of equal period; while at the North Pole itself the year comprises a six months day and a six months night. If we should sail to the tropics we should find an equality in the days and nights throughout the year which becomes more perfect as the Equator is approached. Within one degree of the line the variation in the length of night is not more than 12 minutes between the two solstices at the rainy and dry seasons.

One term, then, in the mathematical equation to the load-factor of any station will be a trigonometrical function of the latitude of the area of supply. In the *Nautical Almanac* the data for calculating the length of night or day at any latitude and at any time of the year are to be found, which raises the curious question as to whether this admirable compilation should not be found on the shelves of a consulting electrician. These data, worked out, may be plotted in the form of a Cartesian curve, similar to that in "*The Electrician* Electrical Trades' Directory and Handbook for 1893," page 190. In order to show the extent of this effect, the author has plotted curves of these quantities for St. Petersburg at latitude 59deg. 52min., and Singapore, latitude 1deg. 20min.

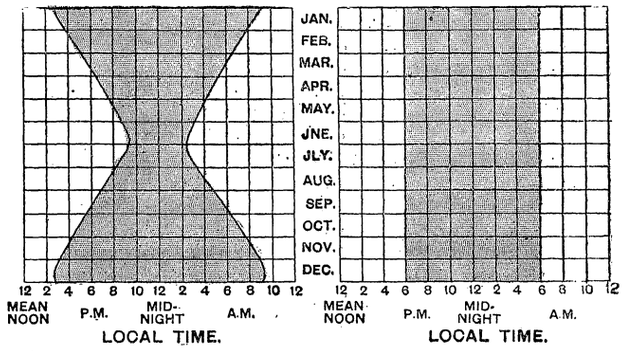

FIG. 1.—St. Petersburg, Lat. 59° 52′ N. FIG. 2.—Singapore, Lat. 1° 20′ N.

These present a very wide variation, but not so wide as would have occurred by comparing the latter with a point within the Arctic Circle. The shaded area represents the time when the sun is below the sea-level horizon. Ordinates are drawn for the hours of the day, reckoning local mean solar time; and abscissæ for the months of the year. Thus, everything is reduced to normal calendar.

Lest it should be supposed that the influence with which we are now dealing is one of importance only where points widely separated on the surface of the globe are taken, two similar curves have been plotted for points within the United Kingdom. Aberdeen and Falmouth are just 7deg. of latitude apart; and the differences in the distribution of darkness are shown by Figs. 3 and 4. At Falmouth the difference between the shortest and longest nights is 8h. 20min.; while at Aberdeen the difference is 11h. 12min. The percentage variation on the shortest night is—in Falmouth 106 per cent., and in Aberdeen 175 per cent.

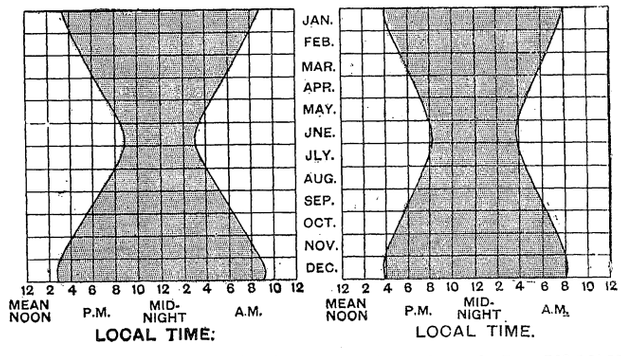

FIG. 3.—Aberdeen, Lat. 57° 10′ N. FIG. 4.—Falmouth, Lat. 50° 10′ N.

Latitude has an indirect influence, in the effects of climate on the refraction and transparency of the air. Where there is a humid atmosphere, as in our "temperate" climate, there is, besides the comforting liability to fog, a general refraction of the sunlight which delays the beginning and hastens the ending of darkness. The apparent time of sunset is later than the actual time, and the limb of the sun may be seen above the horizon before he is actually risen. Humid atmospheres also reflect and refract the lingering rays of sunlight, producing the gradual disappearance of day which is called twilight. This phenomenon is almost completely absent in a tropical atmosphere; and, in those climates where the day is constant in

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length, it also passes swiftly into the blackness of night. At Hong Kong all the lights must be switched on within five minutes of sunset, for it is as dark as midnight by then. Twilight renders it easier to start numerous machines at a station, as they may be started in slow succession; but it leads the consumer to be indecisive in turning on lamps, and thus makes the load creep up gradually instead of running up to a maximum sharply. In the latter respect twilight has a tendency to reduce the load-factor of the station all the year round. Within the Arctic Circle the irregularity of the nights would be compensated by the long runs which the machinery would have in the polar night, and by the reduced cost of such a station during the long polar day. It is true that the Aurora Borealis lightens the gloom by its occasional brilliance; but the uncertainty of the display would render it impossible to save much of the station expense on that account, while a first-class Aurora might, perhaps, induce the economical Scandinavian to turn his lamps off.

The moon, too, has her influence on the load-factor; especially in those climates where the dryness of the air renders her light of certain and practical value. In many of the tropical and colonial towns street lighting is only contracted for for about a fortnight in each lunar month; during the other fortnight the moonlight being sufficient to light the streets. Whether lamps must be run during a total eclipse, and whether this item has been taken into account in the estimate, is not clear; but it is evident that both solar and lunar eclipses may play some part in the yearly work of the supply company, and would be a matter of gain as regards private house lighting; though it is possible that, as with Mark Twain's hotel-keeper, "a succession of total eclipses might ruin the business"—as regards street lighting. Perhaps eclipses are too infrequent to be worth considering in most places; and it is certain that, in London, latitude, twilight, moonlight and eclipses, all put together, are not equal in importance to one or too big London fogs.

NEW KELVIN ENGINE-ROOM WATTMETER.

The latest invention of Lord Kelvin is an engine-room wattmeter. One of these instruments was exhibited by Dr. Fleming at his Cantor lectures at the Society of Arts last

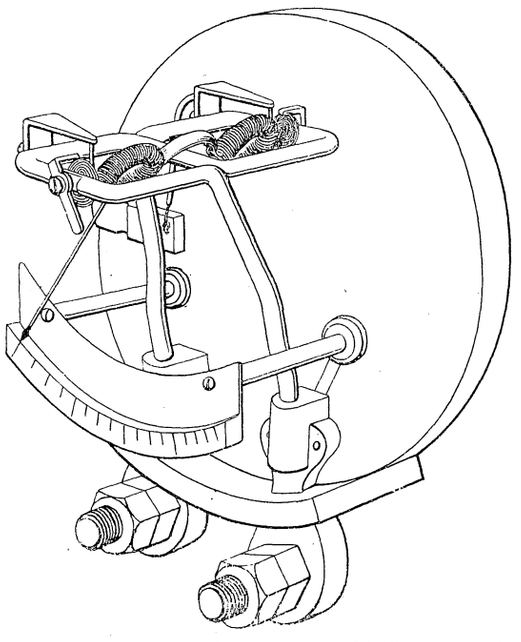

Fig. 1.—General View of Instrument, with Case removed.

week. The interior is shown in Fig. 1. It has a main circuit formed of a double rectangle of copper rod having sufficient area to carry 200 amperes, and a shunt circuit with two fine wire coils astatically arranged. The main coil is mounted on a slate back so that the rectangles are horizontal. The shunt coils are mounted on a light but strong aluminium frame in the manner shown in Fig. 2. One end of this frame has a circular knife-edged hole fixed to it, and the other end has a straight knife-edge. These two knife-edges rest on two phosphor-bronze hooks attached by insulating supports to the outside ends of the double rectangle. By this method of suspension complete freedom from friction is obtained, while the moveable system is kept in a definite position without end guides.

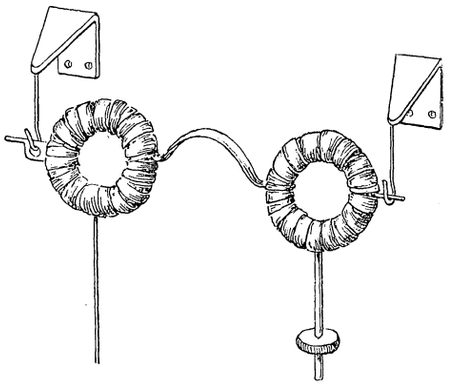

Fig. 2.—View of Fine Wire Shunt Coils, showing Details of Suspension. Controlling Springs removed.

Each fine wire coil has about 1,000 turns of insulated wire, and its resistance is about 100 ohms. The current is conducted in and out from the moveable system by two flat palladium spiral springs which also supply the restoring force for governing the sensibility of the instrument. Not more than 1-20th of an ampere is allowed to pass through the fine wire circuit, and in order to regulate this, a large non-inductive resistance is rolled on the case of the instrument which offers a large cooling surface. The scale has nearly uniform divisions, and is graduated to read directly in watts or kilo-watts as required. The capacity of this instrument is 200 amperes, the volts being immaterial.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 24th.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "A Handy Focometer," by Prof. J. D. Everett; (2) "Plane and Spherical Sound Waves," by Dr. C. V. Burton; (3) "Motion of a Perforated Solid in a Fluid," by G. H. Bryan, M.A.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Students' Meeting. Paper to be read: "On the Methods usually adopted in Devon and Cornwall for Dressing China-Clay and Tin-Ore," by R. Hansford Worth, Stud.Inst.C.E.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Ladies' Night. Concert at St. James' Hall Restaurant.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Electrical Railways," by Dr. Edward Hopkinson, M.A.

TUESDAY, February 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Resumed discussion upon the Paper "On Electrical Railways," by Dr. Edward Hopkinson. Paper to be read, time permitting: "On Plant for Harbour and Sea-Works," by Walter Pitt, M.Inst.C.E.

WEDNESDAY, March 1st.

INSTITUTION OF CIVIL ENGINEERS.

4 p.m. Students' Visit to the Houses of Parliament, to inspect the Clock-Tower and the Ventilating and Lighting Arrangements.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Tele-Photography," by Thomas R. Dallmeyer.

THURSDAY, March 2nd.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting. Papers to be read.

FRIDAY, March 3rd.

OLD STUDENTS' ASSOCIATION.

8 p.m. Meeting at the Central Institution. Lecture "Mountaincraft," by Clinton T. Dent (illustrated by lantern views).

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THE TRANSMISSION OF POWER FROM CENTRAL STATIONS.

On Friday last Prof. UNWIN concluded his course of six Howard Lectures before the Society of Arts. We have heard and read about electrical transmission of power until the subject has become wearisome. The ingenuity of the inventors of the *drehstrom* system has been equalled only by the boldness of those who have proposed schemes for distributing power from the coal fields to the towns, and it is quite time that the tendency to overrate the advantages of electrical transmission of power and to lose sight of commercial considerations should receive a check. Prof. UNWIN's confession, on opening this course of lectures, that he was not an electrician, so far from placing him at any disadvantage, greatly enhanced the value of the comparisons which he made, and even if electrical transmission had come out rather badly at his hands there are plenty of enthusiasts who would do their best to neutralise the possible effect of his decision by any amount of talk. But Prof. UNWIN did not attempt to recommend one system of distribution rather than another, even for special purposes. The importance of a comparison between the rival methods has led us to devote more space to a report of these lectures, and thus to place more non-electrical matter before our readers, than is usual.

One of the most interesting and original features of this series of lectures was the recognition of a definite money

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value for different systems of storage. A reservoir of power, whether it be a mountain lake, or a fly-wheel may be considered from three points of view—the first cost, taking only the storage capacity into account; the first cost, taking the discharge rate into account; and, lastly, the annual charge to cover interest and maintenance. The first of these is the prime cost of a reservoir of energy of a given capacity, the cost being reckoned at per horse-power-hour of the whole energy stored; the second is the prime cost of a reservoir, the cost being reckoned at per horse-power discharged; and the third simply is energy in horse-power-years. As an illustration of the difference between the first two, we may take the extreme case of a good Leclanché battery. A single cell discharging through 10 ohms for three weeks with a mean current of 85 milliamperes, will do about one-twentieth of a horse-power-hour. But it would be absurd to call 20 such cells a two horse-power battery; it would only be a two horse-power-hour battery. A cell giving 746 amperes at two volts would be a two horse-power cell. Prof. UNWIN's estimate of 5s. 6d. as the cost of a gas holder per horse-power-hour stored must be taken with caution, and in all other cases the rate of discharge must be carefully considered in connection with the cost of a reservoir. Two extreme figures were given for the cost of secondary batteries, differing, indeed, so widely as to be of small value. These, together with other prices given by Prof. UNWIN, we give in the form of a table, making no attempt in this or in the succeeding table to add in any way to the original figures as given in the lectures.

Cost of Storage.

	H.P. Hour Stored.	H.P. Discharged.	Annual Charge.
	£ s. d.	£ s. d.	£ s. d.
Gas Holder	0 5 6	6 0 0	0 10 0
Battery, Frankfort	23 0 0	78 0 0	15 6 0
„ Epstein	8 0 0	20 0 0	—
Druitt Halpin (condensing)	1 13 0	—	—
„ (non-condensing)	2 5 0	—	—
Geneva reservoir	2 4 0	—	0 3 0

Prof. UNWIN did not make any direct comparison between Mr. DRUITT HALPIN's thermal storage scheme and secondary batteries for obvious reasons, but they appear together in the table. In the use of secondary batteries an attempt is made to store the actual thing produced by a supply station, but it seems that when they do little more than the air-vessel of a water-works they are most satisfactory. The hot water storage stops a long way short of this, and is practically a storage of steam in no way relieving the dynamos and engines from the irregularities of load which so seriously affect their efficiency.

The following table of costs of power is compiled directly from the Howard lectures, with no change save conversion of dollars into English money, in round figures.

Cost of Power per Horse-power-year.

Water Power.	£ s.	*Hydraulic Supply.*	£ s.
United States, N.W.	2 5 – 2 10	Hull	104 0 – 83 0
„ New Jersey	12 0 – 16 0	London	175 0 – 35 0
„ Holyoke	4 15	*Compressed Air.*	
St. Lawrence	4 7	Paris (3,000 hrs.)	6 5
Switzerland (average)	6 0	*Steam Supply.*	
Geneva	8 0	New York, steam (3,000 hrs.)	12 10 – 7 10
Schaffhausen	4 16 – 6 0	*Electric Supply.*	
Freiburg	8 0	Electric Supply at 6d.	60 0
Bellegarde	8 0 – 12 0	„ „ 3d.	30 0
Zurich	7 10 – 16 0	*Gas.*	
Heilbronn	42 0	Gas at 3s.	12 0
		„ 2s.	8 0
		„ 1s. 6d.	6 0

The figures, in some cases, will hardly bear separation from their explanatory context, but this has been given in our columns, and even a gas engineer will hardly compare the price of water power in the North-West of the United States with the maximum charge of the London Hydraulic Supply Company. To these figures may be added the annual cost of steam-power according to the independent, but remarkably coincident estimates of Mr. SWINBURNE and of Messrs. CROSS and BEVAN, namely £6.11s. per horse-power-year of 8,760 hours.

At the commencement of his third lecture Professor UNWIN called attention to the way in which the cost of steam-power and that of water-power was affected by the length of a working day. Until the full text of Prof. UNWIN's lectures is published, there is an ambiguity about the horse-power-year. In some cases it means 300 days of 10 working hours. A horse-power-year, if it means anything, means work done at the rate of one horse-power for 365×24 hours, and if we ask Niagara or the Rhone to signify their assent to modern ideas by adopting the eight hours system their only reply is a rise of 300 per cent. in the cost of the power which they provide.

OBITUARY.

HENRY-JOSEPH ARCHEREAU.

The death is announced of M. Henry-Joseph Archereau at the age of seventy-three. The deceased made a name for himself in the middle of the century by his work on the Bunsen cell, and by his arc lamp. Later on M. Archereau suggested the idea of converting coal-dust into briquettes, a form of fuel now largely used on French locomotives.

M. Archereau came to Paris in the last years of the reign of Louis-Philippe, and in 1849 made the sensible and obvious improvement to the Bunsen cell of placing the carbon inside and the zinc outside the porous pot, thus rendering the moulding of carbon cylinders unnecessary. He, at the same time, substituted retort carbon for the agglomerate carbon of Bunsen. In the Grove cell, as originally arranged in 1839, the zinc was inside the porous pot and the platinum foil, rolled into a cylinder, was outside. Science had very lofty notions in those days, so much so indeed that although Grove investigated the question of using cheap carbon instead of costly platinum as the negative element of his cell, he was of opinion that scientists would deem the use of carbon scarcely in harmony with pure science, and so said nothing about his work in this direction, with the result that carboned Grove cells were soon being sold as "Cooper" cells by a Charing Cross optician. However, the high price of platinum necessitated some kind of recognition of existing facts, and the first arrangement of the elements was soon reversed. Bunsen, however, re-inventing in 1843 the carboned Grove cell, adhered to the original arrangement of the elements, using carbon cylinders. About the time that M. Archereau came upon the scene many people were at work upon the task of getting rid of the noxious fumes given off by the nitric acid cell. Some tried hermetic sealing; others absorbents, such as oleic acid. M. Archereau attempted with but moderate success to overcome the defect by placing an inverted vessel containing iron-filings over the cell. Another device of M. Archereau was an elaborate contrivance for filling and emptying large electric lighting batteries of a hundred or more cells, which could, it was claimed, be filled in this way in five minutes. In 1850, M. Archereau brought out an arc lamp in which the lower carbon holder was actuated by an iron-copper core moving within a helix of wire traversed by the main current, the balance being maintained by a counter-weight.

Fortune did not smile on M. Archereau, but for many years he was maintained in comparative comfort by the liberality of the late M. Gaston Planté. A few years ago M. Archereau's friends got up a subscription on his behalf, but the small sum realised was wasted on profitless inventions, and M. Archereau finally died in misery.

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REVIEWS.

Pioneers of Science. By OLIVER LODGE, F.R.S. (London: Macmillan and Co.)

Since the pioneers of science, whose lives and labours have been related by Dr. Lodge in a course of eighteen popular lectures, were, almost without exception, astronomical pioneers, some justification is, perhaps, necessary for reviewing the book, into which these lectures have been converted, in the columns of a journal devoted solely to electricity. Our excuse cannot, it is certain, be that references to electrical science and its bearings upon astronomy are to be found strewn up and down the volume in a sort of milky-way fashion. On the contrary, the only mention of electricity that we can call to mind is that on p. 343, where allusion is made to the hypothesis that a possible, if not probable, cause of the peculiar wag of comets' tails as these erratic bodies approach the sun is electric repulsion, due to the sun and the tail being similarly electrified. For us the chief attraction of Dr. Lodge's lectures lies in the very fact that they deal with a subject outside our own, with a science far more entitled than electricity to be called "Imperial." A branch of learning in which infinity is no longer a mere mathematical abstraction, but something like a solid fact, and eternity is made well-nigh comprehensible, which comes into contact, more or less close, at every turn with geology, chemistry, optics, climatology, and electricity, and is concerned with the past, present, and future, not only of the human race and the solar system, but of the universe, surely approximates more nearly to an Imperial Science than the comparatively limited dominion governed by the laws of electricity and magnetism.

From first to last the lectures are instinct with the vigorous style and somewhat combative spirit of the lecturer, although naturally more scope is found for the exercise of these powers in the earlier discourses dealing with the dawn of modern astronomy and the poverty and persecutions of the adherents of the cause of progress than in the later ones referring to more prosaic times. A persevering but hardly successful endeavour is made by the author to assume what is considered by polite society to be the correct attitude in these days in regard to the ancient battle between science and its persecutors, to wit, an attitude of "not blaming over much." One ingenious and, it must be confessed, wholesome device of the author is to balance every instance of theological obstinacy by a piece of "petrified professorial wisdom," such as that of the Padua pedant who refused to inspect Jupiter through Galileo's telescope for fear he should see the satellites and have to admit their existence. An Act of Oblivion is, however, no doubt on the whole the best thing, though it is right that all students of science should know what has rendered such an Act necessary.

By a strange irony of fate the founder of modern astronomy, with all the tremendous consequences it involves, was Copernicus, an obscure and wholly orthodox Polish monk. Within a few years of the death of Copernicus, Tycho Brahé was born, and although more famous amongst his contemporaries for his ingenious artificial nose than for his astronomical discoveries, the accuracy of his observations remains a marvel to this day. Then came Kepler, with his dire poverty and laborious gropings and discovery of the elliptical path of the planets and the laws governing the length of their year. The next name of note is the venerable one of Galileo, almost as memorable for his tragic battle with the powers of darkness as for his attractive personality and glorious services to science. Although it is impossible, even at this distance of time, to read the oft-told tale of Galileo and the Inquisition without a feeling strikingly like unto indignation, it cannot be gainsaid that Galileo courted his doom. Throughout his life he seems to have given way to the fascinating but highly-dangerous pursuit of making the powers-that-be look foolish, and his publication of his "Dialogues on the Ptolemaic and Copernican Systems" on his return from Rome was an imprudence which almost merited the terrible punishment meted out to it. We are certainly bound to tell the truth that is in us, but not necessarily at all times, and in an irritating manner. After Galileo we come to Bacon, that precursor of fashionable science of the Friday Evening Discourse order, to whom Dr. Lodge naturally does not allot quite so prominent a niche in the Temple of Science as the literary critic almost invariably does. After a chapter on Descartes and his theory of vortices, we come to three on Newton, whom the author regards as superhuman, though his superhumanity unfortunately did not save him from being elected a member of Parliament, nor from being involved in one or two of those miserable squabbles which so frequently disturb the calm of the scientific world. Bradley, the discoverer of the aberration of light; Laplace and Lagrange, who mathematically demonstrated the stability of the solar system (from insufficient data alas), and first propounded the nebular hypothesis; Herschel, the founder of stellar astronomy, occupy the next five chapters. The remainder of the volume is taken up with the discovery of Neptune, comets and meteors, the tides and planetary evolution, the closing lines being devoted to the dismal task of proving that the moon will one day crash back upon the earth, which, by the way, only escapes a daily destructive meteoric bombardment owing to the fact that it has a skin of air adhering to it, the friction of which is sufficient to reduce the meteoric bombs to vapour, moving towards the earth, as they generally do, with a total velocity of about 162,000 miles an hour. The inhabitants of a planet, the habitability of which hangs upon a thread so thin, may look forward to the contingency of its being crushed out of existence a few million years hence with "sombre acquiescence," if not cheerful resignation.

The Year-book of Science for 1892. Edited by Prof. T. G. BONNEY. (London: Cassell and Co.)

This volume consists of a digest of Papers read before certain scientific societies, and of articles contributed to scientific journals and periodicals. The first section, Physics, is divided into General Physics, Physical Astronomy, and Metereology. The sub-sections of general physics deal with the subjects of electricity and magnetism, and in 74 pages give a number of interesting abstracts. The index is by no means so complete as it should be in a book of reference of this kind. The names of authors or investigators are not given in it; a very serious omission.

Annuaire pour l'An 1893. Bureau des Longitudes. (Paris: Gauthier Villars et Fils.)

The Bureau des Longitudes was created by the National Convention, under the law of the 7th Messidor Year III. (June 21, 1795), and one of the duties of the Bureau was the annual publication of an almanack, which should serve as a model to the whole Republic. Last year a new era was inaugurated, the dry tables of the Annuaire being supplemented by scientific articles of current interest. In the present issue this new departure has been carried still further. M. Cornu contributes an article, of over 70 pages, on the correlation of electrostatic and electro-dynamic phenomena, and the definition of electrical units, while M. Janssen has something to say about the Mont Blanc observatory. The table of magnetic elements has been extended by M. Moureaux, and now includes every *chef-lieu d'arrondissement* in France. The Annuaire contains a mass of accurate and useful scientific data, and is, moreover, provided with an admirable index. The editing committee consists of MM. Janssen, Cornu, Lœwy, and Tisserand.

Laxton's Price Book for 1893. (London: Kelly and Co.)

This well-known handbook has reached its seventy-sixth edition, and has been further enlarged and improved. An index printed on the edges of the book, as in "*The Electrician* Electrical Trades' Directory," facilitates references to various trades. The prominence given to patented or proprietory articles in such a book is unavoidable, but as a result, a number of ordinary materials and fittings are omitted. Turning, for example, in the index, to "Gas burners," a matter on which we are supposed to be completely ignorant, but on which we are glad to receive information, we are referred to page 338, but find no reference whatever to the still-surviving productions of Bray, Peebles, and Sugg. Some historian in 1993, on consulting a copy of this book in the

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British Museum, might hastily conclude that these useful inventions had already been swept away by the advent of electric lighting. The section on Electric Lighting must needs begin with a dissertation on absolute units, and definitions of which the following is an example: "Electromotive force (mostly written E.M.F.) is the name used to express the force which tends to move electricity from one place to another, and is proportional to the difference of potential of the two places." It is generally considered sufficient that the engineer in charge of electric lighting plant should have a special knowledge of the subject, but we note that "The Brush Electrical Company manufacture engines with a special knowledge of the requirements for electric lighting." The prices of electrical machinery, &c., appear to be fairly representative.

House Lighting by Electricity. By ANGELO FAHIE, Inst.C.E.I. (London: E. and F. N. Spon.)

The author of this latest addition to the host of shilling guides to those about to "go in for" electric lighting has succeeded in turning out a very fairly useful little *brochure*, useful, that is to say, from the consumer's point of view. We are not prepared to go bail for the absolute accuracy of every statement, definition, and analogy contained in the eighty pages which go to make up the book, but there is less science and more sense than is usual in such publications. The advantages of electric lighting are naturally made the most of, but there is no hocus pocus with the figures in getting out the relative cost of gas and electricity. The hints to users in the last chapter are really serviceable, and the appendix giving approximate cost of wiring and lighting various sized houses seems as reliable as any general estimate can be. The author has an ingenious theory by which he accounts for the statement so commonly heard that glow lamps are trying to the eyes. His idea is that people *will* stare so at glow lamps, and that when they cease to be novelties people will cease to stare at them, and complaints will die out.

Calvert's Mechanics' Almanack. By WM. CALVERT. (Manchester: John Heywood and John Calvert.)

This publication is now in its twentieth year, and, as its title denotes, its contents are intended for consumption by mechanics. Amongst other items of information we note an interesting article on "Patents," by Mr. W. Lloyd Wise, and a somewhat behind-the-time note on "Lightning Conductors." Dr. Oliver Lodge's Mann Lectures are now six years old, and the important practical fact brought out by them, namely, that for lightning rods iron is, at least, as good as copper from the electrical point of view, should surely have soaked down by this time into a note intended for practical workmen.

Index to the Journal of the Institution of Electrical Engineers. Vols. XI.-XX., 1882-91. Compiled under the direction of, and edited by, F. H. Webb, Secretary. (London: E. and F. N. Spon.)

As we recently announced, the suggestion thrown out by Prof. Ayrton in the opening sentence of his Presidential Address to the Electrical Engineers that the issue of a complete Index to the second ten volumes of the *Journal* would be an appropriate method of marking the arrival of the Institution at the end of the second decade of its existence, bore fruit, and on the last day of the old year the Index in question was in the hands of the members. We venture to think that the money which has been devoted to this work could not have been better spent, and that the members of the Institution and others will find this compilation both well done and exceedingly useful. Perhaps the most helpful feature of the combined Index is the printing of the titles of Papers actually read before the Institution in heavy type. The main Index occupies over 100 pages, and that relating to the Abstracts runs to nearly 80 pages.

Professional Papers of the Corps of Royal Engineers. Edited by Capt. W. A. GALE, R.E. Vol. XVIII. (Chatham: Royal Engineer's Institution. London: Simpson, Marshall and Co. 1892.)

This volume contains papers by Major R. H. Brown on "Egyptian Irrigation"; by Capt. S. D. Cleeve on "Application of Works to Irregular Ground"; by Mr. Graham Harris on "Electric Welding"; by Mr. Kapp on "Alternating Currents of Electricity"; and a very elaborate and fully-illustrated treatise by Mr. G. Bodmer on "Hydraulic Machinery."

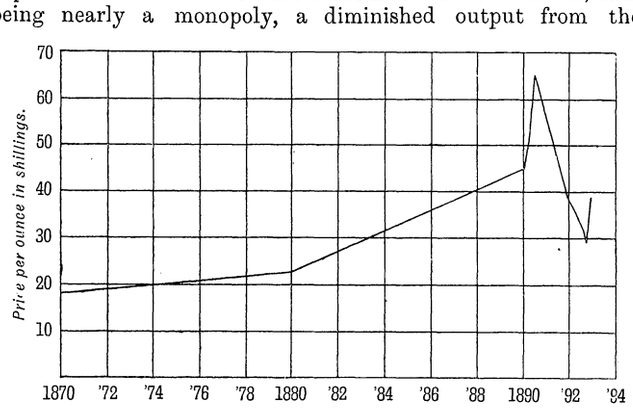
THE ST. LOUIS AND SUBURBAN RAILWAY.

In view of the forthcoming Convention of the National Electric Light Association at St. Louis, the *Electrical World* has commenced a well-written and well-illustrated series of descriptive articles on "The Electrical Side of St. Louis." The article in our New York contemporary's issue of February 11th relates mainly to the St. Louis and Suburban Railway, the most noteworthy feature of which is the fact that in October, 1891, it changed over at one step from steam and cable traction to electricity. The mileage of the line is 24½, and the car equipment consists of 74 motor cars and 62 "trailers," each of the former being provided with two 15 H.P. single-reduction T.H. motors. Owing to the high speed of 25 miles an hour which is attained outside the town, double bogies are almost entirely employed. The system of the Company consists of two lines, running from the heart of St. Louis into the suburbs, one of the branches stretching to a place called Florissant, 15 miles away. As "an incentive to travel" the St. Louis and Suburban Company purchased some 60 acres of land near the line, laid it out in orthodox pleasure-ground fashion, and dubbed it Ramona Park. The district through which the line runs, outside the town, is undulating and well wooded, and the advent of the electric cars has run up the value of land 100 per cent. and more in six months; as no doubt it was intended to do. Mindful of the likes and dislikes of the travelling public, the Company provides closed cars, even in the hottest weather, and alternates non-smoking with smoking cars, so that the devotees or opponents of the fragrant weed need only miss one car and wait three minutes before their speciality comes along. A letter and parcel post per electric car has also been inaugurated.

The power station is at De Hodiamont, six miles from the St. Louis terminus. The station has an area of over 14,000 square feet, and contains three 750 H.P. Hamilton-Corliss engines, ten 100 H.P. multipolar Thomson-Houston generators, and two 270 H.P. generators of the same type and make, all direct belt driven. The length of the longest feeder is 12 miles, and the pressure at its station end is 540 volts. The worst gradient is one of 3½ per cent., and it is one mile in length.

THE PRICE OF PLATINUM.

The supply of platinum is in the hands of so few dealers that the real history of the recent rise in the price of this metal is difficult to discover. Until recently the supply of raw ore depended on contracts held from the Russian Government, and, being nearly a monopoly, a diminished output from the



Curve showing Fluctuations in the Price of Platinum from 1870 to the Present Time. These Prices do not include the Cost of Manufacture into Plate or Wire.

mines, together with the rapidly increasing demand for platinum wire in lamp making, as well as the steady consumption for chemical and dental purposes, sent up the price rapidly from 22s. 6d. in 1880, to 45s. in 1890 reaching no less than 65s. in June of that year. It seems probable that this price was quite artificial, and it must have fallen rapidly, even if new sources had not been opened. But the sudden collapse

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in 1891 came as a surprise to those who had accumulated no small stock of platinum, under the impression, no doubt, that the natural supplies were nearly exhausted, or were, at all events, quite unable to meet the demand. The decline has, however, been due to a large extent to the development of mines in British Columbia and although there has been a slight advance lately, the present prices will probably be maintained. The prices given in the diagram are for raw material, and do not include the somewhat expensive process of manufacture. We are indebted to Messrs. W. and J. Jamieson, of Broad-street, Golden-square, W., for assistance in compiling these particulars. In a letter to *The Chamber of Commerce Journal*, Messrs. Matheson and Grant say that they have before them a sample of platinum from mines in British Columbia which are in full operation, and from which a considerable quantity has been sold in London during the last two years, as much as 1,000 to 1,500 ozs. having been annually produced since 1886, all from placer mining. From the present hydraulic mining the production can be considerably increased.

DOULTON'S VITRIFIED STONEWARE CASING FOR ELECTRIC MAINS.

Messrs. Doulton and Co. are offering a stoneware casing for underground mains, made of their well-known, highly vitrified stoneware. It possesses great strength, and therefore affords a very perfect mechanical protection to insulated cables. The makers state in a circular that the casing is made in lengths of three feet or less, with two or more separate ducts. The interior surface has a hard and smooth glaze, presenting exceptional facilities for drawing cables in and out of the "ways."

Where it is necessary to maintain the complete separation of the ducts where the lengths are connected, the joint shown in Fig. 2, as applied to a 2-way casing, may be adopted. The method is as follows:—The lengths of casing are laid in the collars with a small space between them. Mandrels with indiarubber heads are then introduced into the ducts, and when opposite the joint between the lengths are expanded by a screw. Cement is then poured in, and this fills up the space between the casings except where occupied

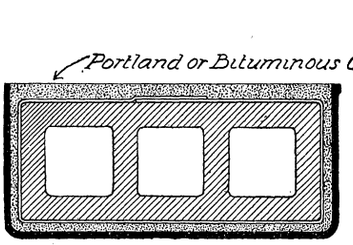


FIG. 1.—Cross Section of 3-Way Casing at Joint.

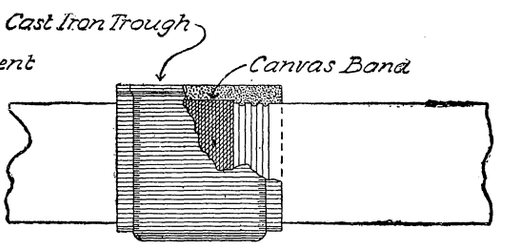
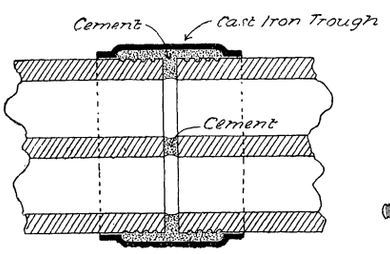
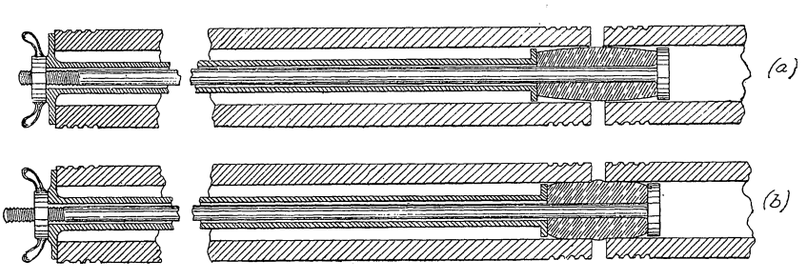


FIG. 1A.—Detail of Joint.

Several methods of joining the lengths of casing have been designed. A simple and efficient joint is shown in Fig. 1. The ends of the casing when brought together are lapped round with a band of prepared canvas, and enclosed in a stoneware trough open at the top. The lower interior surface of the trough, before being placed in position, receives a layer of Portland cement, which is prevented from entering between the casings by the canvas band. by the mandrels. In two to three minutes the cement will be set, and the mandrels are unscrewed and withdrawn. Small changes of direction at the joints can be made with the above-described modes of connection. In systems of distribution in which any considerable change of direction is effected by the introduction of a draw-box into the line, Messrs. Doulton are prepared, if required, to provide specially made water-tight stoneware boxes with iron



Horizontal Section of 2-Way Casing at Joint.



Detail of Expanding Mandrel. (*a*) As introduced into Duct. (*b*) Expanded to close Duct.

FIG. 2.

The trough is then filled to its upper edge with cement. Where space is a consideration, a light cast-iron collar or trough may be substituted for the stoneware, as shown in Fig. 1A, the same method as last described being adopted; or the trough may be simply filled with bituminous or other cement, the canvas band being used as above described.

surface-frames and covers to suit any requirements, where the opening does not exceed 2ft. 6in. in its greatest dimensions. The jointing of stoneware tubes by ordinary methods is always attended with some difficulty, and the strength and simplicity of these casings should command the attention of electrical engineers and contractors.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

BY PROF. W. CAWTHORNE UNWIN, F.R.S.

In opening his last lecture the lecturer said he found he had a little exaggerated the cost of hydraulic power in London. He gave as the lowest price 2s. per thousand gallons; he found that to large consumers it was supplied at 1s. 6d. per thousand. That gave a cost of £35 per effective horse-power per annum.

Distribution of Power by Steam.

Most commonly, where steam power was used, the boilers which generated the steam were close at hand. But in special cases it had been necessary to convey the steam some distance before it was used in the motors. Sometimes pumping machinery underground had been worked from steam boilers above ground. It would, nevertheless, hardly have been thought very reasonable to of collecting and conveying the natural gas great distances it completely took the place of coal both in manufactories and for domestic heating. The cost of coal at Pittsburg was 4s. or 5s. a ton, and slack coal sold at from 2s. to 2s. 6d. a ton. In spite of that coal went absolutely out of use. They obtained gas there in enormous quantities from wells, and the first transmission was to Mr. Carnegie's works, a distance of nine miles. It was a new

* Sixth and last Howard Lecture, delivered before the Society of Arts, Friday, February 17th.

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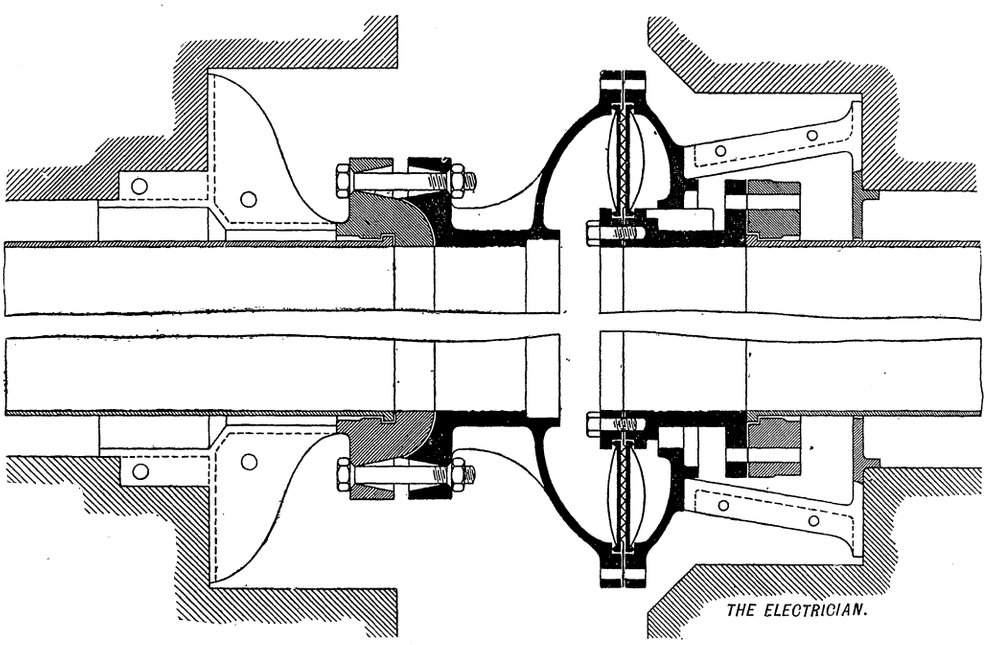
distribute steam widely for power purposes through pipes, but the defects of steam as a means of distributing power might be balanced by its convenience as a means of distributing heat. At any rate, in America the experiment of distributing heat and power from a central station by steam had been tried on a very large scale and with a considerable amount of success. The first system was one started by Mr. Holley in a number of towns in America. There the steam was conveyed through pipes to the buildings to be warmed, and afterwards discharged through steam-traps into the sewers. Generally, before it was discharged it was taken through coolers over which the air entering the building passed, so that the steam was reduced before discharge to as low a temperature as possible. In New York, Mr. Emery concluded that steam could be distributed economically from one station to buildings within a radius of half a mile. In the first station were placed boilers working to 12,000 or 16,000 H.P. It might be judged that the system was not entirely unsuccessful from the fact that they were building up-town another station in which they had already provided for 3,000 H.P. They worked the steam at 80lb. or 90lb. pressure per square inch. The main pipes were of wrought iron, 15in., 13in. and 11in. in diameter, and the return mains were 8in., 6in. and 4in. in diameter, the idea being, of course, to bring back the hot water, and so save some of the heat which had been expended in the generating station. For steam used for heating, the charge was made on an estimate of the size and character of the building, and the amount of heat probably required. This method proved not very equitable or satisfactory. The charge for power was, for a time, based on the nominal power of the engine, and that also proved unsatisfactory. They appeared now to have contrived a steam meter which worked satisfactorily. It gave a graphic record of the amount of steam used. The ruling price at first was 50 cents per 1,000 "cals.;" * that was about ¾d. per horse-power hour. They now charged for either power or heating on a sliding scale, 70—40 cents. per 1,000 cals. That meant that they sold their steam power practically at from £12. 10s. to £7. 10s. per indicated horse-power per year of 3,000 hours. In the case of certain newspapers working chiefly at night the charge was reduced to £5. 12s. As these prices had been fixed after eight years experience it must be assumed that they left a possible margin of profit to the company. The pipes were laid in bricked trenches, covered with slag wool and roofed with boarding. There was an expansion joint at every 50ft. The expansion joint had been one of the principal difficulties of the system. A stuffing-box required too much attention and caused too much leakage. The ordinary diaphragm form of expansion joint did not give expansion enough for a 50ft. length of pipe, and the difficulty had at last been got over by an exceedingly ingenious expansion joint (*see* Figure) which Mr. Emery called the "variator." He used a thin corrugated copper diaphragm only 4-100ths of an inch thick. This was supported by a number of plates or girders on each side, which had more or less power of movement, and merely supported the expansion plate which made the joint tight. They had had a great deal of difficulty in New York of a practical kind. The loss of pressure in the mains over the area through which they supplied was not at all serious. But they had two other losses, the loss from radiation and the loss from leakage. They believed they had reduced those sources of loss to a comparatively manageable amount now. The radiation loss they though they could keep within 5 per cent. of the carrying capacity of the pipes. Of course the radiation in that case was serious, because they kept their pipes hot throughout the 24 hours. With a 6in. main with 45lb. steam pressure they could distribute through one main 260 H.P., and at 75lb. pressure 400 H.P. With an 18in. main, which was quite a manageable size, they could distribute through one main 2,400 H.P. at 45lb. pressure, and 3,500 H.P. at 75lb. pressure. So that they were not landed in any practical difficulty in regard to the size of main which was to be used in distributing any considerable amount of power.

Distribution of Power by Gas.

In the distribution of power by gas they had a problem in which there was nothing which was new or untried. Gas was manufactured on an enormous scale and distributed over town districts. It was enough to mention that in the United Kingdom there had been expended in capital account on gas undertakings £60,000,000; the amount of coal carbonised annually was 11,000,000 tons, and the amount of gas produced annually was 98 thousand millions cubic feet. At the cost at which gas was commonly sold, 2s. or 3s. per thousand, and taking the consumption of a gas engine at a moderately varying load as 26½ cubic feet per effective horse-power per hour, the result obtained in the Dessau station, then they found the cost of getting motive power by gas came out at from £8 to £12 per effective horse-power per annum. The cost included a very large amount due to the vast system of distributing mains which a gas company was obliged to have because it had to supply an enormous number of comparatively small consumers. They lost both in the interest on their mains and in the leakage from the mains. If they wanted motive power only in a manufacturing district a good deal of that could be saved. Even with ordinary lighting gas, it could then be supplied at a much lower cost than could be charged for ordinary lighting purposes. The actual cost of the manufacture of gas was 10d. per thousand cubic feet, and if they allowed 1s. 6d. to cover the cost of distribution over a manufacturing district with comparatively simple mains for motive power purposes, then the cost of power would work out at £6 per effective horse-power per annum. At Dessau the gas company had started an electric lighting station worked with gas engines, and it worked with considerable success. They gained by it because they could produce the surplus gas wanted at a cheap rate, and they gained because they retained the customers who elected to take the electric light. At that station they worked at about 160 E.H.P. In connection with gas he would just casually refer to the distribution of natural gas at Pittsburg, because there was a case in which gas, entirely for heating and motive power purposes, was enormously widely distributed. In spite of the cost



Emery Steam Pipe Expansion Joint.

* 30 cals. = 1 H.P. hour.

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undertaking, and they arranged with Mr. Carnegie that they would put in the pipes and convey the gas to his works if he would pay for it the price he was paying for the coal it replaced up to the time the cost of the mains was covered. Then they would supply the gas to him at half the price he had previously been paying for coal. In that particular case the cost of laying mains was recouped in 18 months. The gas was then taken into Pittsburg, 18 miles away, and afterwards carried a distance of 100 miles. In connection with the distribution of gas for motive power, he found that at the ordinary pressure of 2½in. of water column a 6in. main would carry 250 H.P., and a 36in. main would carry 22,000 H.P.; so that there again they were not brought to any narrow limit in the amount they could distribute by the cost of the distributing arrangements. If they choose to adopt gas somewhat compressed they could distribute much more.

Transmission and Distribution of Power by Electricity.

Coming now to the electrical transmission of power, in 1877 Dr. William Siemens indicated the importance of electrical methods in transmitting power to considerable distances. In his address before the Iron and Steel Institute he stated that a copper rod, 3in. in diameter, would transmit 1,000 horse-power a distance of 30 miles. At that time he was not able to quote actual and practical working transmissions of power. There was very little else than the Lichtefelde and Portrush Railways. From the dawn of the science of electrical engineering the hope had constantly been put forward that now at last some advances had been made which would revolutionise the transmission of power. The world had been promised all things, even the working of railways and Atlantic greyhounds by electrical energy. He was ready to admit that electricians could do much, all, in fact, that they promised; with one proviso—that they were allowed unrestricted expenditure. The world, however, was not carried on on the principle of making unremunerative investments. In a great deal that was said about electrical distribution two things were forgotten; there had always been some means of transmitting power; that if electrical transmission was to become important it must be because it could be carried out so cheaply that the power could be delivered cheaper than power delivered in any other way. There were, indeed, certain directions in which electrical engineers had already achieved a great deal. In the field of electric lighting, which in one sense was distribution of energy from a central station, a great deal had been accomplished. Electric lighting appeared to be succeeding, although it was too early yet to estimate the measure of its sucess. In towns like Geneva, where gas was sold at 7s. per 1,000ft., electricity had not, even on the ground of cost, a formidable competitor. In other cases the unquestionable convenience of electric lighting balanced its extra cost. In the United States there were some four or five thousand miles of electric tramways working with perfect mechanical success. He could not discover that the cost of electric traction was, except in very favourable cases, much lower than the cost of horse traction, but electric tramways, especially in American towns, possessed great advantages over horse traction, especially in the matter of speed; within half a mile of the centre of Buffalo they ran their cars at 15 miles an hour. Almost without exception the electric tramways which had been successful had cheap overhead conductors carried on posts. With the more expensive systems suitable to towns in this country the financial success would be more problematical. A third case in which electricity was likely to achieve success was in the working of underground and overhead railways. Where a three or four minutes' service of passenger trains was required, electric motors distributed over numerous carriage axles had great advantages. It was possible that even in working cost the electric motor would be better than the steam locomotive. Putting aside the cases of lighting and traction, and looking to the transmission and distribution of power, the progress of electrical methods was very far less rapid. Mr. Shoolbred had mentioned in that room a case where, in Bradford, a demand arose for motive power from the mains for electric lighting, but the cost of the horse-power per annum was at 6d. per B.T.U. £60, a charge which made a large use of the power impossible except in cases of working intermittent machinery. Even if they supposed electricity sold, as it was sold in some cases, at 3d. per unit for motive power purposes only, the cost of the power would be £30 per horse-power per annum. There was an interesting case of the development of power at a considerable distance at Oyonnaz, near Geneva. There were turbines of 250 H.P. at Charmines which generated current at 1,800 volts, which was transmitted about eight kilometres to the village, where it was reduced in pressure and used partly for lighting and partly for driving workshops. Nothing could exceed the appearance of general prosperity of the place when he was there 18 months ago, but at that time only 30 H.P. for motive power and 40 H.P. for lighting was used. The Schaffhausen system was fully described by Mr. Kapp before that society. That station a year ago was only distributing power to a single factory. It was delivering electricity to work one 380 H.P. motor and two 60 H.P. motors. Just about the same time there was a similar installation worked by Mr. Hillaret, at Domêne, near Grenoble. There a turbine was erected in a gorge, and worked at 300 H.P. The gorge was almost inaccessible in winter time for about three months. A paper mill at a distance of five kilometres was worked in this way; the efficiency of the whole arrangement being 65 per cent. All those installations had three points in common: the electric current was continuous, the current was conveyed by bare wires on wooden posts, and the source of motive power was a fall of water. In the future, alternating currents might replace continuous currents. So far as he knew, it was only where water power was available and cheap overhead conductors could be used that electricity had been supplied at a distance at a price low enough to compete with other means of obtaining power.

A very important continuous current plant had been constructed at Genoa by MM. Cuenod-Sautter, of Geneva. At Genoa the possibility of an electrical supply had arisen in an exceptional way. Some ten or twelve years ago a scheme of water supply additional to that which already existed was matured, and works had been carried out, the level of the source being 2,050ft. above Genoa. The first service reservoir was at the end of a tunnel, by which the water was carried through a mountain ridge, and was 600ft. below the source. There 730 gross horse-power was available. The next reservoir was 360ft. below the first, and there again 730 H.P. was available. The third was 500ft. below the second, and there 1,000 H.P. was available. The water supply system was not altogether satisfactory. The water had a colour, and although it was perfectly healthy people disliked it. The engineer and consulting engineer were thus led to consider the utilisation of the fall in the mains for generating electricity for lighting and power purposes. At the three points indicated were three stations, the Galvani, the Volta, and the Paccinotti. The Galvani and Volta stations were in operation and the third was in the course of construction. The first installation of 140 H.P. was made in 1889 at the Galvani station. This proved successful, and the complete work was then undertaken. The Volta station supplied 15 motors distributed along the valley and actuated besides a motor of 60 H.P. in the railway station at Genoa. It also drove the dynamos of the central electric lighting station in Genoa. The rest of the power in this station, amounting to 600 H.P. at least, worked a telodynamic transmission. The Galvnai station supplied electricity for lighting the station of Sempierdarena, and drove a motor of 60 H.P. It also supplied power to a number of mills and factories and repairing shops connected with the railway. The transmission was a series constant current one. At certain hours all the motors were out of action; then the dynamos had to furnish only some 450 or 500 volts. At certain hours the dynamos for lighting the town were in action, as well as the other motors; then the voltage reached 5,000 to 6,000. The changes of voltage were sometimes extremely sudden. At the Galvani station, which was the first in which they made the experiment, they had a single group of machines consisting of a two Thury continuous current 6-pole dynamos coupled to a Rieter 140 H.P. turbine, having a normal speed of 250 revolutions per minute. In that case the regulation was effected by hand. The speed varied from 20 to 475 revolutions, according to the demand for power. The dynamos were coupled in series. The variation of speed there was effected entirely by varying the speed of the main turbine. Having succeeded so far with the first installation of 140 H.P. at the Galvani station, they proceeded to design the Volta station, and endeavoured there to carry out a more refined method of regulating the voltage. The Volta station was put in operation in 1891, and had been in successful working ever since. It consisted of four turbines of 140 H.P. each and eight dynamos working at 47 amperes and 1,000 volts at full load. These generators worked at constant speed, and the regulation was effected by varying the exciting current. The whole of the exciting current for the whole eight dynamos was governed by a single governor. The regulation of the current presented difficulties because the motors varied from moment to moment quite suddenly, as the motors driven by the current could be put out of action almost instantly by short-circuiting. To meet these conditions the exciting dynamo was driven by a separate 15 H.P. turbine, which had as little inertia as possible. The exciting dynamo had a very light armature, so that it followed instantly the variations in speed of the turbine driving it. The exciting dynamo was itself excited by a small machine lighting the station, and the stability of its magnetic field was thus secured. The turbine driving the exciter was provided with an ordinary relay governor, but the conical pendulum ordinarily used to secure the constant speed of the turbine was replaced by a solenoid holding in eqilibrium a soft iron core. This was directly attached to the valve of the relay. This system had given good results, but notwithstanding at the new Paccinotti station it was in contemplation to return to the system adopted in the Galvani station. For the transmission of the current there were bare copper wires ⅜in. in diameter, carried overhead on poles. The transmitting line had a length altogether of thirty miles, and a resistance altogether of 500 ohms, and the efficiency at full load was about 90 per cent. The motors were all

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Thury motors, of from 5 to 60 H.P. From 5 to 18 H.P. they were bi-polar, and their regulation was effected by shunting. The motors of more than 18 H.P. were multipolar, and the mode of regulation was to reduce the power by making some of the convolutions of the field magnets receive current in the reverse direction. In that installation they reckoned that the ratio of the effective work on the motors to the effective work at the turbines was 72 per cent. That was a good efficiency, but it was not more than it was possible to obtain under conditions not very different by some other modes of transmission.

Another rather interesting transmission was at Biberist, near Soleure, also constructed by MM. Cuenod-Sautter. There they had turbines of 360 H.P., and power was transmitted 28 kilometres to a paper-mill. The generating stations had two Thury continuous-current dynamos coupled directly through Raffard couplings to the turbine, running at 275 revolutions. The current was transmitted at over 3,000 volts pressure by a bare copper overhead wire a quarter of an inch in diameter. An efficiency of 70 per cent. was guaranteed. The Lauffen-Heilbron transmission on the alternating three-phase system might next be mentioned The owners of some cement works having surplus water power conceived the idea in 1889 of utilising it by means of electricity for lighting and power purposes in the town of Heilbronn, six miles distant. They accepted plans for a a three-phase current plant. The current was produced at Lauffen at 5,000 volts pressure, and at Heilbronn it was first reduced to 1,500 volts, and then to 100 volts. The cost of the current for lighting purposes was 9d. per kilowatt hour, and for power purposes 4d. per kilowatt hour; that worked out at about £42 per horse-power per annum, without allowing for the interest on the cost of the motors. In November last there were eleven motors in Heilbronn, aggregating altogether 32 H.P., so that it was quite an insignificant affair. It was too early to say whether, even at the prices charged, this transmission and distribution could be regarded as commercially successful. So far as he had any means of judging, the three-phase method proved to be an expensive method of working. Mr. Brown, who designed the Lauffen dynamo, never spoke very strongly in favour of the transmission. He had said that one object of the Lauffen-Frankfort installation was to show the advantages of the three-phase system, but it actually showed the disadvantages of complication in the line, generators, and transformers.

Looking to accomplished results, it appeared that electricity generated by steam was nowhere supplied at less than from £30 to £40 per horse-power per annum, exclusive of the cost of motors. Its use at that price was necessarily limited. On the other hand, there were important cases of distribution which had been described, besides some in America, where it been successfully carried out, where power was initially obtained from water, the cost of power being nothing more than the interest on machinery for using water power. There was no prospect of a reduction in the cost of electrical distribution. In one case it seemed to a non-electrical engineer that the cost would have to be increased, for wires on telegraph posts did not suggest adequate security or permanency in a great power distribution working, as such a distribution must work, night and day all the year round, and on which the industrial life of a whole community would depend. The smallest self-respecting town in requiring a water supply would not hesitate to build a substantial conduit. An important power distribution did not seem to require less permanent construction than a water supply, and such a conduit would carry conductors free from risk from lightning and much freer from risk from accident than telegraph poles. But, of course, if a conduit of that kind had to be adopted the cost of distribution would be increased.

Referring to the Herstal plant in Belgium, the lecturer said it had been always a question where steam power was used of how far it was desirable to centralise the power or to distribute it. There had been cases where each principal shaft was driven by separate motors. In some large works at the present time they were replacing steam engines by scattered gas engines. It was found at Birmingham that one of the advantages of compressed air power distribution was that a considerable amount of shafting could be dispensed with in some of the workshops, and separate air motors could be distributed over the works; the motors required very little attendance, and they did not, like small steam engines, fall off in efficiency because they were small.

The Future of Power Distribution.

It had been shown that where power was easily and cheaply obtainable the demand for it grew, and the advantage to the community was very great indeed. Power could be distributed in various ways at a cost varying partly with the original cost of power, and partly with the interest on the distributing arrangements. There was no hope that the cost of the distributing arrangements could ever be made small. The engineer therefore was forced to study modes of cheapening the sources of power. Where water power was available it had enormous advantages, so great that its utilisation would probably lead to a transfer of industries in many cases to new localities. As to steam engines, probably the limit of improvements had very nearly been reached. With gas engines there was perhaps a larger, through not very large, prospect of reducing the cost at which power could be produced. In central station working by steam, the cost of working was the chief difficulty. The fundamental difficulty was the variation in the demand for power and the expensiveness of any means of storage of power hitherto tried. The variation of the demand had led the London gas companies to discover the advantage of combining with their primary object of lighting, the supply of power and the supply of heat. In his address to the Gas Institute two years ago Mr. Trewby said there were 2,500 gas engines and 70,000 gas heating stoves in London. Comparing two similar days in June, 1880, and June, 1890, it could be seen that the night consumption chiefly for lighting between 8 p.m. and 3 a.m. had increased 20 per cent. in ten years; in the same ten years the day consumption of gas in London had increased 73 per cent. That was chiefly due to the increased employment of gas-engines and stoves. In Paris compressed air was used for driving refrigerating machinery, for driving an electric light sub-station dynamos, and for ventilation. At Cologne the water supply and electric lighting stations combined, so that when power was not required for lighting it was used for pumping. At Dessau the gas company erected an electric lighting station on the principle that the use of gas in driving gas engines increased their profits as gas engineers as well as obtaining for them new customers. *The chief hope of reducing the cost of power distribution would be by combining the supply of as many demands as possible.*

LEGAL INTELLIGENCE.

Tibbits v. Alabaster and Others.

This case, part of which was briefly reported in our last issue, was opened on Wednesday, the 15th inst., before Mr. Justice Mathew and a special jury. The action was brought by Herbert Tibbits, M.D., against the proprietors of the *Electrical Review*, in respect of an alleged libel published in that paper. The defence was that what was published was fair criticism on a matter of public interest, and, therefore, justified.

Sir R. Webster, Q.C., M.P., Mr. R. Wallace, and Mr. R. A. Germaine were counsel for the plaintiff; Mr. Lawson Walton, Q.C., and Mr. Bankes appeared on the other side.

Sir RICHARD WEBSTER, in opening the case, said that the action was brought by Dr. Tibbitts in respect of a libel, in the sense that it imputed misconduct as well as ignorance to Dr. Tibbits. Dr. Tibbits was a medical man, an M.D. of the University of Edinburgh, and possessing, in addition, considerable qualifications in England; and he had for a long time been interested in what was called "massage and electrical" treatment of complaints. The defendants were the proprietors of an electrical paper who had thought fit to make a series of attacks upon the treatment that would be the subject of discussion in this action, and to include therein anybody who had expressed an opinion, however honest his opinion might be, and however well-grounded, having regard to his own investigation. There had been established at 52, Oxford-street, for some years an institution on which a very large amount of money—between £40,000 and £50,000—had been spent in fitting it up with the most elaborate and improved appliances for electrical treatment. Quite apart from the electrical treatment that went on in the institution itself, Mr. Harness had invented what was called Harness's Electropathic Belt. Dr. Tibbets was asked by Mr. Harness to examine his methods and make a report. Dr. Tibbits said he would do so, but his report must be taken whether it was good or bad. Mr. Harness agreed, and undertook to pay the plaintiff a fee of 100 guineas. The learned counsel then referred to what he termed the libel written concerning the plaintiff, and published in the *Electrical Review* of September 23, 1892. It was headed 'Electricity and the Medical Profession," and referred to the pamphlet on the "Treatment of Disease by the Prolonged Application of Currents of Electricity of Low Power," by Dr. H. Tibbits, as a grave reflection upon the intelligence of the medical profession generally, seeing that Dr. Tibbits was supposed to be a recognised authority in the medical world. It proceeded: "A perusal of the foregoing by any one who has a very elementary knowledge of galvanic electricity, and who has one of the Harness belts before him, will at once show that the writer exhibits a most incredible ignorance of electrical laws, an ignorance which utterly unfits him to speak as an authority, and which in view of the support which it affords for the bolstering up of this appliance, seems to call for an interdiction by the British Medical Association. . . To get at the public, so as to protect them, is most difficult; the daily Press is, unfortunately, too interested, from an advertisement point of view, to enter into the matter. Although it may take time, we feel little doubt but that perseverance will eventually command it, and that what is undoubtedly a grave scandal, may at last be unveiled in all its grossness, and the promoters and abettors brought to book." He (Sir Richard) might tell them "interdiction" meant the preventing of a man being allowed to carry on his medical practice. If the Medical Council chose, they could remove a man from their rolls, and prevent him carrying on his profession. He called attention to the fact that Dr. Tibbits was charged with almost incredible ignorance of electrical laws—ignorance which it was suggested had been so applied as to render his "interdiction" desirable. It did not follow because continuous currents were sneered at from a scientific point of view, that they were useless; in fact, there was an overwhelming amount of

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testimony that the benefit derived from these belts had been immense. That what had been read was a libel there could be no doubt. To charge a professional man with imposture, and to say that he was an abettor of a gross fraud, was calculated to do as much harm to a medical man as could well be imagined. It was particularly hard on Dr. Tibbits, because he was a bankrupt. His bankruptcy, however, had been caused by an enthusiastic (it might be a rash) desire to promote a hospital for the poorer classes, where the processes he had started and developed for the treatment of diseases should be carried out. In conclusion, the learned counsel submitted that in the face of what he should prove Dr. Tibbits knew when he wrote the report in question, to speak of him in the way this libel had done was a gross and slanderous libel, entitling Dr. Tibbits to very substantial damages.

The plaintiff was then called, and bore out his counsel's opening statement.

Cross-examined by Mr. WALTON: Dr. TIBBITS said he was bringing this action for his own benefit exclusively. Mr. Harness was finding the money to carry it on. He explained his connection with the West-End Hospital and the West-End School of Massage. He disapproved of both the *Lancet* and the *British Medic l Journal*. Mr. Harness simply gave him the belt. He had not seen any belt without external connections, but his opinion at present was that they should all have them.

In reply to further questions, Dr. TIBBITS adhered to his opinion that some current did pass through the body.

Would the experiment I have referred to lead you to say that either quantity or intensity could be obtained?—The intensity refers to the belt when not worn. It was not written to be cross-examined on by a learned counsel in a law case. (Laughter.)

Mr. JUSTICE MATHEW: We are not here to try the belt.

Re-examined by Mr. WALLACE, the plaintiff said his first experiments were with the belt detached from the body. Then he proceeded to see whether the current, instead of going outside, went inside the body. All the moneys he received from the bazaars went to the hospital. He made himself responsible, and the last resulted in a loss of £1,500, which sent him into the Bankruptcy Court. The School of Massage was carried on first at the hospital, and afterwards at a house close by.

Dr. ARTHUR JOHN HARRIES and Dr. RUSSELL HARRIS were called, and gave it as their opinion that the belts which had been submitted to them generated a current of electricity which, when applied to the body, passed through.

Mr. J. W. WILSON, C.E., said he was the principal of the Engineering School at the Crystal Palace. He was one of the jurors in the Electrical Exhibition of 1892. The belt produced, when coupled up, generated electricity. He had no doubt it would, when placed upon the body, pass through it.

Cross-examined by Mr. BANKES: He wrote to Mr. Harness and asked him to send a belt, as he (witness) thought he would like to see what it was. He wore it some time, and then tested it. Subsequently Mr. Harness obtained a report from him. There could not have been any stream of electricity in the manner suggested in his first testimonial. He supposed he had made a mistake. Mr. Harness asked him to examine seven belts, and he paid him fifty guineas.

Mr. H. F. JOEL, an electrician of over 25 years' experience, said he had had about ten of the belts submitted to him He found that each and every one did generate electricity. He had tested the electromotive force, the resistance and the quantity of electricity. Beyond all doubt, the greater part of the current must go through the body, as the part that offered the least resistance.

Cross-examined by Mr. BANKES: Mr. Joel said he was an electrician pure and simple. Any pieces of copper and zinc coupled up and placed in anything that would act as an electrolyte would produce electricity. Four of the discs neutralised each other and the other two gave a resultant current. The most he obtained was $\frac{2}{10}$ths of a milliampere.

Mr. S. J. MACKIE, C.E., of 27, Chancery-lane, for 27 years the science correspondent of the *Standard* and other journals, said he had come to the conclusion the belts generated electricity which went through the body. When the belt was on the body he obtained a click from the telephone.

Cross-examined by Mr. BANKES: When coupled up the belt gave 1·4 micro-amperes.

THURSDAY, FEBRUARY 16TH.

Mr. LAWSON WALTON, Q.C., in opening the case for the defendants, said that the defendants who invited the jury to express the opinion that they had exercised fairly their right of criticism, and expressed frankly their opinion and their censure of an appliance sold to the public, and which the public were invited to purchase, were men who could form an opinion of some weight, and who claimed to have formed in this case a perfectly honest, a perfectly dispassionate opinion, and one which he trusted they would hold, fell within the domain of fair criticism. This action was important to the defendants; it was none the less important to the public. The right to think and form an opinion upon, and, if necessary, to condemn, any one of the various new appliances of science which were seeking a public market, and were apt to impose upon the uninstructed and credulous members of society, was a right which ought not to be lightly invaded The whole attack had been on the appliances—a censure on those who sold the appliances, and on those who made large profits by putting upon the market what these gentlemen (the defendants) honestly thought—and thought for good reasons—to be an utterly worthless article of trade. In his opinion, before Dr. Tibbits lent his name to Mr. Harness in connection with the publication recommending the public to purc ase the belt, he ought to have said he confined himself to the mere abstract scientific inquiry whether electricity could be generated by the belt or not. He maintained that the article did not attack the plaintiff, but denounced in the strongest terms the action of Mr. Harness, who must have smarted from head to foot when he read the opinions of the writer. Mr. Harness, however, had not brought the present action.

Sir RICHARD WEBSTER, interposing, said there was an action by Mr. Harness pending.

Mr. LAWSON WALTON, continuing, said Mr. Harness had brought no action with reference to the article in question, but had commenced another action, which the defendants would deal with when it came on for trial. At all events, looking at the position of Dr. Tibbits, it was manifest that this was really an action by Mr. Harness, and that he had found the means for it. There could be no doubt that Mr. Harness was the real plaintiff in this action and "financed it," and yet he had not been called as a witness. The action was really brought by him to punish the defendants for free criticism on his belts. The pamphlet put forth by him had actually been sent to their paper for the purpose of review, and they had the right to criticise it and the appliance it was sought to puff. It would be proved that the belts were sold and worn in the ordinary course, without the outside connection, which was with a view of attaching the appliance to a battery. The wire was sold loose, for attachment or detachment. Not a single member of Mr. Harness's staff had been called to show that the defendants were under a misconception with regard to that. The jury would be asked to come to the conclusion that Dr. Tibbits had ignorantly or negligently attached his name to an opinion which would encourage the sale of the belts. Lord Kelvin's, otherwise known as Thomson's, galvanometer, an instrument of remarkable delicacy, had been used in such a way as not to test the current passing from zinc to copper, but from zinc to the platinum pin inserted. Of course, what should have been done to prevent the independent current being set up, would have been to insert two platinum pins.

Lord KELVIN, the President of the Royal Society of London, said he had made a life-long study of electricity. One of Mr. Harness's electropathic belts had been submitted to him for examination.

Sir RICHARD WEBSTER submitted that the belt must be shown to be similar to that given to Dr. Tibbits.

Mr. W. T. A. BEARE, of Finchley, was interposed to depose to going to the Zander Institute in 1892 and purchasing a belt for 5 guineas. The belt was the one produced He took it to the offices of the *Electrical Review*. He asked how the electricity was generated. He never asked what the sockets on the belts were for, but he saw the sockets. He had not seen the internal arrangements of the belts, and knew nothing about them. There were no external wires on the belt. Re-examined: Absolutely nothing was said to him about outside connections on the belt—there were none. His attention was not called to any directions.

Lord KELVIN said that the belt if worn on the body in its present condition was not capable of generating any electricity on the body. He had seen a copy of Dr. Tibbits's pamphlet. The word "intensity" was not used in its proper electrical sense. Nothing in the belt could realise the expression that "either intensity or quantity could be obtained." There was no means of coupling up the belt as it was put into his hands. The words implied an impossibility. To connect the belt with a galvanometer, appliances which did not accompany the belt were necessary. If outside connections were on and applied to the galvanometer, you would get no perceptible current because the belt would be short-circuited. There would be an infinitesimal current, but he believed it would be too small to show on the galvanometer. From the description of the experiment it was absolutely certain that the short wires were not connected up. In the third experiment, the current spoken of arose from one formed between the platinum needle and the copper or zinc. A single needle could not tap the current; there must be two needles.

In cross-examination by Sir RICHARD WEBSTER, WITNESS said that what was known as Sir William Thomson's galvanometer was his (Lord Kelvin's) invention. It was an instrument used for testing very mild currents of electricity.

Did not you say, assuming proper connections, that a current would certainly flow through the body, entering the body by the zinc surface and leaving by the copper surface?—Yes, there would certainly be a small current. Whether enough to deflect a galvanometer he had not tried.

You are not a medical man, Lord Kelvin; I believe it is the only attainment you do not possess?—I am an M.D.—(loud laughter)—an honorary M.D. of the University of Heidelberg. I have a license to practice, but I have never exercised it.

Sir RICHARD WEBSTER said he did not dispute Lord Kelvin's evidence, which no doubt, he said, was scientifically correct; and in his view it admitted enough for his case—*i.e.*, a slight current of electricity.

Mr. T. E. GATEHOUSE, part proprietor of the *Electrical Review*, said that neither he nor his partners had any connection with *Science Siftings*. He could take the sole responsibility of the article in question. Witness went on to state that Dr. Tibbits's pamphlet had been sent to the office of the *Electrical Review* "for review," and it was reviewed. He had had no personal knowledge either of Dr. Tibbits or Mr. Harness, and no feeling at all against them. He had read the pamphlet carefully, and had written the review, honestly believing what was stated in it. He had made many experiments upon the belt, and for the purpose of experimenting had purchased several of them. With the belt purchased and produced to-day there were no printed directions, nor had he ever seen or heard of any directions as to connecting the discs.

Sir R. WEBSTER here observed that this was an action by Dr. Tibbits, and so far as Harness was concerned he complained of nothing in the article, and if there were nothing in it reflecting on Dr. Tibbits there was an end of the case; but what he complained of was reflections upon the character of Dr. Tibbits

Mr. BANKES: May I say that the whole system is a fraud.

Sir R. WEBSTER: Certainly not, unless you prove it.

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Mr. BANKES: Then I am entitled to prove it, and am proving it. He then read from one of the pamphlets that the belts had discs "all connected."

Sir R. WEBSTER: "All connected."

The learned JUDGE pointed out that the belts sold were described as having the discs connected. The article spoke of discs not connected. It would be for the jury to say whether that was a fair criticism on Dr. Tibbits's pamphlet, which spoke of belts with the discs connected.

Examination continued, Witness said he had made tests as to the quantity of electricity produced. The quantity depended on the moisture of the skin of the subject, and he found from one hundredth to one four-hundredth of a milliampere. He should say that there were several paths open for the passage of the current—the surface of the skin, the web of the belt, and the underclothing in contact with the body.

Cross-examined: The action was being defended solely by the defendants. His original position was that practically no electricity could go through the body. Witness explained the working of the Pulvermacher belt, from which he said a current passed to the body.

Mr. HARRY ROBERT KEMPE, one of the defendants, said he had been engaged in the electrical profession 25 years—20 years in the Post Office. He was a member of various societies, and had written standard books on electricity. He agreed with what Lord Kelvin said about the experiments described in Harness's pamphlet. He (witness) had tested the belt. When coupled up, and with the body extremely moist, he had obtained a current of one-tenth of a milliampere. In the ordinary condition it would be one-four hundredth to one-five hundredth of a milliampere. Two to five milliamperes was recognised as the minimum medical dose. After the belt had been worn any time, polarisation would set in, and reduce the current almost to nothing.

Cross-examined by Sir RICHARD WEBSTER: Polarisation would be rubbed off by the action of the body?—No, it would not.

Mr. JAMES SWINBURNE, an electrical engineer whose electrical qualifications Sir Richard Webster said he did not dispute, stated he had seen the pamphlet which the defendants criticised He thought the statements made by Dr. Tibbits showed he had hardly the most elementary acquaintance with electricity, and was therefore incompetent to deal with the subject he wrote about. For instance, it was clear he did not understand the elementary principles underlying batteries. That was proved from his remarks in regard to intensity. The pamphlet also demonstrated that the author did not know how to tap a current. From passages in the pamphlet, he would infer that the belt was not coupled inside or out. He agreed with what Lord Kelvin said as to that, entirely. He agreed with Mr. Gatehouse, that in respect of these belts the current going through the body was practically non-existent.

Cross-examined by Sir RICHARD WEBSTER: He was never of opinion that no current would pass through the body.

Prof. SILVANUS P. THOMPSON said he had examined several of the Harness belts—some with couplings or connections, some without. With those without connections there were no "currents" at all, and with the others very small. It was not possible to connect the discs in these belts so as to produce much effect. The quantity of electricity generated would be infinitesimal. He should call it an infinitesimal current, considerably less than one could obtain by taking a needle and a pin, connecting them together, and dipping them into a drop of ink. Having read Dr. Tibbits's pamphlet, he should say of it, "The dear old doctor did not know what he was writing about."

Sir R. WEBSTER: And that would not have been a libel.

Mr. WALTON: It is very much like what we wrote—that it showed "ignorance of the laws of electricity."

Dr. ARMAND DE WATTEVILLE, who had made a study of the medical effect of electricity, stated that he had examined these Harness belts, and thought that without outside connections there would be no current, and that it would be of no therapeutic value. It would practically be nil if the skin were dry.

Dr. LEWIS JONES, a physician, who had written on medical therapeutics and taught the subject at one of the London hospitals, stated that he quite agreed with Lord Kelvin. He stated the smallest strength of an electric current which would produce any therapeutic effect.

Sir R. WEBSTER objected that this was irrelevant.

WITNESS stated that everything depended upon time; and he stated the remarkable fact that the quantity of electricity passed through the body during ten minutes—the ordinary duration of medical treatment—if passed through the body at once, would be instantly fatal.

Sir R. WEBSTER said he objected to evidence as to the therapeutic value of these belts, as evidence he had offered upon it had been rejected.

Mr. de TUNZELMANN gave it as his opinion that these belts produced no perceptible current—none of any appreciable value. Looking at Dr. Tibbits's pamphlet he should say that he had no electrical knowledge.

In cross-examination he said he had written on the subject in *Science Siftings*. Mr. Harness had brought an action against the publisher, but not for witness's article.

In cross-examination, he said that with connections there would be a current through the body, though, he added, very slight—a mere trace.

Mr. JOHN GRAY and Mr. SEGUNDO gave evidence. None of the last witnesses were cross-examined.

Mr. WALTON, in reply, said that in the first place, an advertisement had been put in evidence which showed the nature and character of the belts as they were being sold to the public. The defendants had to defend their description of the belt and their criticism from the pamphlet. It was clear that the belt Dr. Tibbits operated upon was without outside metallic connections. Sir Richard Webster had had ample opportunity of showing that these belts were supplied with these outside connections, but he had not done that, and he had even failed to show that the public were in a position to know what the connections were for. If the sockets on the belts were not intended for the purpose of coupling with batteries, why was the connecting wire not permanently fixed on instead of being left loose? The defendants assumed, and he asked them to assume, that without connections was the ordinary method in which these belts were supplied to the public. What was the electrical result which these people got for their five guineas? It could only be detected by an extremely sensitive galvanometer, and was not equal to that produced by a needle connected with a pin and dipped into a drop of ink. What was the position the defendants took up? They had not referred rudely nor too severely to Dr. Tibbits. They had hit at the appliance and the sale of a trumpery article, and the man they wished to draw into that Court was the man who had thought it convenient to keep in the background and out of the witness box, and to put forward Dr. Tibbits to fight "the battle of the belt." The plaintiff was responsible for lending his name for forwarding the sale of an invention which the defendants had good grounds for saying had absolutely no value, and said they thought it was a case for the intervention of the medical authorities, to prevent the sale of a worthless article. He (the learned counsel) trusted the jury would find his clients had not exceeded the right which, so long as it was exercised honestly, was a valuable privilege to all of them—namely, that of bold and free criticism—and that they would not by their verdict allow Mr. Harness to get an advertisement out of this matter, when Dr. Tibbits's loss (if any) at the most, could be counted by farthings. In the circumstances, he asked the jury to return a verdict for the defendants on the grounds he had stated.

The Court adjourned.

FRIDAY, FEBRUARY 17TH.

The hearing of this action was resumed.

Sir RICHARD WEBSTER, Q.C., in addressing the jury on behalf of the plaintiff, said his duty to his client, having regard to the extraordinary way this case had been conducted, rendered it necessary that he should bring their minds back to the real issue in the case. Might he say once and for all that he was not appearing there for Mr. Harness; he had nothing to do with Mr. Harness—he appeared for Dr. Tibbits. No doubt the case had been conducted according to the instructions given to his learned friend, but he (Sir Richard) desired the jury to understand that it was no part of his case, as representing Dr. Tibbits, to criticise or comment upon anything the defendants might have said of Mr. Harness. They knew that there were other proceedings pending with regard to earlier articles, and it would be—subject to what his lordship would tell them—a very great injustice indeed if, under cover of defending this action, the defendants should be allowed to turn the articles in question into an attack upon Mr. Harness, instead of what he would undertake to show it was, an attack upon Dr. Tibbits. For when the libel came to be examined and regarded by fair-minded men, he would point out that there was scarcely a word, scarcely a sentence, which was even libellous or slanderous upon Mr. Harness; the whole sting of the article was directed against Dr. Tibbits and against the medical profession as distinguished from Mr. Harness Prior to the end of 1892 Dr. Tibbits did not believe in the possibility of these weak currents going through the body. Dr. Tibbits had published in a series of medical works a statement to this effect as recently as 1888. The jury had seen Dr. Tibbits in the box and heard his evidence, and in justice to Dr. Tibbits he must point out (his lordship observed it at the time) that Dr. Tibbits, having stated that he declined to investigate the matter at all unless his report was accepted by Mr. Harness as it stood, there was no single word of cross-examination with regard to that. He (Sir Richard) had been twitted with not having called Mr. Harness; but if he had done so, not only would he have been wrong, but the evidence would have been irrelevant. Dr. Tibbits claimed to have demonstrated to his own satisfaction that currents did pass through the body, not in the sense of going from side to side of the body, though he daresay they did that (for, as his lordship said on the previous day, if the current got under the skin nobody knew what became of it), but through other parts; and whatever Mr. Gatehouse might have said, that was the statement which was proved to be true by the simple admissions of Lord Kelvin and the other electricians who had been called; whether that fact was of value or not, attention should be drawn to a further point. Dr. Tibbits had been held up to opprobrium because he circulated or allowed this report to be published without pledging his opinion to the medical value of these currents. It would have been in his favour if he could have said that they were useful from a medical point of view, but, fortunately, Dr. Tibbits did not require to eke out his case by any expression of knowledge of the practical working of these belts before proper tests had been made. Accordingly he said, "I have not had sufficient experience of these matters to say whether or not they are therapeutically of medical value." The facts he was going to read were those deposed to by Lord Kelvin. There could be no controversy that Lord Kelvin, from the great pinnacle of his scientific position, put exactly what Dr. Tibbits, with lesser electrical knowledge, and after five or six weeks of experiment, had discovered, and had told in his report which the defendants had before them. Lord Kelvin was asked, "If the belt were placed on a human body in a state of perspiration, and metallically connected, would a current flow?—Yes, a small current would flow." Mr. Walton actually went the length of saying that the defendants came into Court supposing they were going to attack nothing but uncoupled-up belts. Unfortunately, they called a perfectly respectable medical gentleman, who produced an old belt. He (Sir Richard) asked to see it, and the witness admitted that there were permanent metallic connections between the zinc and the copper. Accordingly, upon the only Harness belt produced by the defendants, there were the metallic connections which caused, and which were necessary to produce, any electrical effect at all. It did not stop there. If this libel had been to the effect that if the belts had been electrically coupled up there was a small current of no electrical value, he could have understood it. But this libel upon the face of it referred to what Dr. Tibbits had said in connection with a coupled-up belt, and nothing else. When a medical

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man said, as Dr. Tibbits had done in this very pamphlet, that the doses of these weak currents must stand the test of experiment, and that all he claimed was that these currents went through the body, he (Sir Richard) ventured to think it was unfair to impute to Dr. Tibbits professional misconduct, being party to a fraud, and being guilty of such unprofessional behaviour in this matter as would entitle him, practically, to be spoken of as a man to be driven out from the pale of honourable people and decent society. What was the libel? Whatever might be said about Mr. Harness, the sting and the whole pith of it was against Dr. Tibbits, and not against Mr. Harness. It was an outrage that, under cover of scientific criticism, such aspersions should be made on the honour and conduct of such a man; and he asked, not for vindictive damages, but, the defendants having pleaded the plea of justification, to say that these aspersions on Dr. Tibbits's character never ought to have been made, that there was no justification for them, and by their verdict to give the plaintiff such damages as would re-establish his position in the medical world.

Mr. JUSTICE MATHEW proceeded to sum up the case to the jury. The alleged libel, he said, was a criticism on a pamphlet written by the plaintiff and published by Mr. Harness. The plaintiff alleged that the criticism was libellous. The defendants, however, alleged that their article did not go beyond the bounds of fair criticism. A newspaper writer had no greater privilege in criticism than any other member of the public. A criticism, so long as it gave expression to an honest opinion, and consisted of honest comment, was not actionable, however pungent, however damaging it may be. There was this well-defined line, beyond which a critic might not go unless he was prepared to justify his allegation—he must not attribute unworthy or dishonest motives to the person whose works he was criticising. The plaintiff here alleged that he was charged with being an impostor and an unworthy member of his profession. If the plaintiff's contention was correct, he was entitled to a verdict. The question was not as to the value of Harness's appliance. Prior to the publication of the articles the defendants had asserted that the electric current generated by the Harness belt did not pierce the skin. Mr. Harness alleged that the current did enter and pass through the body. As it appeared to Harness of great importance to prove the correctness of his contention, he communicated with the plaintiff, a man of considerable scientific attainments, who had established a valuable medical and electrical hospital. But the plaintiff had not been so successful in life as he might have hoped, and it was suggested by the defendants that in his position he would be more likely than an independent man to fall in with Harness's views of the merits of these belts. That was a question for the jury to consider. In 1889 Dr. Tibbits expressed an opinion adverse to electrical appliances of similar, though by no means the same, construction. The doctor had given his explanation of this change in opinion, and of the difference between the appliances. It must be remembered, in considering the position of the plaintiff in regard to Harness, that he made it an absolute condition that the report should be accepted, whatever its contents might be. The pamphlet appeared to convey the impression that Dr. Tibbits's opinion was that the belts he examined were useful instruments. In the witness-box Dr. Tibbits declared he had not formed any opinion as to the value from a medical point of view of the belts. It was for the jury to judge whether in the pamphlet the doctor did give expression to such an opinion. It must, however, be noted that the reference to "dosage" in the pamphlet seemed to indicate that the plaintiff intended to carefully limit any opinion which he might have expressed. The first part of the libel referred to the vendors of these articles; the second portion more directly to the plaintiff. It was for the jury to judge whether the criticism went beyond the limits of fair criticism already pointed out. Did it imply that the plaintiff was attempting to dishonestly bolster up appliances which the defendants allege were useless? Again, it was for the jury to determine whether the phrase in which the hope was expressed "that a grave scandal may at last be unveiled in all its grossness and the promoters and abettors brought to book" was or was not fair comment. If the jury thought the article had gone beyond the limit, probably they would think it very close on the line. Sharp, pungent criticism did not make libel. If this was an honest expression of opinion on which honest opinion was challenged by the plaintiff himself, the defendants were entitled to a verdict. Further, it had been dwelt upon that this action was not brought to relieve the character of the plaintiff from any professional stain, but with a view of recommending to the public appliances of which the plaintiff had approved, and from which Mr. Harness was drawing large profits. The jury must consider if it were a question of damage by what figure they marked their sense of any wrong they considered had been done by the defendants to the plaintiff.

The jury having consulted seven minutes returned a verdict for the defendants.

The announcement was received with applause.

Judgment, with costs, was given accordingly.

BOOKS, &c., RECEIVED.

"Journal of the Electrical Society of Tokyo." Vol. IX., Nos. 51 and 52. (Tokyo: The Electrical Society.)

"Original Papers on Dynamo Machinery." By Dr. John Hopkinson, F.R.S. (London: Whittaker and Co.) 250 pp., 8vo.

"English Manufactures and Australian Trade." By Louis Anson. (London: English Manufactures and Australian Trade Office.) 100 pp. Price 1s.

"Absolute Measurements in Electricity and Magnetism." By Prof. Andrew Gray, M.A. Vol. II., Parts 1 and 2. (London: Macmillan and Co.) 900 pp., 8vo. Price 25s.

CORRESPONDENCE.

THE BROWN MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have the honour to inform you that the new motor described by Mr. Brown in your issue of January 27th last, was invented by us in 1890. You will find a description of it, together with the complete theory, in *La Lumière Electrique* of May 30, 1891, pp. 419—422.

We should be much obliged if you would kindly verify the accuracy of our claim of priority, and to announce it to your readers.

Thanking you in anticipation, we remain yours, &c.,

63, Allée du Jardin Anglais, HUTIN-LEBLANC.
Le Raincy, February 18, 1893.

[As stated last week, in our brief reference to this letter, we have referred to *La Lumière Electrique*, and find an elaborate mathematical dissertation together with illustrations of a 15 kilo-watt motor.—ED. *E*]

USEFUL FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following is a useful rule for rapidly finding the square of any number under 120 without the use of pencil and paper.

Add to, and substract from, the number to be squared a small number a, so that one of the two results becomes a mutiple of ten. Then multiply these two results together and add the square of the small number a. Thus, to square 67—Add and substract 3; then $70 \times 64 + 9 = 4489$.—Yours, &c.,

ALAN WILLIAMS.

21, Shaa-road, East Acton, W., Feb. 22, 1893.

"THAT BLESSED WORD 'INSTALLATION'"!

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have found this much-abused word most useful here as covering wiring, fittings, lamps, holders and glassware. In many contracts we have arranged to supply the whole "installation" consisting of these items at a fixed price per light, and I do not known what other single word we could have employed.—Yours, &c., L. A. SELBY-BIGGE.

University College, Oxford, Feb. 21, 1893.

SUBSTITUTE FOR PLATINUM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We notice your article on p. 46 in last week's issue on the subject of a substitute for platinum wire for incandescent lamps, and it may interest you to know that we manufacture wire under the Langhans patents for many different uses, amongst others for use in sealing into incandescent lamp bulbs. We have had a number of lamps made some eighteen months ago, which have burned from 700 to 800 hours, and in which, on being tested after an interval of twelve months since they were used for lighting purposes, the vacuum still remains perfect. In the manufacture of the wire, in the process of which we have made many important improvements, the difficulties first experienced were in obtaining the proper alloys, and in the platinising process. We find that there is no difficulty in sealing into the ordinary glass, and in special work we can obtain qualities of glass suitable for alloys of our wire, with different expansions.—Yours, &c.,

THE COMPOUND WIRE SYNDICATE,
Feb. 21, 1893. Alfred Riley, Secretary.

NATAL LIGHTNING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Attached I send you a cutting from our local paper, the *Natal Advertiser*, the publication of which by you will probably cause your numerous readers a little amusement. I think you will agree with me that Mr. Walter Stead must be

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a genius of the highest order, and should not any longer be allowed to remain unknown to the leading spirits of the electric world.—Yours, &c., H. J. SEALY.

Durban, January 20, 1893.

[*Extract from the "Natal Advertiser."*]

LIGHTNING ACCIDENT AT NOTTINGHAM ROAD.

CURIOUS BUT SUCCESSFUL TREATMENT.

Last Monday afternoon a rather serious accident occurred at Nottingham Road, which, but for the prompt measures which were taken, might have had a fatal termination. During a heavy thunderstorm Mr. Sam Stead, a well-known and respected farmer in the district, was struck by lightning while standing on one of the front windows of his house, the lightning paralysing one side and rendering him speechless. He entered the house, and conveyed the intimation by signs to his family, who as once took steps to relieve him. Fortunately, Mr. Walter Stead, one of the sons, was at home, and being acquainted with the nature of electricity and its mode of treatment, at once commenced pouring hot and cold water alternately down the side that was affected, following up this treatment by chafing, as the electricity was beginning to draw Mr. Stead's body up. Brandy was administered internally, after which he was able to speak. He was put to bed, while Mr. Walter Stead procured some copper wire, which was utilised as a conductor from the injured man's body out of the window into the ground, and by means of which he obtained speedy relief. We are glad to state that Mr. Stead has now almost completely recovered from the shock. Great credit is due to Mr. Walter Stead for the prompt and effective manner in which he treated the case.

[*Letter to the "Natal Advertiser."*]

A WONDERFUL EXPERIMENT.

SIR,—If the account in to-day's issue of your paper is a correct one, the lightning at Nottingham Road must be of a peculiarly accommodating nature, and different to that experienced in any other part of this sinful world. If, as you say, Mr. Walter Stead is acquainted with the nature of electricity, he must know that, when a man is struck by lightning, the electricity passes through him and goes to earth immediately, and does not, as we are asked to believe, remain in his body, fooling around waiting the advent of some budding genius, anxious to try experiments with a copper wire.

You may take it from me that Mr. Stead's recovery was due to one of two things: either to the administration of brandy, or to the utter astonishment he must have experienced at his son's experiment.

I intend sending the paragraph in question to *The Electrician*. It will, I feel sure, cause Lord Kelvin and others a good laugh, or else send them into a fit—in any case, it will effect something, and that is more than can be said for Mr. Walter Stead's copper wire!—I am, &c., S.

Durban, Jan. 13th, 1893.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This useful book contains over 1,000 pages, and several new and handy features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

TENDERS INVITED.—The Bristol Urban Sanitary Authority invite tenders for the supply, delivery, and erection of switchboards, terminal bars, transformers, and other articles for their central electric lighting station and sub-stations. Specifications, &c., can be obtained of Mr. D. Travers Burges, the town clerk, 51, Prince-street, Bristol. Tenders must be in by March 15th.

——— The Corporation of Huddersfield invite tenders for the supply of main switches and main fuses for controlling the supply of electrical energy to consumers' premises. Samples and tenders to reach Mr. A. B. Mountain, borough electrical engineer, Gasworks-street, Huddersfield, not later than March 15th.

——— Electric light companies are invited to furnish to the Portrush Town Commissioners, on or before March 1st, statements of the terms upon which they would be prepared to undertake the public lighting of the town of Portrush by electric light.

TENDERS ACCEPTED.—Messrs. Laing, Wharton, and Down have secured the contract for electric wiring and supply of fittings to Messrs. Stubbs and Co.'s offices at 42, Gresham-street, E.C.

——— The tender of Messrs. S. Dixon and Sons, of Leeds, has been accepted for the lighting of the *Yorkshire Post* office and works. The installation will consist of about 400 lights.

SALE BY AUCTION.—The sale by auction by Messrs. Wheatley Kirk, Price and Goulty of the contents of the Plashet Hall Works, Forest Gate, E., comprising electric motor tramcars, dynamos, engines, machines, tools, electric fittings, &c., will take place, as will be seen from our advertisement columns, on March 8th.

——— Messrs. Edward Rushton and Son, of 13, Norfolk-street, Manchester, and 21, Richmond-terrace, Blackburn, notify the piecemeal sale of a valuable electric lighting plant, portable engines, &c., recently in use by the National Electric Supply Company (Limited), of Preston, Lancashire. The sale will take place on Wednesday, the 1st prox., at Strand-road, Preston, and includes engines, boilers, dynamos, and a quantity of copper cable and electrical apparatus, comprising a complete installation. Further particulars are given in our advertisement columns.

——— Messrs. F. J. Bisley and Sons announce that they will sell by auction, at 89, Union-road, Rotherhithe, S.E., on March 2nd, at 12, for 1, the stock and plant of an electrical engineer, comprising electric light fittings, batteries, copper wire, switches, bell pushes, tools, and miscellaneous effects.

APPOINTMENTS VACANT.—An assistant telegraph superintendent is required for India. Particulars are given in our advertisement columns, and applications in writing must be sent to Mr. G. Berkley, 57, Charing-cross, London, S.W., from whom all further particulars can be obtained.

——— The County Asylum at Lancaster require an electrician to take charge of a 300-light plant, who is also competent to look after the telephones and electric tell-tales. Other particulars are given in our advertisement columns, and application should be made to the Medical Superintendent of the County Asylum, Lancaster.

THE INTERNATIONAL ELECTRIC COMPANY (34, ALDERMANBURY, E.C.).—This Company have just been appointed sole agents for the United Kingdom by the Helios Company, of Cologne, for the sale of their direct and alternating current arc lamps, which, it will be remembered, obtained special mention at the Frankfort Electrical Exhibition.

LONDON ELECTRIC SUPPLY COMPANY.—In order to dispel the idea that high-pressure supply by alternating currents is dangerous, this Corporation is issuing a circular with some very clear diagrams printed in colours, showing the complete distinction between the high-pressure circuits and those which enter the houses of the consumers.

NATIONAL WORKMAN'S EXHIBITION.—Mr. J. G. Lorrain sends us some printed matter relating to the National Workman's Exhibition, which is to be held at the Agricultural Hall, Islington, London, N., during June, July, and August. The prospectus states that the aim of the promoters of this exhibition is to confine the exhibits to the highest-class skill of our artizans, mechanics, and apprentices. It is intended to afford workpeople of both sexes an opportunity of proving their inventive capacity, and is intended to be an effort towards arresting the growing disregard for good work which is only too plainly apparent in many departments of trade and manufacture in this country. The exhibition has received the support of the London Trades Council, the Lord Mayor of London, the City Corporation and Guilds, and should, we think, find many supporters in the electrical and allied trades. It is to be hoped that the Exhibition will not generate into a mere show by shopkeepers, and that, under the special patronage which it will receive, an effort will be made to include in the exhibits only such work as can be legitimately placed to the credit of the actual workman. Amongst the executive committee are the names of several leaders of workmen's associations, but we hope to find in a later list the names of the leading employers in a number of trades which it is only reasonable to suppose may be distinctly affected by the exhibits shown.

BANKRUPTCY NOTICES.—Claims against the estate of James Collins, of 80, Church-road, Hove, electrical engineer, are to be sent in by March 7th to Mr. R. J. Ward, 7, Pavilion-buildings, Brighton.——The discharge of Victor Silberberg, who traded at 47, Oxford-street, W., as the Electrical Fittings Manufacturing Company, has been suspended for two years.

CREDITORS' MEETING.—The meeting of the creditors of Mr. F. Silvester, of Newcastle-under-Lyne, trading as Fred. Silvester and Co., was held at Stoke-on-Trent, on Friday last, at which it was resolved that a circular should be sent to the creditors to ascertain whether they would consent to a deed of assignment of all his effects to a trustee for the general benefit of the creditors.

BACUP.—At the last meeting of the Tradesmen's Association a discussion arose on the subject of the introduction of the electric light, and as to whether the time had now come when this should be attempted. Mr. Priestley made a long statement on the sub-

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ject, advising the members of the association not to push the matter at present, but to wait until the lamp royalties expired. This course was supported by the Chairman, Councillor Salmon, and was ultimately adopted.

BATAVIA EXHIBITION.—*The Engineer* of the 17th inst. contains particulars of the exhibition to be held in the Dutch colony of Batavia, in August, September and October of the current year. Amongst the exhibits, which it is stated will be likely to be profitably shown, are included steam, gas and petroleum motors, water-wheels and turbines, light and portable railway plant, mining machinery, and apparatus for electric lighting, which is coming into favour in the colony. It is suggested that a 300 16-c.p. plant would be a saleable one at the close of the exhibition, and that smaller installations should also be sent, the price of gas being high in the colony. Applications for space should leave this country not later than April 14th, and offers for the supply of power, or for electric lighting, should be sent immediately. All exhibits have to be delivered at the Port of Batavia before June 30th. Machinery and other implements are admitted free of duty, and also the transport of exhibits in the colony, both by rail and local steamers, will be free of charge. The export steamers from Europe will carry goods for the exhibition at the usual rates; but goods unsold, or not otherwise disposed of, will be brought back to this country free of cost. Messrs. John Birch and Co., of 10 and 11, Queen Street-place, E.C., will supply further information, and render assistance to intending exhibitors.

BERWICK.—The Lighting Committee of the Town Council have in preparation a scheme for the electric lighting of the Borough.

COMMISSIONERS OF SEWERS (LONDON).—At the last meeting of the Commissioners an account was submitted from the City of London Electric Lighting Company, and passed, for lighting the public streets of the City up to December last, the amount being £4,213. The Commissioners resolved to advance certain objections to the National Telephone Company's Bill now before Parliament.

MESSRS. CROMPTON AND CO. (LIMITED).—Considerable interest was taken in the assortment of new electric heating apparatus, which was shown at the President's reception at the Institution of Civil Engineers on Tuesday last. The apparatus was shown working, and it was generally admitted that Messrs. Crompton and Co. had brought the application of electric heating to a very advanced stage. A large number of orders are being received for electric ovens, and the firm have quite a difficulty in meeting the orders for their other apparatus, which are coming in from all parts of this country and abroad.

EALING.—The Local Board have received the report of Messrs. Bramwell and Harris as to the best means of lighting Ealing by electricity. The Chairman moved that the report be printed and circulated amongst the members, and this suggestion was adopted. He stated that from the report it was clear that the electric lighting of Ealing was quite possible, and resolved itself merely into a question as to the amount of support they were likely to get from the ratepayers. Another member of the Board thought the ratepayers would appreciate the report. Instead of having to pay for power they would have the effluent water and the heat of the destructor at their service, and if the works were well managed he did not see why the whole concern should not result in profit to the ratepayers.

EDINBURGH.—It appears that after appointing a deputation to visit the chief electric lighting stations throughout the country, the Town Council of Edinburgh will not, after all, undertake the electric lighting of the town, owing to agreements with the Gas Commission. At their last meeting it was ultimately decided to remit to the Lord Provost's Committee to consider and report as to whether the powers under the Electric Lighting Provisional Order, 1891, should or should not be transferred to the Edinburgh and Leith Town Commissioners. Councillor Anderson, who proposed that this step should be taken, stated that if the Council supplied the electric light it would come into direct conflict with the Gas Commission, and if they gave the work to a local company they would be acting in violation of their arrangement with the Commission.——The Town Council have under consideration the introduction of the electric light at their destructor premises at Powder-hall, and have decided to consult Mr. Murray with the object of receiving from him a report on the subject.

ELECTRO-HARMONIC SOCIETY.—This (Friday) evening, in the Banquet Room, St. James's Hall, Regent-street, W., a "Ladies' Night" Concert will be held, under the direction of Messrs. Gatehouse and Izard.

THE ELECTRIC LIGHT FOR PUBLISHING OFFICES.—Messrs. Lowdon Brothers, of Dundee, have just completed an installation of the electric light in the editorial and publishing offices of the *Dundee Advertiser*.

HARROGATE.—The sub-committee appointed by the Town Council to consider the subject of electric lighting has presented its report, in which they recommend the Council to transfer to a company the powers, duties, and liabilities undertaken under the Electric Lighting Provisional Order of 1891. A long discussion on the subject ensued, and a resolution was carried that the Council apply to the Board of Trade for an extension of time, in order that negotiations may be entered into for the purpose of making satisfactory arrangements for the transference of the Council's powers to a Company.

HUDDERSFIELD.—The engineer and house surgeon of the Huddersfield Infirmary have been instructed by the County Council to visit London for the object of inspecting the systems of lighting adopted in the various hospitals here. Satisfactory progress is reported with the public lighting of the town.

HYTHE AND SANDGATE.—Negotiations are pending with the South-Eastern Railway Company for the supply of electric power for the tramway between Sandgate and Hythe, the power also being used for lighting the Parade from Sandgate and Seabrook to Hythe.

LIVERPOOL.—The City Council have given permission for the Liverpool Electric Supply Company to lay their mains through Sefton Park, in order to enable the Company to supply the adjoining districts with the electric light.

MALTON.—The electric light has been introduced for the first time in Malton (Yorkshire), at the works of the Farmers' Manure and Trading Company (Limited). This Company was the largest consumer of gas in the town, and has now started to make its own gas on the Dowson principle for use with the gas engines employed in the generating plant. Messrs. Parr and Gillies have put down the plant, which included, at the ceremony of turning on the light for the first time on Saturday last, a search light of 100,000 c.p., brought into play from the top of the mill, to the considerable astonishment of the natives.

THE MILITARY SEARCH LIGHT.—Speaking at the annual dinner of the 4th Middlesex Volunteers, Captain Ronald Scott, who commands the F Company, referred to a new type of waggon designed for transporting the search light apparatus with which his name is associated. He announced that he had been in consultation with the Horse Guards, and that within a short period the light would be tested as to its capability for use in night attacks on a large scale.

MORECAMBE.—The plans submitted by the Morecambe Electric Light and Power Company (Limited), for the proposed lighting of the front, has been approved by the Local Board.

NEWCASTLE.—At a meeting of the City Lighting Committee of the Corporation on Tuesday a deputation of merchants was heard on the subject of introducing the electric light into the principal thoroughfares. A motion was unanimously adopted that a meeting be held to consider the advisability of the Corporation taking up the electric lighting on its own account.

NEW TELEPHONE COMPANY (LIMITED).—We have received from Manchester the new list of subscribers to the New Telephone Company, which is in slip form. The present list shows a considerable augmentation of members over the list previously issued by the Company, and includes the subscribers to the Bolton and Radcliffe and Eccles and Penderton exchanges. We think the list would be handier in book form.

PRIVATE LIGHTING.—Mr. Francis Ricardo, of the Friary, Old Windsor, possesses an electric light installation, possessing some special features of interest. The estate is an extensive one; and the lighting mains have to pass under the public road, and under a portion of the estate from the engine-house to the mansion. Messrs. Edmundson were the contractors for the installation, which comprises a Davey-Paxman "loco" type boiler of 12 H.P. nominal, double cylinder Davey-Paxman engines, and an Elwell-Parker shunt-wound dynamo, capable of giving 80 amperes at 180 volts. The lamps supplied represent 230 16-c.p. lamps (a few being 32's), and are lighted at the exceptional pressure, for a private installation, of 135 volts. Under ordinary circumstances the light is supplied through E.P.S. L type accumulators, which have a total capacity of 450 ampere hours. Besides the private house installation, Mr. Ricardo owns an electric launch, for charging which a separate cable is carried beneath the high road to the river-side. This craft is 40ft. long with a 7ft. beam, and is fitted with 58 15-plate E.P.S. cells (1888 L type), and an Immisch motor. Running at full-speed the launch can cover about seven miles an hour, and five miles at half-speed with the cells in parallel.

RICHMOND, SURREY.—The Town Council have been in communication with Messrs. Latimer Clark, Muirhead, and Co., Limited (who are contractors with the Corporation for the electric lighting of the town), and have arranged with that Company for the lighting of the Town Hall, the work to be completed by the first week in May next.

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ROMNEY.—The Lighting Committee has been enlarged by the addition of two members, and will meet next week to discuss the question of the electric light with the Directors of the Gas Company.

ROTHESAY.—The Harbour Trust and Town Council have had under discussion their electric lighting scheme. Messrs. Mavor and Coulson, it will be remembered, reported on this question some time back, and the matter now in doubt was whether the Trust had water power enough for a turbine wheel plant, this being recommended on economic grounds by Mr. Milloy, the Chairman of the Electric Lighting Committee. It was ultimately decided to obtain another engineer's report, either to confirm or otherwise the report previously received.

ST. HELENS.—At the meeting of the County Borough Council last week, the Surveyor submitted his report dealing with the subject of the supply of electricity to the Town Hall and offices, which showed an increased cost over the charge made for gas the previous year, which was, however, explained by the fact that the light had been burning a considerably longer period and with better effect. The Surveyor has calculated that the cost of generating the light represented gas at 2s. 11d. per 1,000 cubic feet, the cost per unit of electricity being 3·47d.

SYDNEY (N.S.W.)—It is announced that the installation of the electric light in the City of Sydney will be carried as a municipal scheme during the current year. The City Council have a Bill before Parliament giving them the necessary powers for undertaking the public lighting, and also supplying private consumers, although it is not yet definitely known whether the matter will be ultimately transferred to a private company.

WEYBRIDGE.—A letter from the Laing, Wharton and Down Construction Syndicate (Limited), announces that the syndicate have transferred the whole of their Weybridge undertaking to the local electric light company as from the 1st January last. The syndicate were under an engagement to remove the existing overhead wires, and the matter is now receiving the consideration of the Weybridge Company. The work of placing the wires underground will, the letter states, be commenced at an early date.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 18, 1893.

1,098. W. E. LANGLON. Derby. Railway junction electric signalling.

1,104. A. FENNEY and C. ECCLES. Barrow-in-Furness. The signalman's electric safety protecting stop catch.

1,112. S. MILLER and C. J. GRIST. London. Improvements in charging primary batteries for electric lighting and other purposes.

January 19, 1893.

1,166. H. R. WOOD. London. Improvements in electric switching devices.

1,168. J. B. PETRIE. Manchester. Improvements in the production of sodium carbonate and sodium bicarbonate from metallic sodium or metallic sodium vapour the said sodium or sodium vapour being obtained electrolytically or by other methods.

1,198. J. BROCKIE. London. Improvements in multiple carbon arc electric lamps.

1,219. C. E. L. BROWN. London. Improvements in single phase alternate-current motors.

1,229. H. H. LLOYD. London. Improvements in secondary or storage batteries.*

January 20, 1893.

1,261. E. and E. CONRADY. Keighley. Improvements in dynamo electric machines.

January 21, 1893.

1,309. H. COURTEEN. Weston-super-Mare. Improvements in or relating to dynamo electric machines.

1,336. E. BLAMIRE. Bradford. An automatic switch for obtaining continuous electrical current from a series of open circuit batteries.

1,354. Sir C. S. FORBES, Bart. London. Electrothermal conductors, plates, tubes, and the like.

1,355. Sir C. S. FORBES, Bart. London. Improved apparatus for forming electrothermal plates, tubes, conductors, and the like.

1,356. A. M. SLOSS. London. Improvements in electric gas lighting appliances and devices.*

1,368. H. C. GOVER. London. An appliance for escape of gas from battery cells.

1,382. W. L. DAVIES and C. W. S. CRAWLEY. London. Improvements in phonophoric inductors.

1,387. E. T. MERCER and M. G. ROSS. London. Apparatus to facilitate the placing of electric or other cables or wires within and the removal from pipes or conduits.

1,388. N. MITCHELL. London. Improvements connected with boots and shoes and galvanic chains or bands therewith for curative purposes.

1,391. K. SCHLEYDER. London. Improvements in electric arc lamps.

January 23, 1893.

1,416. L. G. WEYGANG. London. A new or improved electric alarum for use in hotels or other large buildings or otherwise.

1,435. A. CONNELL. London. An improved supporter for the receivers of telephones and the like.

January 24, 1893.

1,502. W. P. THOMPSON. Liverpool. Improved process and apparatus for the electrolytic production of porous finely subdivided lead for use in secondary batteries. (Erich Correns, Germany.*)

1,528. W. MOSELEY and E. OLDENBOURG. London. Improvements in the electrical insulation of wires.

1,539. C. A. PFLUGER. London. Improvements in and connected with arc lamps.

1,561. H. H. LAKE. London. Improvements in dynamo-electric machines or electric motors. (Robert Lundell and Edward Hibberd Johnson, United States.*)

1,574. J. C. FELL. London. Improvements in current adapters for incandescent electric light circuits. (Alexander Frank Vetter, United States.)

1,579. L. G. WEYGANG. London. Improvements in connection with electric bells.

1,592. A. L. FYFE. London. Improvements in the method of and means for the production electrically of spectacular effects.

1,595. P. JENSEN. London. Improvements in carriage attachments or dial indicators and electric light fittings. (Arthur Middleton Blake, United States.)

January 25, 1893.

1,610. Sir D. L. SALOMONS, Bart. Tunbridge Wells. Improvements in electric heating apparatus.

1,615. N. STANTON HILL. London. Improvements in electrical accumulators. (Iwan Nicolariff, Russia.)

1,620. G. HALL and J. DE MARR. London. Regulable electric lamp.*

1,621. C. S. BRADLEY. Glasgow. An improved system of distribution for polyphase alternating currents. [Date applied for under Patents Act 1883, Sec. 103, July 29, 1892, being date of application in United States.*]

1,661. E. ANDREOLI. London. Improvements in electrolytic apparatus.*

1,675. W. WEBSTER. London. Process for treating the effluent from electrolytically or chemically purified sewage for neutralizing its alkalinity and for the production of bye-products therefrom.

1,683. F. G. LOTT. London. Improvements in electric arc lamps.

1,697. G. BINSWANGER and A. J. COATES. London. An improved electric clock.

January 26, 1893.

1,720. M. C. GREENHILL. Tulse Hill. An improved electric alarm.

1,759. G. F. FLEMMICH. London. Improvements in electrical apparatus for use in ships and other purposes.*

1,778. THE LONDON METALLURGICAL COMPANY, LIMITED, and S. C. COWPER-COLES. London. Improvements relating to the coating of articles with alloys by electro-deposition.

January 27, 1893.

1,812. R. J. SANSOME and H. HAWES. Southsea. Electric light regulating switches.

1,829. W. A. M. BROWN. Leeds. An improvement in electrical transmitters.

1,840. T. E. DEAN. Manchester. Improvements in and connected with electric signalling on railways.

1,849. A. S. GILES. London. A new and improved form of two-way electric switch.

1,863. H. L. DOULTON. London. Improvements in the manufacture of insulators such as are used in electric lighting.

January 28, 1893.

1,894. J. A. TIMMIS and A. J. SMITH. London. Improvements in self-regulating dynamo electric generators and motors.

1,895. T. CLARK and W. B. REDGRAVE. London. An improved and simple means of procuring a "dead beat action" of a coil or coils of wire suspended and moving horizontically or vertically in a magnetic or electro-magnetic field of force.

1,902. H. A. MAVOR, W. A. COULSON, S. MAVOR and W. B. SAYERS. Glasgow. Improvements in or relating to metallic junction boxes for concentric electric conductors, and in the mode of connecting conductors therein.

1,948. H. IMRAY. London. An improvement in secondary voltaic batteries. (La Société Anonyme pour le Travail Electrique des Metaux, France.)

1,951. T. G. MARSH. London. An improvement or improvements in the arms used for supporting insulators on telegraph poles.

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1,956. S. P. Thompson and W. M. Mordey. London. Improvements in dynamo-electric machines.
1,958. Sir J. Anderson and A. Fraser. London. Improvements in electr ic telegraphs and mechanism inconnection therewith.

January 30, 1893.

2,010. W. H. Scott. Norwich. Improvements in electricity meters worked from a central position.
2,044. Sir D. L. Salomons, Bart. London. Improvements in mechanical pianos or other musical instruments worked by electricity.
2,059. A. Heil. London. Improvements in or relating to telegraphy.*

January 31, 1893.

2,134. G. Lentz. London. Improvements in porous vessels or pots, and diaphragms for secondary and primary batteries.
2,145. H. H. Lake. London. Improvements in dynamo electric machines. (Robert Lundell and Edward Hibberd Johnson, United States.)*
2,159. J. H. Rose. London. Improvements in or connected with arc lamps.
2,161. L. B. Miller and M. W. Woods. London. Heating liquids by electricity.
2,167. L. Kahn. London. An approved apparatus for registering telephone calls.

February 1, 1893.

2,182. T. O'Brien. Manchester. Improvements in apparatus for transmitting movements or indications by electricity.
2,190. C. B. Crawshaw and C. Gray. Halifax. Improvements in field magnets.
2,191. H. A. C. Saunders and A. C. Brown. London. Improvements relating to telephone transmitters.
2,199. W. Thomson, Baron Kelvin. Glasgow. An instrument for the measurement of electric currents.
2,203. J. E. A. Gwynne. London. Improvements in alternating current arc lamps.
2,241. C. A. J. H. Schroeder and H. E. R. Schroeder. London. High-tension battery.
2,242. Sir D. L. Salomons, Bart. Tunbridge Wells. Improvements in electric cooking or heating apparatus.
2,267. C. T. J. Vautin. London. Improvements in the method of and apparatus for the electrolytical separation of the basis of salts and of compounds of the same from saline solutions.
2,272. A. L. Holt. London. Improvements in electric light hangers or supports.

February 2, 1893.

2,280. J. D. England. London. Electric toy.
2,311. J. B. Hannay. London. A new or improved apparatus for the electrolysis of saline solutions.
2,318. G. H. Williams. London. Electric tool.*
2,320. R. Conedera. London. Electro-chemical cementation for separating copper from solutions by means of iron.
2,329. J. C. Richardson. London. Improvements in the manufacture of white lead electrolytically.
2,331. N. H. Edgerton. London. Improvements in electric storage batteries or accumulators. (Date applied for under Patents Act, 1883, Sec. 103, 11th July, 1892, being date of application in United States.)
2,334. E. Bailey and G. M. Gordon. London. Improvements in electric incandescent lamps.
2,361. F. Szymanski. London. An improved depolarizing material for galvanic elements.*

February 3, 1893.

2,375. A. R. Bennet. London. Improvements in and relating to insulating supports for electrical conductors.
2,402. A. T. Mirza. Manchester. Improved electrical alarm for use in connection with steam guages.
2,403. J. A. Kingdon. London. Improvements in the means of distributing electrical energy, and in dynamos and other apparatus therefor.
2,455. J. Jergle. London. Improved friction coupling for the carbon feed mechanism of electric arc lamps.*
2,463. J. Marx. London. Improvements in and apparatus for the electrolysis of solutions of salts or compounds of the alkalies, more especially intended for the manufacture or production of alkalies and chlorine, and for bleaching.

February 4, 1893.

2,494. A. Whalley. Helsby. Improvements in telephone annunciators.*
2,520. A. J. Eli. London. Improvements in apparatus for automatically indicating and registering the score obtained in electric target practice.

February 6, 1893.

2,552. R. Pippette. London. Improvements in the construction and control of arc lamps.
2,557. H. T. Barnett. London. Improvements in and connected with electrically driven screw propellers.
2,583. G. Hayward. London. Improvements in electrical indicators, which improvements are also applicable to electric belts, watches, or other apparatus.
2,586. C. N. Waite. London. An improved diaphragm for electrolytic cells.
2,593. J. C. Fuller, G. Fuller, and W. E. Langdon. London. Improvements in or connected with telegraph pole fittings.
2,598. C. D. Abel. London. Processes for effecting the electro deposition of metals upon aluminum. (Georg. Lehnert, Germany.)
2,600. R. Haddan. London. Improvements relating to electric incandescent lamps. (Gaston Dedreux, Germany.)*
2,632. G. R. and C. A. Rollason. London. Improvements in electric lighting.

February 7, 1893.

2,672. C. S. Bradley, R. J. McDonald and R. S. Taylor. London. Transmission of power by high potential direct currents of electricity.*
2,674, J. H. L. Holcombe. London. Improvements in combined electric cut-outs and door locks.*
2,696. P. W. Newton. London. Improvements in telautographs or writing telegraphs. (Elisha Gray, United States.)*
2,703. Darwin Bates. London. Improvements in high tension electrical fuses.
2,725. W. F. Taylor and G. F. Barnes. Croydon. Improvements in incandescent electric lamps.
2,740. J. J. Rathbone. London. Improvements connected with electric arc lamps.

February 8, 1893.

2,744. W. Claypoole. Woodley. Improvements in the means for applying the static electrical brush discharge to the human body for curative purposes.

February 9, 1893.

2,888. H. Brocklehurst and H. Constein. Chelsea. Electric fog signal.
2,922. H. Scott and H. K. Burnett. Bradford. Improvements in electric clocks.

February 10, 1893.

2,940. J. E. Richardson. Derby. Improvements in the electric dissociation or modification of gases, gaseous compounds and products.
2,946. R. J. Crowley and J. R. Grant. London. Improvements in or relating to galvanic batteries.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1892.

843. Coad. Incandescent lamps.
3,233. Rawson and Others. Electrically driven machines.
3,919. Rawson and Woodhouse and Rawson United (Limited). Repairing incandescent electric lamps.
4,190. Laurent-Cely and Finot. Electrical batteries.
4,248. Brockie. Arc lamps.
4,276. Paul. Electric meters.
4,427. Kingsbury (Western Electric Company). Telephone switchboard systems.
4,428. Kingsbury (Western Electric Company). Telephone switchboard systems.
4,429. Kingsbury (Western Electric Company). Switchboard systems for telephone exchanges.
4,768. Maquay. Electric batteries.
4,841. Spence. Electric railway trains.
5,141. Snell and Others. Electric circuits.
5,528. Booth. (Hermann). Coinfreed telephonic apparatus.
5,750. Johnson. Electrical switch.
8,987. Germain. Secondary batteries, &c.
10,466. Forbes. Telephone combination.
12,506. Jones. Telephone transmitter.
14,813. Usher. Electric battery plates.
14,815. Usher. Storage batteries.
15,040. Gray. Printing electros.
15,994. Holmes. Electrical conductors.
17,751. Redfern (Green). Door lock switch for electric lights.
18,025. See and Tyler. Electric elevators.
19,061. Irish. Electric railway system.
20,606. Day (Higham Electric Company). Electric arc lamps.
20,611. Mills (Lundell). Governing electric motors.
20,693. Hansen. Electric arc lamps.
20,864. Pollitz. Telephone receivers.
20,894. Wetzer. Telegraph, &c., call systems.
20,989. Upcraft. Electric light bracket.
21,268. Porter and White. Suspending electric incandescent lamps.
21,273. Ethridge. Electric contact breakers.
21,613. Groper. Telephone transmitters.
21,621. Von Mito. Incandescent electric lamps.
21,830. Atkinson and Others. Electrical conductors.
22,375. Thompson. (Coffin). Welding metals electrically.
22,639. Kroeker. Secondary batteries.
22,958. Garton and Daniels. Lightning arresters.
22,987. Justice. (Griscomb). Secondary batteries plates.
23,086. Smillie. Telephone communication.

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COMPANIES' MEETINGS & REPORTS.

Cuba Submarine Telegraph Company (Limited).

The forty-third ordinary general meeting of the Cuba Submarine Telegraph Company (Limited) was held at their offices, 58, Old Broad-street, on Wednesday, February 22, 1893, to receive the Directors' report and accounts for the half-year to December 31, 1892, and to transact the other general business of the Company. The chair was taken by Mr. Charles W. Parish.

The CHAIRMAN: Gentlemen, I will ask the Secretary to read the notice calling the meeting.

The SECRETARY (Mr. James Scott) having read the notice,

The CHAIRMAN said: Will you take the report as read, gentlemen? It has been in your hands for some days, and I presume you will not wish to listen to it again. (A voice: Take it as read.) I am very sorry to have to tell you that our Chairman is unwell, and is therefore unable to attend our meeting to-day. He has not been well for some little time, but he is now better, and had fully hoped to be able to address you this morning. Unfortunately, however, he has had to send us word that he cannot come. I know you will join with us in expressing regret at this occurrence, and in wishing Mr. Greenwood a speedy and complete recovery. (Hear, hear.) It is with great pleasure that your Board ask your approval and acceptance of the report and accounts, and which cover the period of six months from July 1st, 1892, to December 31st last. Happily, we have had no interruptions in our traffic, and we have thus been able to carry quickly and accurately a large volume of business, which must be not only satisfactory to the public whom we serve, and to the Companies with whom we work, but also, I am sure, to our shareholders. It has been a wise custom at these half-yearly meetings to compare the results of the six months working with the corresponding period of the previous twelve months, for you will understand that conditions of business in the West Indies are naturally more uniform at certain seasons of the year, and so more useful for comparison. Following this custom I will now offer you a few remarks comparing the last six months of 1892 with those of 1891. It is with great satisfaction that we can point out an increase of traffic receipts of over £700. In 1891 we earned £19,362. 12s. 9d., while last year, as you will see from the accounts before you, the figure reached no less than £20,089. 2s. 8d., and it is an especially favourable result when you notice that there has been an actual reduction in our working charges of £235. 4s. 5d. In looking more closely at these costs we find under London office expenses an item of £47. 14s. for travelling expenses which did not occur in 1891, and I would mention that this arose from a special journey to Madrid undertaken by Mr. Keith. But under the station expenses, there is a saving in salaries and wages, and also in the maintenance of the land lines, while there is an increase of travelling expenses from some changes in our staff. You will recollect that at our last meeting, held in August, our Chairman mentioned that we hoped to clear off under date of December 31st last the remaining balance of the £48,000, which, as you are aware, has been charged to revenue for the Cienfuegos-Santiago 1881 cable. The exact amount of this balance was £497. 4s. 9d., and this, with the usual half-yearly charge of £1 875, makes up the £2,372. 4s. 9d., which figures in the accounts before you—to the debit of revenue, of course. You doubtless are all aware of the failure of the New Oriental Bank, with which the Company has a deposit of £3,000, and as there are grounds for fearing the liquidation of this unfortunate bank may not be satisfactory, your Board has charged the half-year's profits, with £1,500 as a reserve, against any loss we may have to sustain. I have good reason for supposing it will not be such a large amount as that. We have been able to carry £4,500 to the reserve fund, which now amounts to the very respectable sum of £94,500. Mr. Keith is unavoidably absent to-day, for he is in Cuba, as mentioned in the report; but we expect he will be home again in three or four weeks, leaving everything in thorough good working order. I do not know whether there are any other points of interest to mention, but perhaps some proprietors may like to put some questions. With your permission I will now move:—

"*That the report and accounts for the half-year ended December 31st last, now submitted, be received and adopted.*"

Mr. ALEXANDER F. LOW: I have much pleasure in seconding that.

A SHAREHOLDER: Do you think that the £1,500 you mentioned is sufficient to cover the loss you may have through the New Oriental Bank?

The CHAIRMAN: Yes, sir. The Board believe it will be fully sufficient; indeed, I may mention that we have good authority for expecting a better dividend than we are now allowing for.

Some discussion followed as to the investments, after which the Chairman moved, and it was carried unanimously:—

"*That the following dividends for the half-year be now declared upon the shares of the Company, viz., at the rate of 10 per cent. per annum, subject to income tax, on the preference shares and 8 per cent. per annum free of income tax, on the ordinary shares, payable on and after to-morrow.*"

Mr. LOW: I beg to second that.

The resolution was carried unanimously.

The CHAIRMAN: I think that is all our business to-day, and I am much obliged to you for your attendance.

A vote of thanks to the Chairman and Directors terminated the meeting.

The following is the report of the Directors:—

"From the balance-sheet and accounts for the half-year ended 31st December last it will be seen that the gross receipts (including the balance brought from last account) amount to £22,850. 15s., and the gross expenditure (including the balance of the contract price of the 1881 cable) to £6,972. 16s. 4d., leaving a sum of £15,877. 18s. 8d. to the credit of revenue account. Of this the sum of £1,500 has been set aside as a reserve against any loss from the deposit with the New Oriental Bank Corporation, which is now in liquidation, and £4,500 added to the reserve fund, making that fund £94,500. The dividend on the preference shares will absorb £3,000, and leave £6,877. 18s. 8d., out of which the Directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income tax, the balance, £477. 18s. 8d., being carried forward to the current half-year's account.

"The main cables have continued in good order throughout the half-year, but the harbour lengths at Cienfuegos and Santiago have been interrupted. Three new lengths, one at Cienfuegos and two at Santiago, have been laid by Mr. Keith since the end of the year. The cost of this work and of the repairs to the old lengths will appear in the accounts for the half-year to 30th June next.

"A little progress has been made in the Company's suit against the Spanish Government at Madrid. The Government has issued a Royal Order for the verification by the Cuban authorities of certain points raised in the case."

Westminster Electric Supply Corporation (Limited).

The ordinary general meeting of the shareholders of the Westminster Electric Supply Corporation (Limited) was held at the Corporation's offices, Eccleston-place, Eccleston-street, Belgravia, S.W., on Wednesday last, the Right Hon. Lord Suffield, K.C.B., presiding.

The SECRETARY (Mr. Frank Iago) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I presume that as a copy of the report and accounts has been sent to each shareholder, you will allow them to be taken as read. [Taken as read.] In moving the adoption of the report I take the opportunity of congratulating you on the fact that the Corporation has reached the position of a dividend-paying concern. You will see from the accounts that the net earnings of the past year have been £8,656. 8s. 1d. to which must be added £3,159. 14s. 3d. brought forward from 1891, making £11,816. 2s. 4d. at credit of net revenue. Out of this the Directors have paid an interim dividend at the rate of 3 per cent. per annum for the half-year ended June 30, 1892; and they now recommend the payment of a dividend at the rate of 4 per cent. per annum for the past half-year, carrying forward a substantial sum to 1893. The Directors feel, and I am sure you will agree with them, that the aim of the Corporation should not be to pay large dividends at first, but rather to build up the business on a sound basis, at the same time paying to the shareholders a fair dividend out of the profits of the undertaking. We have written off all bad debts, which are very small, a proportional part of the preliminary expenses and suspense account; and depreciation of plant, buildings, and furniture, and no sum fairly chargeable to the revenue of the year has been carried to capital or suspense account. You will observe that the depreciation of plant has been fixed at £2,500 for 1892, and this the Directors consider to be a fair amount, looking at the fact that some of it was not ready for use at the beginning of 1892, to the efficient state in which the plant has been maintained, and the expenditure for all repairs and maintenance which has been charged to revenue exclusively. The whole of the plant has worked thoroughly well during the past year, and the stations for generating the supply are well equipped and working most satisfactorily. When we had the pleasure of meeting you last, attention was drawn to the fact that for the two last quarters of the year 1891 the cost per unit had shown a great decrease in comparison with the preceding periods, and you will be glad to learn that for the year ending December 31st last the expenditure under this head shows a still greater economy. You will notice that we now have mains laid in 33 miles of roadway, equal to about 130 miles of ways, and, practically, the whole of the principal streets in our area have been laid, with the exception of the streets now being rebuilt on the Duke of Westminster's estate in Mayfair. The principle adopted by the Directors is not to lay a main in any street not already provided for, unless they see the prospect of a good percentage on the capital expenditure, a policy which has resulted in the whole of the capital expended in the streets earning a fair profit. Owing to the unexpected number of lights applied for it became necessary to raise more capital, and the Directors therefore carried out the promise made at the last general meeting, and offered an additional amount of £40,600, in £100 debentures, to the then existing shareholders. Owing to the progress made by the Corporation they were enabled to do this at a reduced interest, 4½ per cent. per annum, instead of the original rate of 5 per cent., and the whole of this issue was at once taken up by the shareholders. Some idea of the advance of the business may be gathered from the fact that whereas on December 31, 1891, the electric energy supplied was equivalent to 62,820 lamps of 8-c.p., on December 31, 1892, the number had increased to 98,686, while at the time the report was printed the equivalent of 102,743 lamps of 8-c.p. were on circuit, and applications were in hand for a further 8,229, the applications still continuing at a considerable rate. You will be gratified to learn that in addition to the numbers already given the Corporation have been requested to provide for supply to Her Majesty's Foreign Office, which we hope will be followed by the other large Government offices situated at Whitehall. I am not aware of the exact number likely to be installed, but I know it will eventually be very considerable, and we are already prepared to supply. The installation at the Houses of Parliament has also been largely increased by the connection of the current to the House of Lords. I must now refer to the reduction which your Directors have already made, and are about to make, in the standard charge per unit. In June last, after very careful consideration, they came to the conclusion that it was advisable to reduce the price from 8d. per unit, allowed by the Provisional Order, to 7d. I think I am right in saying that the Westminster Corporation was the first Supply Corporation in London to voluntarily reduce the standard charge to their consumers, and experience has already shown us that it was a wise

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policy to adopt. Not only has it created a good feeling among the consumers who were then on circuit, but it has, we feel sure, greatly increased the number of applicants for current, and it was found that when the reduction was made many consumers added to their existing installations. The Directors have lately again had this matter under consideration, and they feel the time has now come when they must be prepared, in justice to the consumers, and without injury to the shareholders, to still further reduce the charge. They have, therefore, issued a circular to their consumers, and to all residents throughout the area of supply, stating their intention to still further reduce the standard charge to 6d. per unit from March 31st next, with a sliding scale of rebates to very large consumers. They feel confident that by dealing thus liberally with their consumers they will not only retain their present customers, but so largely increase the number of applicants as to be able to earn a much larger net revenue than if they held to the present charge of supply. I will not further detain you, except to say that while we, your Directors, have all given our best attention to the concerns of the Corporation, we, and you, are greatly indebted to an excellent staff for the success of the undertaking. The engineer-in-chief, Prof. Kennedy, with untiring zeal and his large experience, has proved invaluable, and has, by his forethought and great care, succeeded in supplying current with the utmost regularity, as to which no cause for complaint has ever arisen. Our manager, Captain Bax, has in all respects given us complete satisfaction, as has also our secretary, Mr. Iago. I must congratulate you, as shareholders in the Westminster Electric Light Supply Corporation, on having sailed out of troubled waters into a secure position. What with competition, rivalry of a strong company (which, to put it mildly, has left no stone unturned to their own advantage), and difficulties of many kinds, it is something to say, notwithstanding, that we find ourselves, after writing off a considerable sum (which, as prudent men of business, we have considered advisable) by way of reserve, and carrying over a substantial sum to the next account, enabled to offer a 4 per cent. dividend for the last half-year, and considering what I have stated as to the very large increase of current which we are prepared now to supply, it is not too much to say that we may hope to add to this dividend before long. I now formally move the adoption of the report and accounts.

Mr. JAMES HESLOP POWELL in seconding the motion, supplemented the remarks of the Chairman by explaining by means of a chart, the area which the corporation supplies, the progress it has made since its inception and its expenditure in proportion to its income.

Mr. FITCH said that he observed that the charges for generation and distribution were 43 per cent. of the net receipts, while those for another company in which he was interested amounted to 33 per cent., or a difference against this Company of 10 per cent. Another company (the Strand company) worked at 40 per cent. of its net income. He hoped that as their income increased they would be able to reduce the working cost.

The CHAIRMAN said that he had already referred to the increased economy likely to be effected, and their chief engineer, Prof. Kennedy, would say something on the subject.

Mr. FITCH said he merely wished to draw attention to the fact, but in no hostile spirit.

Prof. KENNEDY said that he was very glad that anyone should analyse the accounts, for the more these were critised the better. Mr. Fitch's remarks were perfectly correct. The St. James' Company generated practically the same number of units, but every lamp took double the amount of current per annum. In spite of that fact he thought that the Corporation were really doing better, because their district was five times as large as that of the other, with, at present, the same output. He would venture just to give the comparison between their first and second month's experience this year. In the first six months the Corporation had sold 560,000 units, and the total cost had amounted to £6,890; whereas, in the second period, they had sold 660,000 units, their total expenses having amounted to £6,750, or 100,000 more units at an outlay of £160 less.

The CHAIRMAN then put the motion to the meeting, and declared it carried. He afterwards moved the declaration of a dividend at the rate of 4 per cent. per annum, payable on March 1st next.

Mr. R. W. WALLACE seconded the motion, which was carried unanimously.

The CHAIRMAN said that he had great pleasure in moving the re-election of Mr. J. Browne Martin to his seat at the Board.

Mr. COOPER seconded the resolution, which was agreed to *nem. con.*

Mr. W. HAYES FISHER, M.P., next proposed the re-election of Mr. Wallace, the other Director retiring by rotation, remarking that Mr. Wallace's technical knowledge and legal experience had proved invaluable to the Board.

Sir MARK J. STEWART, Bart., seconded the motion, which was carried unanimously.

Mr. MARTIN and Mr. WALLACE expressed their acknowledgments, the former observing that he agreed with Mr. Fitch that the reduction of the price of the electric light which the Corporation had made, and the expiry of the Edison and Swan patents, would lead to a great consumption of the illuminant, and, consequently, increased dividends to the shareholders.

Mr. T. S. SCRIMGEOUR proposed and Mr. TROLLOPE seconded the reappointment of the auditors, Messrs. Cooper Bros. and Co., which was agreed to unanimously.

Sir MARK J. STEWART then proposed a vote of thanks to the Chairman and his colleagues for their able conduct of the business of the Corporation.

The CHAIRMAN in expressing his acknowledgment paid a warm tribute to the interest taken in the Corporation by all the other members of the Board, and said that he could cordially endorse what had been already said by Mr. Wallace that he believed there was a great future for the Corporation.

Votes of thanks were afterwards accorded to and acknowledged by the chief officers of the staff and the proceedings terminated.

Kensington and Knightsbridge Electric Lighting Company (Limited).

The general meeting of this Company was held at No. 1, Great George-street, Westminster, on the 16th inst., Mr. Granville R. Ryder in the chair, "to receive report of the Directors, to declare dividend to elect retiring Directors and to transact other business of the Company."

The SECRETARY (Mr. R. S. Erskine) read the notice convening the meeting and the minutes of the last meeting, which were approved by the present meeting, and signed by the Chairman as correct.

The CHAIRMAN then said: I beg to move the first resolution:—

"*That the report and accounts now read be adopted, and be entered on the minutes.*"

Before putting that to the meeting, I desire to make a few remarks on the report and accounts now submitted to you. I believe, gentlemen, you will agree with me in thinking that they show substantial and steady progress, though, perhaps, not quite as rapid as we could wish. At the same time there are some features about them which are of an encouraging and satisfactory character. In the first place, with respect to the houses and shops taking the light, the number on December 31, 1891, was 436, while on December 31, 1892, it was 550, an increase of 114; and the 8-c.p. lamps sprang from 38,408 on December 31, 1891, to 47,441 on December 31 last. There is also a very satisfactory increase in the output of units, which jumped from 385,051 in the year 1891 to 535,343 in 1892, an increase of 150,292. The gross earnings per 8-c.p. lamp remained practically about stationary—in fact, rather less than more, being 7s. 7d. per lamp in 1892, as against 7s. 8d. per lamp in 1891. As to the gross earnings, in 1891 they were £12,266, but they have increased in 1892 to £16,628, being an advance of £4,361. The net profits have increased by the sum of £2,446—that is to say, from £4,381 in 1891, to £6,828 in 1892. There is a satisfactory point in these figures, namely, that the ratio of profit to gross earnings has considerably increased. It has increased from 36 per cent. in 1891 to 42 per cent. in 1892. That point might be further elaborated by this fact also—that the increase of profit of £2,446 may be put against the increase of £4,361 in the gross earnings; and in that case the increase would stand at something over 56 per cent. of profits as against gross earnings. That, I think, is an extremely satisfactory item, because it shows that the ratio of profits increases with the increase of business. The next point I would call attention to is as to the capital expenditure for the past year. The total amount spent was £12,800 in round figures, and I may mention the main items on which that outlay has taken place. On buildings £868. 18s. 8d. has been spent. That expenditure has really been on coal bunkers at the Knightsbridge station, and it will tend very much to the economical working of our business in the future. The sum of £1,788 has been spent on batteries, £733 on connecting to mains; meters £1,013, plant £3,764, and mains—this being the largest item—£4,441. No doubt the shareholders will observe that there is a considerable increase in the capital account, and First Mortgage Debentures, issued during the past year—or rather up to December 31 last—amounted to £29,400, whereas in the former account, that is to say, to December 31, 1891, the amount was only £7,930. There would naturally appear to be on the face of it a discrepancy, because £12,800 only has been expended on capital, and the increase in the issue of mortgage debentures has been £21,470. However, by looking at the figures of this year, and comparing them with those of last year, you will see that the item following that of mortgage debentures, "sundry creditors and open accounts," stood at £11,347 in 1891, whereas in the accounts now presented the item is only £3,011. 14s. 4d. That accounts for the difference of £8,000. There is another item on the other side which requires explanation, "suspense account (law)," £1,800. That comes from the action that was brought against us by Mr. Lane Fox As you are aware, we had not to stand the whole expense of that contest ourselves. Some of the other companies, and also some private firms, joined with us. The total cost of the action was over £6,000, and the amount which falls to us is about £2,000. As you are aware, we gained the victory over Mr. Lane Fox, but it is probably true in law, as in many other things, that the next worse thing to defeat is the reverse. Mr. Lane Fox was condemned in costs, but up to the present time they have not been paid, and whether they will be paid or not I cannot say. Negotiations are going on, which we hope may result in his paying our costs. The actual amount of our share he will have to pay will be about £1,300, and this will reduce the amount we have to pay to £300. We only hope that that may be the result, but it is impossible at the present moment to say whether we shall get that £1,300 paid by Mr. Lane Fox. The next item I would call attention to is the first item on the debit side of the revenue account—"To manufacturing electricity, coal, oil, water, waste, wages, and sundries"—amounting to £3,746. 11s. 4d., as compared with £4,067. 11s. 11d. last year. Thus you will see that with an increase of output of very nearly one-third, we have managed that the expense of the production of the electricity should be something like £300 less than that in the year before. That, I think, is a very satisfactory statement, and it reflects the greatest credit upon the staff. The principal item of diminution is in the wages. The coal, which is a very large item, cost very much the same, but the reduction made shows that by devoting their attention to the economical working of our business they have been successful. You cannot have a better proof of that than the fact of their having worked a much larger business at a less cost of £300. The next item which I would draw your attention to is less satisfactory—bad debts. I suppose it is always open to us to have some bad debts, but I hope that the amount will not always be as large as £393. This arises from Hyde Park Court, one of Hobbs and Co's properties. Two quarters had been paid, but in the summer quarter they disputed the amount, and the meters had to be tested. That gave them time, and the result was that when the meters were tested and were

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found quite satisfactory, they had nothing to pay with. I am afraid we must regard this as lost. With regard to the item of "Renewal account in respect of buildings, mains, plant, and batteries," £3,395. 15s. 7d. That sum includes the actual maintenance, which amounted to £2,124. 15s. 7d., and added to that the £921 which has been written off what you may call antiquated plant, and the sum of £350, by which we have increased the renewal account, increasing it from £1,713 to £2,063. I think these are the only points to which I need call your attention on the accounts, but I shall be very glad to answer any question. There are one or two other things that I would draw your attention to, and one is with respect to the district belonging to the Kensington Parish, which the Chelsea Company have agreed to sell to us. We have had the Wharncliffe meetings with respect to this matter, and it has been approved by the shareholders. The Chairman then indicated on the map the district proposed to be transferred to the Company, and continuing, said : You will see that it comprises by no means a bad district. At the present time it is producing £1,700 a year gross, and I shall be very surprised if, out of that £1,700, we are not able to get 10 or 12 per cent. upon the amount of our purchase money, which is agreed at £7,000. There are 673 houses in this district, and at the present moment only 50 or 60 take the supply, but our mains run the whole way on this side of the new district, and it will be easy to make connections anywhere. The system of the Chelsea Company, too, is the same as our own. We certainly think that this will turn ut a satisfactory bit of business for the Company. There is one other point I would mention before I sit down, namely, with respect to the statement made in the report, that "No provision has been made in the accounts for directors' remuneration." The same remark might have been made with respect to all the accounts that have preceded the present statement; but I should, at the same time, inform you that up to the end of December, 1891, the Directors have been paid by certain shares which were handed over to them by the old Kensington Court Company. The fact is that the Kensington Court Company received from this Company the sum of £25,000, of which £5,000 was not distributed, the idea being that it might be required for paying the expense of syndicating the capital of the new Company. As it so happened, when we tried to syndicate it we were unable to do so, as electric lighting companies were not at the time in favour. We, however, went among our friends, and in that way got the capital without appealing to the public. A good many of the shares were not issued, and about 3,000 were left. The Directors having had no remuneration whatever for six year's work, suggested to the Kensington Court shareholders that they could not lay out this money better than in remunerating the Directors and officers for their work for six years. This was done, and every single shareholder agreed to it. I think it is right, as it might occur to some shareholder to move that some provision should be made for the Directors for their work last year, that they should know the position. The fund is now exhausted, and we must depend at future meetings on what the shareholders may vote to us. I now conclude by proposing the resolution.

Mr. G. H. HOPKINSON seconded the motion.

Mr. SAUNDERS, Q.C., said he desired to congratulate the Directors on the working of the Company. He had made certain enquiries privately, which would avoid the necessity of his asking them at the meeting.

Mr. KILLINGWORTH HEDGES said he also desired to congratulate the Directors on the past year's working, especially on the reduced cost of manufacturing the electricity. At the same time he was rather dis appointed, for the Company had been going on for six years, and they had come to a dividend of only four per cent. on the ordinary shares. He was a shareholder in another company which only started last year—the Electricity Supply Corporation—which, with only 29,000 lights, had got a revenue of £19,717 net ; whereas this Company, with 47,400 lights, had only about £16,000. He did not wish to bring this forward in any invidious spirit.

The CHAIRMAN : That is the Strand Company, is it not ?

Mr. HEDGES, continuing, stated that that was so, and that it used to be known as Gatti's Company. This company's district was, he said, not one in which money could be made as in the case of the Electricity Supply Company and the Pall Mall and St. James' Company, and he desired to point this out as there was a desire to increase their area. He thought that they ought to see if they could not get some richer district. He thought that theirs was too much of a residential district, and as Mr. Crompton once remarked concerning another company, they would do much better if they could supply a few public houses. He could not agree that the Directors were entitled to any more remuneration at present, looking at the trifling dividend of 4 per cent. He did not think that the shareholders should be asked to give any more for Directors' remuneration until a dividend of 5 per cent. was paid. He was not a preference, but an ordinary shareholder. He had had no dividend for some time, then he received 2 per cent., and now he got 4 per cent. He did not think there was much "catch" in his investment, especially as he had joined another company which, in the first year of its working, paid 5 per cent.

The CHAIRMAN : That company has been in existence five or six years, or longer.

Mr. HEDGES, resuming, said that if the Company could get a little more business they would have some more revenue, and there would then be more reason for a liberal payment to the staff. He thought that they had now a "lean year" to face, as he saw that the different companies were reducing their charge per Board of Trade unit, and he presumed that their Company would have to do the same. Moreover, next year they would have rather the dreadful question of how much they would have to pay for the license for the three-wire system. He did not think that this was a year to ask for extra remuneration for the Directors.

Mr. HOPKINSON : We do not ask for extra remuneration, but for some remuneration.

Mr. WYLLIE said he thought that the Directors had done very well indeed, and he proposed that the sum of £350 should be awarded them for their services for last year.

Mr. SAUNDERS, Q.C., in seconding the motion, said he did not at all agree with the idea of allowing directors to work for nothing. He knew many cases of companies which paid no dividend, but the directors of which received handsome fees. He thought that the Directors deserved to be encouraged by the shareholders, and he considered that the sum of £350 was very moderate indeed.

Mr. HEDGES said he thought it would be best to consult the shareholders generally on the matter, nothing having been said in the Directors Report that the subject would come forward.

The CHAIRMAN replied that he did not think the shareholders could be consulted any further than they had been. If they did not come to the meeting it was not the Directors' fault. He then put the motion for the adoption of the report, which was carried unanimously.

Mr. WYLLIE then put the resolution, voting the Directors the sum mentioned, and it was carried.

On the motion of the CHAIRMAN, seconded by Mr. HOPKINSON, the dividend recommended was afterwards declared.

The CHAIRMAN, in answer to a shareholder, said that there was no question as to the right of the Company to get the sum mentioned from Mr. Lane Fox, as judgment had been given against that gentleman in the action which he brought against the Company.

Mr. R. W. WALLACE proposed the re-election of Mr. Hopkinson to his seat at the Board, and said he thought that in doing so he might thank the shareholders for having voted the Directors £350 for their services during the past year. It might be supposed in such a company as theirs, which was not a very large one, there was not so much to do, but he thought that if the shareholders—and especially Mr. Hedges—were to attend one of their board meetings, and saw the amount of work which had to be done, they would think that the Directors were not at all adequately remunerated, although, in the present financial position of the Company, they would not think of asking for more. An enormous amount of work had been done during the past year in connection with matters which had affected what they might, perhaps, call their somewhat infant industry, and these matters had occupied not only their board meetings, but also their very anxious thought and care at other times. Mr. Hopkinson reminded him that there were committees of all the London Electrical Companies which met very frequently, and there was always one member of their Board present at these meetings, for which service nothing was paid. The directors of other Electrical Companies were paid very much more than the Board of this Company. With respect to the extension of the district, the Directors had gone in the matter very carefully, and were certain that it would lead to a very great development in the amount of energy they supplied, while it would pay them at least 10 per cent. on the outlay, and very possibly more—that was, if they only took the present consumers of electricity. With regard to the reduction of price, they were not situated like other companies who had made the reduction. They had no competition in their district. They did, however, make a very considerable reduction to large consumers, and it would be a question that would require very serious attention on the part of the Directors as to whether or not they should make a reduction. The ordinary law of supply and demand, however, did not apply to the reduction of the price of electrical current ; there were other circumstances that influenced this matter. They had not found it desirable at present to reduce their price, but they would do so if they saw that it would lead to an increased amount of business and be advantageous to the shareholders.

Mr. ALFRED S. BOLTON seconded the motion, which was carried unanimously.

Mr. HOPKINSON returned thanks, and afterwards proposed the re-election of Mr. Ryder. He did not think that the Chairman had explained exactly how the shares which the Directors received for their remuneration up to the end of 1891 were divided. The fact was that several of the officers outside the Board had had a considerable amount. As far as he (the speaker) was concerned, he received ten shares, or £50, representing something like two years' work, so that it could not be said that he had been extravagantly paid out of the funds in question. He thought that Mr. Hedges ought rather to blame himself than the Directors for having displayed a want of judgment in investing in the Company if he were not satisfied with the return that he received from it. He did not think that the Directors could be held responsible because the business of the Company had not developed to the same extent as that of other companies supplying more favourable districts. He did not, however, think that there was any reason to complain with regard to the progress of their Company. When he first joined it the total number of lamps were, he thought, 12,000, and now the number was very nearly 50,000. This was in something like four years. Almost every item quoted by the Chairman, and his remarks on the report, showed an improvement of from 25 per cent. to 33 per cent., and he (the speaker) did not think that that was unsatisfactory progress. He only made these remarks because he did not think that any body of shareholders could possibly expect any gentlemen to devote a considerable amount of their time to looking after the interests of the Company for a series of years for nothing. The present, he believed, was the third half-year in which the shareholders had been paid 4 per cent., and he therefore thought that the claims of the Directors for some remuneration might very properly be brought before them.

Mr. HEDGES, in seconding the motion, said that he had not meant in his remarks to make any censure on the Directors. If, however, electricity was "going to go" and to be one of the great commercial enterprises which they hoped it would be, they must pay more than 4 per cent. The public might invest in gas companies to pay them something like 6 per cent., and whereas the latter would be able to on go for ever—

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except for the action of some very Radical Government—the electric lighting companies had only a certain period to work in, during which they must build up a large reserve.

The motion was carried unanimously.

The CHAIRMAN, in returning thanks, expressed a hope that next year the dividend declared might be better.

The Auditors, Messrs. Lovelock, H. W. Whiffin and Dickinson, were afterwards re-elected, and the proceedings then terminated.

Electricity Supply Corporation (Limited).

The annual ordinary general meeting for 1893 of shareholders of the Electricity Supply Corporation (Limited) was held at the Town Hall, St. Martin's-in-the-Fields, Charing Cross, on Friday, February 17th, in the afternoon, for the following purposes, viz.: (*a*) To receive and consider the annual statement of accounts, balance sheet, and report of the Directors thereon. (*b*) To sanction the declaration of a dividend, and to transact the ordinary business of the Company. (*c*) To elect two Directors in place of those retiring by rotation. (*d*) To elect auditors for the ensuing year and settle their remuneration. Mr. Spencer Chadwick, the Chairman of the Company, presided.

Mr. EDWD. WILMOT SEALE (the Secretary) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, In asking you to consider question *a*, that is, to receive and consider the annual statement of accounts, balance-sheet, and report of the Directors thereon, I will ask you to accept that report and the accounts as read. And there are one or two observations that I would like to make in supplementing what is contained in that report; and, first of all, with regard to the reserve fund of £250 that is provided for bad and doubtful debts, and it is, we believe, amply sufficient for that purpose. Then, gentlemen, as to the amount available for dividend, it is, you will see if you will turn to the accounts, £4,248. 19s. 11d., but this amount would have been £5,726. 12s. 9d. but for the fact that we have had to pay out of the profits of the year 1892, in accordance with the directions of the Board of Trade, the debit balances brought forward from last year; that is to say, from the account of 1891, and those debit balances amounted to £919. 14s. 10d. and £557. 18s. 8d. Had it not been for those debit balances that have had to be paid out of the profits, the dividend for this year would have been two and a-half per cent. more than it is. The profits for the last half-year of 1892 show a large increase of business, and, I think that if anything like the same amount of progress is maintained in 1893, the result of that year will to a very great extent be in excess of the result for 1892. Negotiations are now pending with likely customers which will probably result at an early date in a large increase in our supply of current to the extent we expect, of 4,000 to 5,000 more lamps of 8-candle power each. That will be a large increase, but it will be maintained, this extra number of lamps of 4,000 or 5,000, without our having to make any increase in the plant and without incurring any outlay in any way for any extra machinery. Indeed, our present plant is sufficient—more than sufficient—to supply that number of extra lamps. Then as to the working capital, you will have seen that there is not a very large sum in the accounts in respect to working capital, but as there is an available balance at the bankers in cash, the Directors consider that, inasmuch as they have the call upon £19,100, it is in the interest of the shareholders not to call up one shilling more for working capital than is absolutely required from time to time. By adopting this course they will save a very considerable amount in interest upon capital that would have to be paid if the money were called up either in the shape of dividend on shares or interest on debentures. The Directors propose to set aside a substantial sum during the present year on account of depreciation which they have not felt themselves justified in doing during the past year, which these accounts cover inasmuch as the whole of the machinery and plant is still equal to new. Everything has been maintained in a state of thorough efficiency, the Secretary will read to you the engineer's report in regard to this if you wish it. The balance carried forward after paying the dividend (assuming you declare a dividend of 5 per cent. to-day) will be £375, and that of course will be available for dividend next year. Gentlemen, with these remarks I propose,

"*That the report and accounts be adopted and that the dividend as recommended at the rate of 5 per cent. per annum be declared.*"

Mr. G. H. BROUGHAM GLASIER: Gentlemen, our Chairman has placed before us very clearly the position of the Company, and what with his statement and the printed accounts there is really no need for further explanation, and I will content myself with merely seconding the resolution,

"*That the report and accounts be received and adopted and that the dividend at the rate of 5 per cent. per annum be declared.*"

The CHAIRMAN invited discussion.

Col. YOUNG: I would like to ask a question. It is simply to ask for a little information of an item which appears in account No. 7, viz., sundry debtors, £7,302. I would like to know why so large an amount stands in the accounts, and whether it has been reduced since the accounts were made up. I have no doubt that there is an easy explanation for it. Then there is another question that I would like to ask—I do not know whether our shares are yet quoted on the Stock Exchange. I would like to know if any steps have yet been taken to fulfil the promise of the prospectus, that application would be made in due course to the Stock Exchange for a quotation. I wish to know whether such application has been made, and if so, what was the result of it; and if it has not been made, why it has not been made?

The CHAIRMAN: With regard to the £7,302 sundry creditors, there could not be otherwise than a large amount owing at December 31. Having regard to the large amount of current supplied, you will observe on the other side of the account that there is the item of sundry creditors, and, of course, the one is set against the other. The quarter that these accounts refered to is the Christmas quarter, which is a heavy one, and as you know these accounts were not made up to to-day or yesterday, but to the 31st December, and the quarter only closed on the 25th December, and it would be impossible to collect the accounts for some days or even some weeks.

Col. YOUNG: What proportion does that £7,000 bear to the total?

The CHAIRMAN: It is about one-third that has been received.

The SOLICITOR: If you look to the accounts you will see that the sales of current during the year were £19,717, and the £7,000 was outstanding on December 31.

Col. YOUNG: I am glad to hear so satisfactory a reply.

The CHAIRMAN: The Christmas quarter is a very heavy one.

Col. YOUNG: I am satisfied.

The SOLICITOR: As to the Stock Exchange quotation: as you know, the whole of the capital of the company has not yet been taken up, and therefore it would be impossible under the rules of the Stock Exchange to obtain a quotation in the present state of things, and therefore it is impossible at present to entertain any application. It is not worth while making the application until we are likely to meet with a fair prospect of success.

Mr. MILLER: I suppose a large proportion of that £7,000 has since been paid?

The CHAIRMAN: Yes, the bulk of it.

The resolution was carried unanimously.

Mr. LING then moved the re-election of the retiring Directors, Messrs. George Henry Brougham Glasier and Isaac Percy Mendoza.

Mr. PEDLER seconded.

The motion was carried.

Mr. CHAPPLE moved the re-election of the retiring Auditors, Messrs. O. R. Johnston and Son at a remuneration of £50.

Col. YOUNG seconded the motion.

The resolution was carried.

The CHAIRMAN: That concludes the business of the meeting. I am much obliged to you for your attendance, and you will receive in due course your cheques for the dividend.

Mr. WYBROW ROBERTSON moved a vote of thanks to the Chairman.

Mr. CHAPPLE seconded the motion.

The resolution having been carried, the Chairman briefly returned thanks, and the meeting then separated.

Telegraph Construction and Maintenance Company (Limited).

The following report of the Directors of this Company will be submitted to the members at the twenty-ninth ordinary meeting to be held on Tuesday next, the 28th inst., at the offices of the Company, 38, Old Broad-street, E.C., at one o'clock:—

The accounts for the year show a net profit of £51,579. 1s. 5d., after charging the interest on the debentures. To this sum must be added £57,084. 0s. 4d. brought forward from last year, making a total of £108,663. 1s. 9d. From this amount is deducted the interim dividend of 5 per cent., paid July 12, 1892, amounting to £22,410, leaving £86,253. 1s. 9d. to be dealt with. Of this sum the Directors propose to distribute a dividend of £1. 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent., free of income-tax, leaving £41,443. 1s. 9d. to be carried forward to the next account.

During the past year the following works have been carried out, viz.:—A cable has been manufactured, and laid between Santos and Chuy, on the coast of Brazil, for the Western and Brazilian Telegraph Company. A cable has been manufactured, and laid on the coast of Sumatra, for the Eastern Extension Telegraph Company, on account of the Dutch Government. Repairs have been made for the German Government in their Valentia-Greetseil Cable; for the Direct United States Telegraph Company in their cable off the Coast of Nova Scotia; for the Western and Brazilian Telegraph Company in their lines off the coast of Uruguay; and in the Anglo-American Telegraph Company's Brest-St. Pierre Atlantic Cable. A contract has also been made with the African Direct Telegraph Company for connecting Bonny, on the West Coast of Africa, with the Cameroons River, on account of the German Government; and an agreement has been entered into with the West Coast of America Telegraph Company for the supply of a cable to connect Valparaiso and Talcahuano, the greater portion of these two lengths having been manufactured in 1892. Various lengths of cable have been manufactured for different telegraph companies during the year, and a total length of 4,222 miles of wire insulated for submarine and land lines.

The Company's steamships, and their factories at East Greenwich and Wharf-road, are in efficient condition.

The Directors regret that their colleague, Admiral of the Fleet Lord John Hay, has resigned his seat on the Board, owing to the impossibility of his giving adequate attention to the Company's affairs through his being obliged to pass the winters abroad. In accordance with the Articles of Association, the Directors have appointed Sir Robert G. W. Herbert, G.C.B., to fill the vacancy thus occasioned.

The retiring Directors are Mr. James Pender and Sir Robert G. W. Herbert, who, being eligible, offer themselves for re-election. The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (of the firm of Messrs. Gane, Jackson and Jefferys) and Mr. Patrick A. Glegg (of the firm of Messrs. Welton, Jones and Co.), who retire, offer themselves for re-election.

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Chelsea Electricity Supply Company (Limited).

The following is the Directors' report, to be presented at the annual meeting to be held at the Central Station, Draycott-place, S.W., on Thursday, the 2nd prox., at 11 a.m. :—

The net profits for the year ended December 31, 1892, after paying debenture interest, amount to £1,336. 2s. 7d., out of which it is proposed to pay a dividend on the Ordinary shares at the rate of 2½ per cent. per annum, carrying forward the sum of £176. 10s. 1d. to next year. In considering these results it must be remembered that a large proportion of the Company's capital is in the form of debentures. To meet the necessary increase in capital expenditure, the balance of the First Mortgage Debentures and £3,700 of the Second Debentures were issued during the year as the money was required for new works. Important additions have been made to the plant and various improvements have been effected. The whole of the plant, including the accumulators, is in thorough working order. A very gratifying feature of the accounts is the large saving shown in the consumption of coal. There were 357,162 units of electricity sold during last year, the expenditure on coal being £2,433, as against £2,692 in 1891, when 290,458 units were sold. The total cost of each unit of electricity sold was 5½d. in 1892, against 7d. in 1891. The number of lamps on the Company's mains at the end of 1892 was 34,876, being an increase of 27 per cent. for the year. The Directors have every confidence that the accounts for the current year will show still further improvement.

The transfer of the Company's area in South Kensington was, subject to the confirmation of Parliament, approved at the extraordinary general meeting held on the 14th inst. The Directors are of opinion that this transfer will be of advantage to both Companies.

In May last Mr. Frank King was appointed managing engineer of the Company, and the appointment has already produced very satisfactory results.

The retiring Directors are Sir George Prescott, Bart., and Mr. E. Garcke, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers and Co., also offer themselves for re-election.

Notice is also given that an extraordinary general meeting will follow, when the subjoined resolution, passed at the extraordinary general meeting held on February 14th last, will be submitted for confirmation as a special resolution :—

"That the Bill proposed to be introduced in Parliament in the ensuing Session, and now laid before this meeting, intituled 'A Bill for confirming an agreement for the transfer to the Kensington and Knightsbridge Electric Lighting Company (Limited) of the undertaking of the Chelsea Electricity Supply Company (Limited), authorised by the South Kensington Electric Lighting Order, 1889,' be, and the same is hereby approved, subject to all such additions, alterations, and variations as Parliament may think fit to make therein."

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

CREDENDA TUBE COMPANY (LIMITED).—This Company was registered on the 14th inst. with a capital of £100,000, in £10 shares, to acquire and take over as a going concern the business of tube makers, hitherto carried on by the Credenda Seamless Steel Tube Company (Limited).

CROWN CONTRACT AND WORKS COMPANY (LIMITED).—This Company was registered on the 16th inst. with a capital of £10,000, in £1 shares, to construct, execute, repair and maintain in any part of the world railways, tramways, docks, water and gas works, telegraphs, telephones, electric works, or works for the supply or use and application of electricity for lighting, heating, or motive purposes, and any other public or private works.

JAMES MACINTYRE AND CO. (LIMITED).—This Company was registered on the 16th inst., with a capital of £50,000, in £10 shares, to carry on the business of earthenware and china manufacturers, and manufacturers of apparatus and appliances for electric work and otherwise, at the Washington Works and Victoria Mill at Burslem, Staffs.

TUCKINGMILL FOUNDRY AND ROCK DRILL COMPANY (LIMITED).—This Company was registered on February 14, 1893, with a capital of £50,000, in £5 shares, to carry on the business of iron and brass founders, mechanical and electrical engineers, &c., at Tuckingmill, Cornwall,

WILLIAM HOUGHTON AND CO. (LIMITED).—This Company was registered on the 16th inst., with a capital of £10,000, in £10 shares, to carry on the business of electrical and general engineers, machinists, iron and brass founders, &c.. at Great Grimsby.

SWINBURNE AND CO. (LIMITED).—This Company was registered on the 16th inst., with a capital of £25,000, divided into 300 deferred shares of £5 each (Nos. 1 to 300), and 4,700 ordinary shares of £5 each (Nos. 301 to 5,000). The objects are: To carry on the business of electrical engineers, electricians, engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus, and mechanical and chemical engineers, and also the business of producing light, heat, sound, and power by means of electricity, magnetism, galvanism, or otherwise, and to carry on any other business which may be considered able to be conveniently carried on in connection with the business of the Company, or which may be conducive to the interests and progress of the Company. The subscribers are :—

	Shares.
James Swinburne, 49, Queen's-road, Wimbledon, London, S.W., electrical engineer	1
Bertram R. Beale, Angel-lane, Northampton, electrical engineer	1
Harold E. S. Holt, Oaklands, Teddington, electrical engineer	1
Joseph Holt, The Grange, Farnborough, Hants	1
Captain Francis G. R. Slaney, Glandore Bassett, Southampton	1
Edith M. S. Kenyon-Slaney, Glandore, Bassett, Southampton	1
Hewitt Bostock, The Hermitage, Walton Heath, Epsom	1

The first Directors of the Company are:—James Swinburne, Harold E. S. Holt, Bertram R. Beale, Wroth Lethbridge, and Hewitt Bostock, the first three of whom are the first managing Directors.

EMILE LANSARD SYNDICATE (LIMITED).—At a meeting held at 216, Goswell-road, E.C., on the 13th inst., it was resolved to voluntarily wind up the Syndicate, and Mr. J. Boss, of 9, Fleet-street, E.C., was appointed liquidator.

FOWLER, LANCASTER, AND COMPANY (LIMITED).—The annual return of this Company, made up to December 8, 1892, has been filed. At the time of making up 1,782 shares, out of a nominal capital of £22,000, in £10 shares, were taken up, of which 620 were issued as fully paid. Upon the remaining 1,162 shares the full amounts were called, and all calls (£11,620) paid.

FROUDE-HURRELL TORPEDO COMPANY, LIMITED (in Liquidation).—Proofs of debts must be sent in to Mr. C. J. Stewart, the official receiver and liquidator, 33, Carey-street, W.C., by March 4th.

ISLINGTON AND GENERAL ELECTRIC SUPPLY (LIMITED).—The annual return of this Company, made up to January 12, 1893, has been filed. The Company was registered on June 28, 1890, with a capital of £1,000, in £1 shares, as the "Camberwell and Islington Electric Light and Power Supply (Limited)," and formed one of a large number of companies promoted and registered with a view to the acquisition of electric lighting orders in the districts referred to in their titles. The capital was subsequently increased to £250,000, in £5 shares, by the creation of 49,820 new shares, and a public issue attempted. This was unsuccessful, as, at the time of making up, only 27 shares were taken, resulting in a payment of £107.

MOUNTAIN'S WIRE MANUFACTURING COMPANY (LIMITED).—A petition for the compulsory winding up of this Company was presented on the 15th inst. by Messrs. Leatham, Tew, and Co., bankers, of Pontefract, and is down for hearing at the Royal Courts of Justice on March 11.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to February 8th, was filed on the 15th. The nominal capital is £200,000, divided into 100 founders shares of £1 each, 19,980 ordinary shares of £5 each, and 20,000 £7 per cent. preference shares of £5 each. All the shares have been taken up, the full amount called, and all calls paid.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended February 19th were £938, as against £872 for the corresponding period of last year, being an increase of £66. The total receipts for half-year amount to £6,800, against £5,905 in the corresponding period of 1892, being an increase of £895.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—The Directors of this Company notify that a payment on account of the dividend of the current year will be made at the rate of 3½ per cent. for the half-year on the "A" shares, with the addition of a payment at the rate of 4·68 per cent. for the half-year in respect of accumulated arrears. This will work out in the following manner :—On the 89,261 shares, £3 paid, 3s. 7¾d. per share ; on the 5,000 fully-paid shares allotted to the Edison Company, 6s. 0⅝d. per share ; on the 12,139 fully-paid shares allotted to the Swan United Company, 4s. 7¾d. per share. The payment will be made upon the register of February 21st inst., and the dividend warrants will be issued on March 14th next.

LONDON PLATINO BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company give notice that the half-yearly coupons falling due on the 1st prox. of the £100,000 Six per Cent. Debentures will be paid by Messrs. Glyn, Mills, Currie, and Co., 67, Lombard-street, E.C., on and after that date. Coupons should be left with the bankers for three clear days.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee appointed yesterday (Thursday) a special settling day in the vendors' ordinary shares, Nos. 31,437 to 40,000, of Woodhouse and Rawson United (Limited).

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The transfer books of this Company will be closed up to the evening of the 28th instant preparatory to the payment of dividend to all shareholders whose names were on the register on the 20th instant.

WEST AFRICAN TELEGRAPH COMPANY (LIMITED).—This Company announce that the half-yearly interest due on March 1st next on the Five per Cent. Mortgage Debentures will be paid on and after that day by the National Bank of Scotland, 37, Nicholas-lane, E.C. Coupons should be left with the bankers three days for examination.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended February 17, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,233.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended February 15th were £3,011, as compared with £2,635 for the corresponding period of last year. October, estimated at £4,121, realised £4,111.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 15	Price Wednesday, Feb. 22.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Feb. 22. Highest	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	17/6	Anglo-American	53½ 54½	53⅜ 54⅜	4 11 9	Jan., Apr., July, Oct.	54⅜	54
£2,876,140	Stock	35/0	Do. Preferred	95 96	94½ 95½	5 9 11	" "	95⅞	94⅜
£2,876,140	Stock	5/0	Do. Deferred	13 13½	13⅛ 13⅜	..	" "	13 1/16	13⅛
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11½ 11⅜	11½ 12	3 10 0	Mar., June, Oct., Dec.	11⅜	11½
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	104 108	104 108	4 12 7	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175 180	175 180	3 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12 13	12 13	6 3 1	February and August	12½	12¼
6,000	10	10%	Do. Preference 10%	18 19	18 19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2½ 3¼	4 11 5	April and October..	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅜ 12	11⅜ 12	5 16 8	Jan., Apr., July, Oct.	11 1/16	11 1/16
400,000	10	2/6	Eastern	14⅞ 15⅛	14⅞ 15⅛	4 5 11	" "	15⅛	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	15½ 16	15½ 16	3 15 0	" "	16⅛	15⅞
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	112 115	112 115	3 9 7	May and November	112¾	112⅜
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	106 109	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅛ 15⅜	15⅛ 15⅜	4 11 1	Jan., Apr., July, Oct.	15⅜	15⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	109 112	110 113	3 10 10	February & August	111⅞	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103 106	103 106	4 14 4	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102 105	102 105	4 15 3	" "	103	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101 104	101 104	3 16 11	February & August	..	..
180,227	10	1/3	Globe Telegraph and Trust	9⅝ 9⅞	9⅝ 9⅞	5 1 4	Jan., Apr., July, Oct.	9 1/16	9⅝
130,042	10	6%	Do. 6 per Cent. Preference	15⅛ 15⅜	15⅛ 15⅜	3 18 1	" "	15⅜	15⅛
150,000	10	5/0	Great Northern	19 19½	19 19⅛	4 7 8	Jan., April, and July	19⅜	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	105 108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	43 45	43 45	5 11 1	May and November	44½	44¼
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	108 111	108 111	5 8 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7⅞ 8⅛	4 14 1	April and October..	..	..
3,381	£100 Cert.	30/0	Submarine Cables Trust 6%	119 124	118 123	4 17 7	" "	..	..
15,609	10	5/0	West African Telegraph	6½ 7½	6⅜ 7⅜	5 6 8	January and July ..	7¼	..
£271,400	100	5%	Do. 5 per Cent. Debentures	102 105	102 105	4 15 3	March & September	..	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	102 106	103 107	7 9 7	June and December	..	..
88,321	10	6d.	West India and Panama	1⅜ 1⅝	1⅜ 1⅝	..	" "	1 3/16	1⅜
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½ 11	10½ 11	5 9 1	May and November	10⅝	10⅜
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9 10	9 10	6 0 0	" "	9	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	106 109	106 109	4 11 9	June and December	..	..
64,242	15	3/0	Western and Brazilian	7¾ 8¼	7¾ 8¼	5 9 1	" "	8⅛	7⅞
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5⅞ 6¼	5¾ 6¼	6 0 1	" "	6¼	6
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾ 2¼	1¾ 2¼	..	" "	2¼	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104 107	105 108	5 11 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104 107	105 108	5 11 1	" "	107½	106¼
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	—
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	103 106	103 106	5 13 2	March & September	—	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
22,850	14/0	1½d.	Consolidated Telephone Const. & Maintenance	3/16 5/16	3/16 5/16	7 16 5	May and November	¼	..
20,000	£1	4⅜d.	Oriental (11s. paid)	⅛ ¼	⅛ ¼	7 18 2	Yearly	..	..
454,747	5	2/6	National	5½ 5⅝	5½ 5⅝	5 9 1	June and December	5 7/16	5½
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½ 15½	14½ 15½	3 17 6	" "	16 1/16	15
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13⅜ 14½	13⅜ 14½	4 4 3	" "	14½	14
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	4⅜ 4⅝	4⅜ 4⅝	..	..	4 9/16	4½
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	112 115	113 116	3 17 7	January and July	115	114
48,000	£10	..	New Telephone, Limited (£4 paid)	.. ..	.. ..	..	..	..	..
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	—	City of London Electric Lighting (fully paid)	12½ 13	12½ 13	.	—	13	12 1/16
20,000	£10	..	Do. 6 per Cent. Preference	8 8½	8¼ 8½	2 18 2	..	8⅝	8⅜
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	5 5¼	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	1⅜ 2¼	.. ..	..	—	—	—
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	5 5¼	.. ..	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	6 6½	.. ..	..	January and July ..	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	4¼ 4½	4¼ 4½	..	March	..	—
10,000	£5	4½% '91	Do. (fully paid)	6 6½	5⅝ 6	..	March	..	..
111,000	5	..	London Electric Supply	⅝ ¾	1 1½	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6 6½	..	—	..	..
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	103	..
16,318	10	..	Notting Hill Electric Lighting (fully paid)	5½ 6⅜	5½ 6½	—	—	..	..
18,680	£5	9½%	St. James' and Pall Mall	8 8½	8 8½	..	—	8½	8
7,900	£5	7%	Do. 7% Preference	8 8½	8 8½	4 2 4	—	8½	8
42,853	5	3%	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 10 0	—	5⅞	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/9⅜	Brush Electrical Engineering	3⅛ 3⅜	3½ 3½	—	—	3½	3 1/16
69,996	2	6%	Do. 6 per Cent. Preference	2¼ 2½	2¼ 2½	4 16 0	—	2⅜	2 1/16
£125,000	Stock	..	Do. 4½ per Cent. Debentures	104 106	105 107	..	..	106	105½
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July	5 7/16	5⅜
12,139	5	..	Edison and Swan United	— —	— —	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	1⅜ 2¼	.. ..	..	..	..	..
45,000	10	12/0	Electric Construction	3½ 4	3⅜ 4½	..	—	3⅜	3⅜
70,000	2	10/0	Elmore's Patent Copper Depositing	⅜ ⅝	⅜ ⅝	—	—	1/16	..
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	2 3	.	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	22½ 23½	23 24	5 4 1	February & August	23⅝	22½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	103 105	103 105	..	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0 6/0	5/0 6/0	..	..	..	..
78,949	5	4/2½	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	3⅜	3 1/16
37,350	12	12/0	Telegraph Construction and Maintenance	38 42	37 40	6 0 2	March and July	39	37½
150,000	100	..	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July	101½	..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	..	—	..	..
..	£5	..	Do. Preference (fully paid)	¾ 1¼	.. ..	—	—	..	..
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	— —	.. ..	—	—	..	..
600,000	Stock	⅝%	Do. Stock	37 39	35 37	1 13 9	May and November	37½	..

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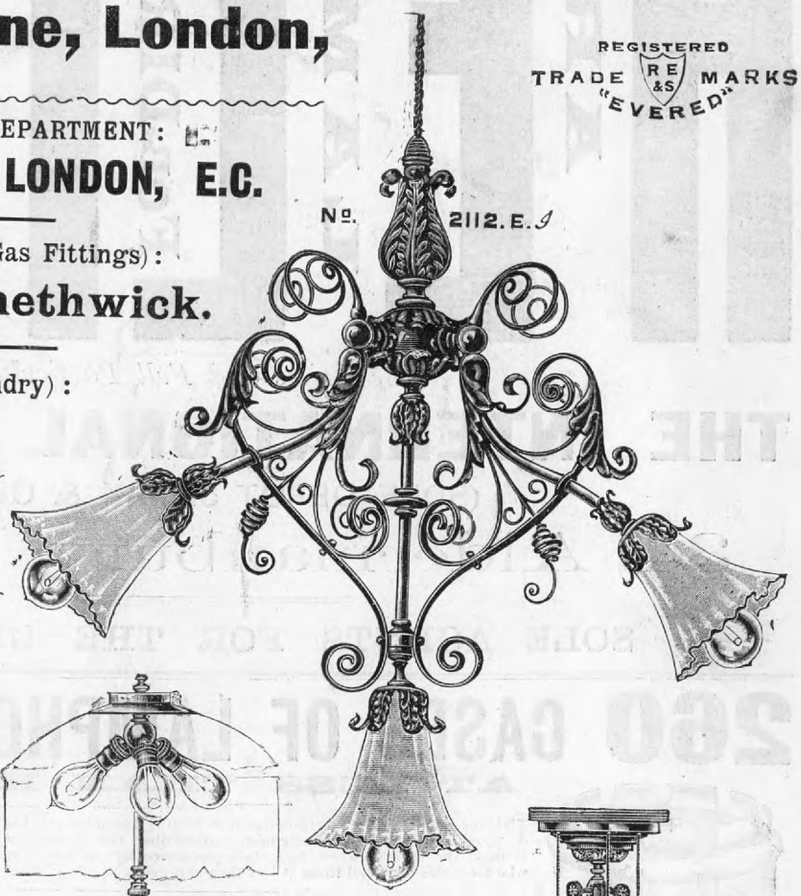

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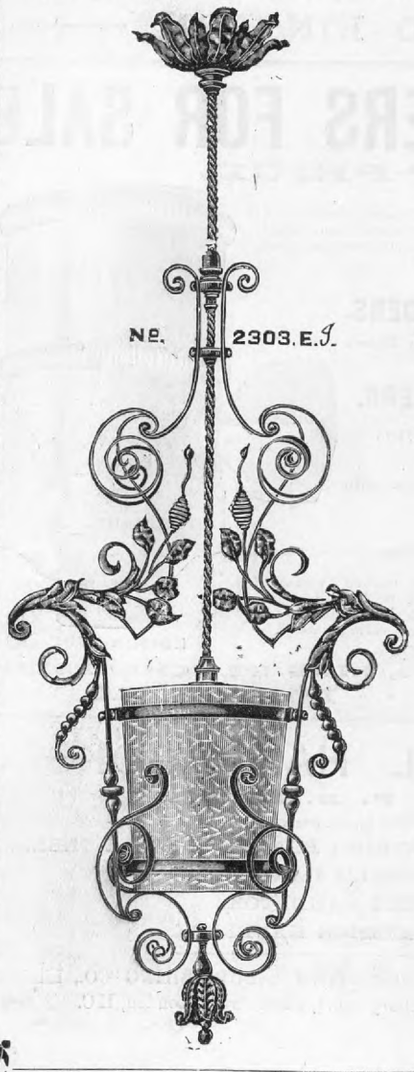

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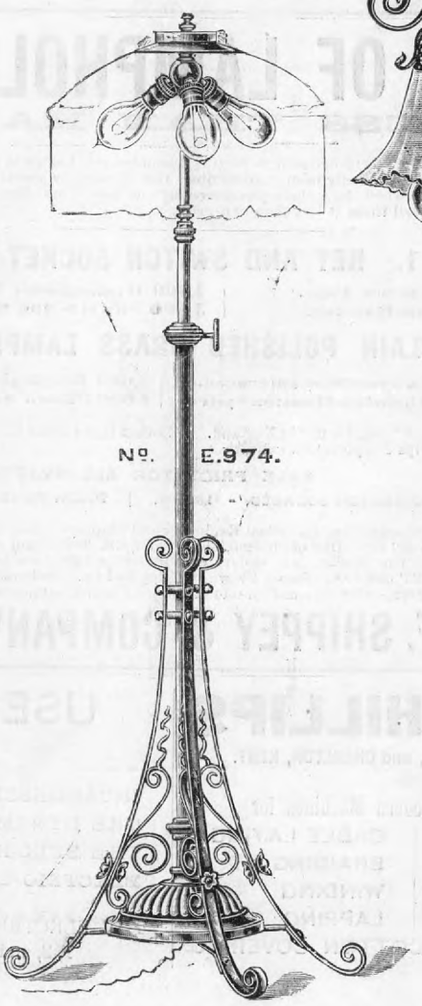

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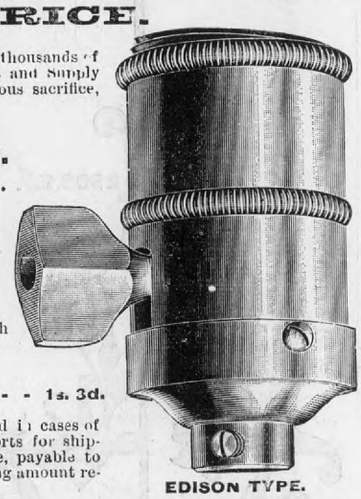

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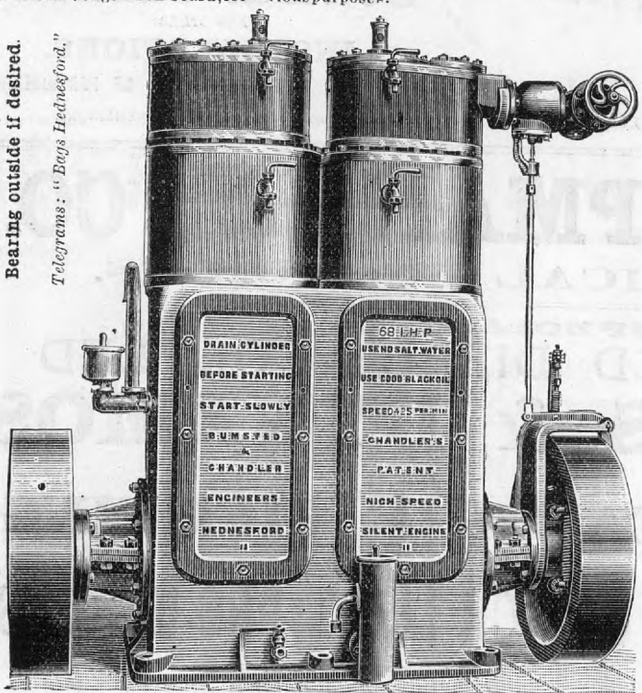

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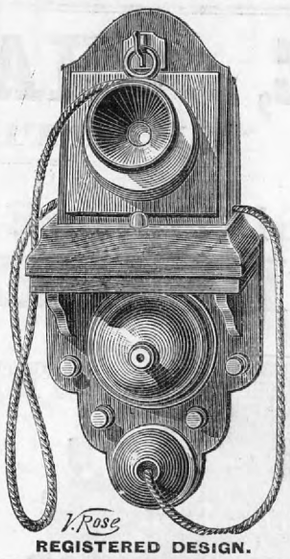

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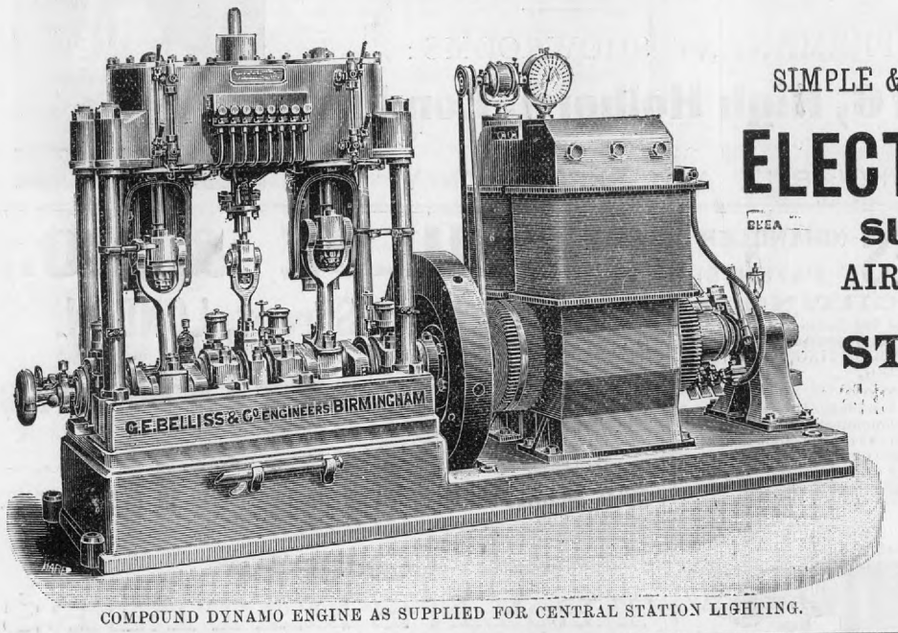

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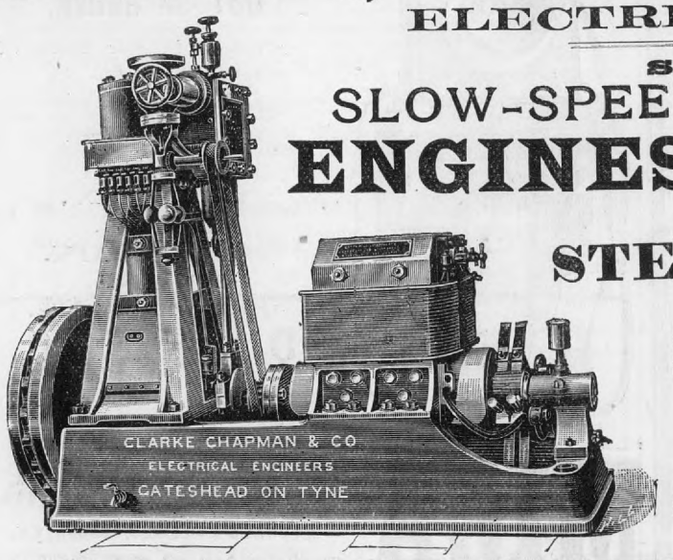

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WHEATLEY KIRK, PRICE AND GOULTY are instructed to SELL BY PUBLIC AUCTION,

On WEDNESDAY, March 8th, 1893, at the Electric Tram Car Station, known as Plashet Hall Works, Romford-road, Forest Gate, London, E., commencing at 10 for 11 o'Clock prompt,

The ENTIRE CONTENTS of the above Premises.

The Sale will include SUBSTANTIALLY ERECTED TIMBER-FRAMED STRUCTURE, 144ft. long, 35ft. wide, 12ft. high from floor line to eaves, timber roof covered with galvanised corrugated iron, glazed louvres, and two pairs of large folding doors, built specially for removal; SIX ELECTRIC MOTOR CARS, specially built for 4ft. 8½in. gauge, together with a variety of Plant, Furniture, and Effects.

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TENDERS are invited for the SUPPLY and ERECTION, upon the Company's Estate, near Barberton, South African Republic, of certain MACHINERY, PLANT, &c., for the purpose of

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Specification and Conditions of Contract, &c., can be obtained from, and Plans seen, at the following places:—

OFFICES OF THE COMPANY:

Pietermaritzburg, Natal;
Moodie's near Barberton, South African Republic;
No. 8, Old Jewry, London, E.C.;

and at

Johannesburg (Messrs. Redwood and Watson), P.O. Box, 500;
Capetown (E. R. Syfret, Esq.), 39, St. George's-street;
America: Messrs. Corner Bros. and Co., New York, in conjunction with their Boston Agents.

Tenders, together with Specification and Conditions of Contract, &c., duly signed, attached thereto, must be sent in to the Head Office of the Company, Pietermaritzburg, Natal, by Noon on the 3rd day of MAY, 1893, and a Duplicate Copy must be lodged with the London Office, 8, Old Jewry, E.C., by the same time.

A Fee of Three Guineas will be charged for Copies of Specification, Conditions of Contract, &c., and inspection of Plans, which will be returned on receipt of a bona fide Tender.

The Lowest or any Tender not necessarily accepted.

By Order of the Board of Directors,
C. J. MACFARLANE, Secretary.
Moodie's Gold Mining and Exploration Co. (Limited).

Pietermaritzburg, Natal,
January, 1893.

BOROUGH OF DEWSBURY.

ELECTRICITY.

The CORPORATION invite TENDERS for the CONSTRUCTION, SUPPLY, and LAYING DOWN of the necessary PLANT and MAINS for the SUPPLY of ELECTRICITY in the Borough, in accordance with the specification, plan, and form of tender, which can be obtained from the undersigned after Friday, the 3rd March, on payment of £2. 2s., which will be returned on receipt of a bona fide tender.

The person or firm whose tender is accepted will be required to enter into a contract and a Bond with two approved sureties for the due performance of the contract. Sealed tenders, endorsed "Electricity," to be delivered at this office not later than THURSDAY, the 23rd March.

Firms tendering may tender for the whole or any part of the Plant.

The Corporation do not bind themselves to accept the lowest or any tender.

By order,
E. MAWDESLEY, Town Clerk.

Town Clerk's Office, Town Hall,
Dewsbury, 2nd March, 1893.

JOURNAL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Edited by F. H. WEBB, Secretary.

Part 103.—Containing a full report of the continuation of the discussion on Professor J. A. FLEMING'S Paper—EXPERIMENTAL RESEARCHES ON ALTERNATE CURRENT TRANSFORMERS, and the Inaugural Address of the new President, Mr. W. H. PREECE, F.R.S.—PRICE TWO SHILLINGS.

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WHITEHAVEN ELECTRIC LIGHTING ORDER, 1891.

TO ELECTRIC LIGHTING CONTRACTORS.

The TRUSTEES of the TOWN and HARBOUR of WHITEHAVEN invite TENDERS for SUPPLYING and LAYING INSULATED CONDUCTORS required in connection with the Central Electric Lighting Station.

Plans can be seen, and a Copy of the Specification and Forms of Agreement and Tender obtained, at the Office of Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, S.W., and also at this Office, on payment of One Guinea, which will be returned if a bona fide Tender is sent in and not accepted.

Sealed Tenders, addressed to the undersigned, and endorsed "Tender for Electrical Conductors," must be delivered not later than 10 a.m. on WEDNESDAY, 22nd March instant.

The Trustees do not bind themselves to accept the lowest or any Tender.

By order,
JOHN COLLINS, Secretary.

Town Hall, Whitehaven, March 2nd, 1893.

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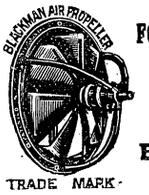

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The following Statement shows the Financial position of the Company on the 31st DECEMBER, 1891—

Capital Paid up	£366,702 0 0
Fire and other Reserve Funds, including Balance of Profit and Loss	2,981,078 0 0
Life and Annuity Funds	4,546,577 0 0
Total Invested Funds, 31st December, 1891	£7,894,357 0 0

INCOME FOR THE YEAR. . . . £2,230,635

The following Comparative Statement shows the progress of the Company :—

1881 ...	Life Funds	£2,737,858 ...	Total Funds	£4,673,299
1886 ...	„	3,257,609 ...	„	5,672,041
1891 ...	„	4,546,577 ...	„	7,894,357

INCREASE OF FUNDS IN TEN YEARS, £3,221,058.

EXTRACT FROM AUDITORS' REPORT.

"We have examined all the Securities held here . . . . and have found them correct and in order, and we further certify that the present aggregate Market Value thereof is in excess of the amounts in the Balance Sheets."

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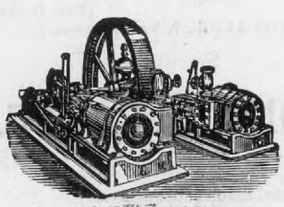

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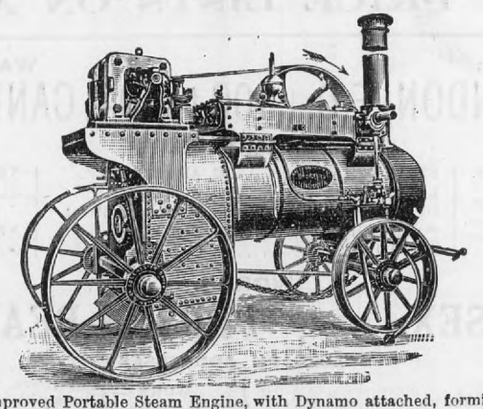

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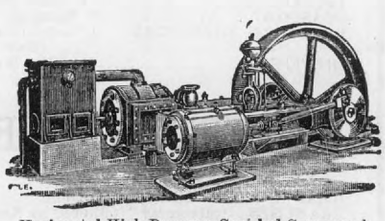

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 772.—Vol. XXX. FRIDAY, MARCH 3, 1893. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

The review of Mr. Mottelay's work, entitled "William Gilbert of Colchester, Physician of London, on the Loadstone and Magnetic Bodies," &c., which will be found in another column, discusses everything but the translation. It may be remarked that one of the first resolutions of the Gilbert Club was that their book should contain nothing but a translation, and that the best possible; so that the reviewer deals only with matters entirely outside the scope of the Gilbert Club scheme. The correspondence on "Gilbertiana," though happily dropped in *The Electrician*, has been raging elsewhere, and the first two letters which appeared in our columns have been freely reprinted in American and English journals, but the trenchant rejoinder, which we published on December 30th, has been discreetly ignored. In addition to many unpleasant insinuations the Gilbert Club was warned not to appropriate the valuable footnotes which would be found in the American edition. This, in connection with the resolution to which we have referred, is rather amusing. Indeed, the general merriment of our American friends over the supposed discomforture of the Gilbert Club was without much point, when we remember that the English translation was essentially a subscription one, and that an ample list of subscribers had been obtained long before the advent of its so-called rival.

In connection with the discussion which has lately appeared in our correspondence columns with reference to the priority of the discovery of the alternate-current motor described by Mr. Brown in *The Electrician* for January 27th, we would refer our readers to a brief summary of the work of MM. Hutin and Leblanc published in our present issue. It will be noticed that the motor they allude to has this characteristic in common with Mr. Brown's, viz., that no torque whatever is developed by the motor until the armature is set in motion. In order to overcome this very serious defect the same device is resorted to in each case, since the Tesla method of using two field magnet currents in different phase is adopted for starting the motor. In each case, when the motor is in motion, the torque increases with the speed until synchronism is nearly attained; but whereas Mr. Brown only uses a single wound armature, MM. Hutin and Leblanc employ one which is double wound.

When the field-magnets of a dynamo are excited with an alternating current, the magnetic field produced may be regarded as a revolving field of nearly constant strength, the speed of revolution corresponding with the frequency of the alternating current. If the armature of this machine be rotated at some other speed, the frequency of the alternating current induced in its coils will correspond with the sum or difference of the speeds, according as the armature is rotated in the opposite, or in the same, sense as the inducing magnetic field. It is on an effect of this kind that the action of Hutin and Leblanc's motor depends. Prof. Trouton made use of the same principle when endeavouring to produce currents of high frequency for electric radiation; and our readers will find a description of his experiments in *The Electrician* for January 22, 1892.

In this issue we print a communication sent to us by Signor Riccardo Arno, on rotating electric fields, and it will be noticed that his experiments are exactly analogous with those of Prof. Galileo Ferraris on rotating magnetic fields. The new alternate current motor which is the result of these researches is nothing more than a toy, since its output is less than a thousandth of a horse-power; but the experiments are of much interest from a theoretical point of view. The author maintains that the experiments show that the dielectrics of condensers absorb energy from electrical hysteresis when subjected to an alternating electrical field. But while these researches, and previous ones by Mr. Steinmetz and others, undoubtedly show that energy is absorbed, they cannot be said to prove the existence of true hysteresis. The phenomenon of residual absorption in condensers is in many ways comparable with that of residual magnetism, but there is this great difference between them, that the former depends on time while the latter is independent of it. The waste of energy due to hysteresis in any particular cycle of magnetic changes is the same, however quickly or however slowly the cycle is performed; but no one has yet shown that the loss in the dielectric of a condenser every time it is charged and discharged depends only on the amount of charge.

We cannot at present agree with Signor Arno that the rotation of the armature of his motor is caused by the lag of the polarisation of the cylinder behind the rotation of the electric field causing it. In a Ferraris or Tesla motor such a lag takes place. This, however, is not due to hysteresis, but to the fact that the eddy currents induced in the iron core, or the copper circuits surrounding it, shift the magnetism of the core. Something similar must occur in the dielectric armature of the Arno motor.

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The result of a very careful determination of the mechanical equivalent of heat, by Messrs. Griffiths and Clark, of Cambridge, has been communicated to the Royal Society. In thermal units Fahrenheit the result was 778·99 foot pounds. The nearest previous determination was that of Rowland. M. Miculescо, in 1891, obtained a result equivalent to 772·3, and Prof. Marks, in 1885, gave 772·8. These latter values agree very well with the 772, or as given in some books, the 772·5 of Joule; but Joule's own results have to be intrepreted by the light of subsequent research. Prof. Rowland has made a careful comparison of Joule's thermometer with the air thermometer, and a further correction was necessary, since Joule had assumed Regnault's expression for the specific heat of water. Mr. Griffiths gives the result of these corrections in his Paper, and finds that after all corrections the value resulting from Joule's own experiments is 776·74. Joule's equivalent must henceforth be known in round numbers as 779.

For many years past the Post Office authorities have been seeking some means of putting an end to the free message system imposed upon them by the railway companies in 1870 as part of their price for assenting to the telegraphs being transferred to the State. The privilege which they enjoyed, and exercised with limitations, under the old telegraph companies has been so much appreciated, or, as some would say, abused, that the number of free railway messages has increased more than fifteen-fold, and, allowing for unrestricted length, probably twenty-fold. At a moderate estimate the Postal Telegraph revenue has been losing between £30,000 and £40,000 a year by this arrangement, and the loss is a steadily growing one. The present Postmaster-General now announces that two of the railway companies have been induced to accept the principle of commutation in extinction of their privilege; and he hopes that the rest of the companies will follow the example. It seems to us that this is one of those cases where Parliament is entitled to impose its own conditions upon any concessions to railway companies asking for increased powers who refuse to come to terms with the Telegraph Department.

In our "Notes" columns this week will be found some statistics relative to the growth of the telegraph system of the Caledonian Railway since 1870. Making all due allowance for natural increase in the length of line open and in train mileage—the average increase of these since 1870 for all the railways of the United Kingdom being respectively about 30 per cent. and 40 per cent.—the comparative figures given are still remarkable. In 1870 the telegraph wire mileage of the Caledonian Railway was only some 3,600, to-day it is over 10,000, an increase of 180 per cent., whilst the number of instruments used to-day is fifteen times greater than twenty-two years ago.

The bulk of this increase may be taken as arising from Board of Trade interference with the management of railways; an interference which, as in the case of the electric lighting industry, has the direct sanction and encouragement of the Legislature, and by the side of which the feats of the Electrical Department look quite puny. Notwithstanding all this, English railways pay, and pay well, having regard to the regularity of their dividends, and are acknowledged by all to be beyond compare the safest in the world. The moral would seem to be, not that interference in one case will bear equally good fruit in another totally dissimilar, but that Board of Trade interference does not of necessity, as some pessimists would have us believe, spell Ruin.

As the day for the opening of the "World's Fair Columbian Exposition" approaches, the weekly "News Letter—No Delay," which is dropped from the "Publicity and Promotion Department," like "the gentle rain from heaven," upon those who do and those who do not want it, becomes more and more "calculated to enthuse." In the latest budget of "pars" we note, amongst other items, that the Queen Regent of Spain will be represented at Chicago by the Infanta Eulalia, the unfortunate Infanta's exact age being duly chronicled; that an English salt concern has taken the liberty of sending a rock-salt model of the Bartholdi statue; and that the King of Siam has decided to make an interesting display. The *pièce de resistance* of this bill of fare, however, is the announcement that the winning exhibitors at the World's Fair will each receive a bronze medal and a handsome diploma, setting forth the specific purpose for which the medal was awarded. "*Provision will be made, it is expected, for 75,000 medals and diplomas.*" We guess this is the biggest provision of the kind ever made.

Manchester.—The Municipal central station is expected to come into operation in June.

Athens.—The central lighting station has now 63 arcs and over 14,000 8 c.p. lamps connected to the mains.

Ealing.—The Ealing Local Board are making application to borrow £30,000 for the purpose of lighting their district by electricity.

Mica.—The Eel Lake, Ont., mica mines have been purchased by the General Electric Company of America, and will be at once put in operation.

Brighton.—On Tuesday next a Board of Trade inquiry will be held concerning the application of the Brighton and Hove Electric Light Company.

Royal Society.—The following Paper was down for reading yesterday:—J. H. Gray and J. B. Henderson: "The Effects of Mechanical Stress on the Electrical Resistance of Metals."

The Hopkinson Three-Wire Patent.—The Westinghouse Company are negotiating with the Dundee and Glasgow Corporations with reference to the three-wire patent.

The Lahmeyer System of Distribution.—A central station on this system has been opened at Bockenheim (Frankfort). Herr Lahmeyer employs four-pole drum armature machines and dynamotor substations.

Aberdeen.—At a meeting of the Plans Committee of the Town Council last week, the plans of the new electric lighting buildings were approved of. The buildings are to be erected near the Gasworks at a cost of £3,500.

The National Telephone Company.—The National Telephone Company has lodged a petition against the addition of certain new clauses proposed to be inserted in the Leeds Corporation (Consolidation and Improvement) Bill.

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A Telegraph Line from the Pamirs to Pekin. — It is accepted as true in Vienna, says the *Daily News* correspondent there, that the Chinese Government has decided to lay a telegraph line from the Pamirs to Pekin.

The American Proposals with regard to Electrical Units.—The Société Internationale des Electriciens devoted its Wednesday meeting to a discussion of the recent proposals of the American Institute of Electrical Engineers with regard to electrical units.

The Cost of the Electrical Horse-Power Year in Berlin.—As current for power purposes is now supplied from the Berlin mains at the rate of 2½d. per kilowatt-hour, the cost of the electrical horse-power year of 3,000 working hours amounts to £23. 10s.

Dundee.—On Monday evening last the municipal central station came into operation, the current being turned on to several of the establishments which had been wired. It is expected that the public lamps in the High-street will be lit about a fornight hence.

Reduced Rates to China.—The Eastern Extension Company notify that on the 1st inst. the tariffs for telegrams to all places in China, except Macao, were reduced to the same rate as the cable stations, viz., 7s. per word.—The Great Northern Telegraph Company make a similar notification.

The Madras Electric Tramways.—It is proposed at Madras to have not one large central power station, but two, three or four smaller stations. At each of these the furnaces will be on the incinerator principle, and the Company are prepared to make away with four, five, or six hundred cart-loads of rubbish daily.

Alloys.—Prof. Chandler Roberts-Austen will commence a course of three "Cantor" Lectures on "Alloys" at the Society of Arts on Monday next, March 6th, at five o'clock. The remaining lectures will be given on the two following Monday afternoons at the same hour.

The Halifax (N.S.) Electric Trams.—The stipendary magistrate of the city of Halifax has convicted the Nova Scotia Power Company of a breach of a provincial statute in running street cars on Sunday. The judge held that the running of street cars on Sunday was a work neither of necessity nor mercy, and was therefore illegal. A nominal fine of $5 has been imposed on the Company.

Blackburn.—Mr. Rienzi Walton, one of the Local Government Board's inspectors, opened an inquiry at Blackburn Town Hall, on Tuesday morning, into an application of the Town Council to borrow £50,000 for electric lighting purposes. The Council recently issued a circular asking tradesmen if they would use electric light if introduced, and the response was so unanimous that the Council decided to adopt it at once.

Platinum.—According to statements of the Russian Mining Department, 258 poods of raw platinum were obtained from the Ural in 1891, which is about 85 poods more than in 1890. According to the price of unpurified platinum ruling at present, the total value of the productions of the Russian platinum industry in the year 1891 exceeded 1,250,000 credit roubles, while the tax thereon amounted to 40,000 credit roubles. One pood = 36lb.

Cable Interruptions and Repairs.—

Repairs.	Interrupted.	Repaired.
Aden-Zanzibar	February 20, 1893 ...	February 25, 1893
Paramaribo-Cayenne.....	January 28, 1893 ...	February 27, 1893

Cables actually interrupted :—

Cayenne-Vizeu	September 24, 1892.
St. Thome-Loanda*	February 17, 1893.
Gibraltar-Tangier	February 18, 1893.

* Communication with South Africa is, during this interruption maintained by the East Coast route.

High Temperature Measurements.—M. Le Chatelier, says the *Gas World*, has found a curious cause of error in the determination of high temperatures. Professor Langley estimated the temperature of the Bessemer converter at 2,000° C., because platinum appeared to melt rapidly in the flame ; but the reason of the apparent melting is that the platinum is dissolved by the fine fog or rain of steel which is carried along by the stream of vapour. Similarly, palladium appears to melt in several furnaces where, in reality, it does not melt, but is transformed, without fusion, into a spongy mass under the influence of hydrogenation or of transient oxygenation.

Shoreditch.—At a special meeting of the Shoreditch Vestry on Tuesday night a scheme prepared by Mr. E. Manville was discussed. The scheme included a supply of electricity for public and private lighting and power purposes, and the combining of the generating station with furnaces for the utilisation of the ashbin refuse of the parish. The report was unanimously adopted, and a special committee elected to carry out the work, which is estimated to cost £63,000.

German Patents in 1892.—The number of applications for patents last year was 13,126, against 12,919 in 1891, which is an increase for last year of 1·6 per cent. In 1891 the increase was 8·7 per cent., and in 1890 2 per cent. The number of patents granted in 1892 was 5,900, against 5,550 in 1891, and 4,680 in 1890, The increase for 1892 was thus 6·3 per cent., compared with 18·6 per cent. in 1891 and 6·2 per cent. in 1890. The percentage of patents granted in 1892 to applications for patents was 85 per cent., against 92 per cent. in 1891 and 87 per cent. in 1890. The number of German patents in operation at the end of 1892 was 15,825, against 14,735 in 1891 and 13,639 in 1890.

Prolongation of the Joy Valve Patent.—The petition for the prolongation of letters patent granted to Mr. David Joy, engineer, for his invention of "improvements in steam engines," dated March 8th, 1879, No. 929, came before the Judicial Committee of the Privy Council this week. Mr. Aston and Mr. Lawson were counsel for the petitioner ; Sir Charles Russell and Mr. Sutton for the Crown. Sir Charles Russell intimated that, in the opinion of the Crown, the case was one in which a reasonable prolongation of the letters patent should be granted. Lord Watson, in delivering judgment, said their lordships would humbly advise Her Majesty to extend the term of the patent in so far as it related to the inventions embraced in the second claim of the specification for a period of seven years

The Electric Railway Bills.—The following arrangements have been made for the Electric Railway Bills in Committees of the House of Commons :—Tuesday next, Waterloo and City Railway ; Hampstead, St. Pancras and Charing-cross Railway, and Brighton and Rottingdean Seashore Electric Railway. Thursday next, City and South London Railway ; Ditto (Extension of Time), Clapham Junction and Paddington and Edgware-road and Victoria Railways. The first committee consists of Sir C. Dalrymple (chairman), Mr. F. Taylor, Mr. J. W. Philipps, and Mr. C. E. Shaw. The Earl of Morley's Committee in the House of Lords considered the Baker-street and Waterloo Railway on Tuesday, and ordered it to be reported with amendments. On Thursday last week the Blackpool, St. Anne's and Lytham Tramways Bill was read a second time. A petition has been lodged against this Bill by the Blackpool Corporation.

Institute of Chemistry.—The annual general meeting of the Institute of Chemistry of Great Britain and Ireland was held on March 1st, at 30, Bloomsbury-square, W.C., the premises recently acquired by the Institute. The report of Council and balance-sheet for 1892 having been presented and approved, the Council and officers for the ensuing year were elected, and the President, Dr. William A. Tilden, F.R.S., delivered an address in which, after referring to the satisfactory progress which had been made by the Institute during the past year, proceeded to explain the new curriculum recently adopted by the Council for the training and examination of associates, and the proposals which had been brought forward by the censors with the object of regulating the professional conduct of members of the Institute. The numbers now on the register are 828 members and 109 students, as compared with 825 members and 34 students at the date of the last annual general meeting.

Telegraphy in Queensland.—We have received from our telegraphic *confrères* in Queensland their Christmas and New Year's greetings, none the less welcome for being, thanks to the post, a little late. The form they take is a pair of excellent photographic views of the exterior and interior of the Brisbane central telegraph office. The former, which, perhaps, we should

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have designated the General Post Office, is an extensive and handsome building of the Italian classic type, arcaded and terraced in the manner common to Government houses in India. Judging by the aspect of the interior, these sheltered galleries and shaded colonades which grace the outside are not mere useless adornments. The time is forenoon and the season Christmas, yet the operatives are working in their shirts and trousers! We are glad to see that the spacious instrument room is fitted with electric glow lamps; and we note with interest a typewriter on one of the desks.

The Telegraph Department of the Caledonian Railway Company.—An interesting statistical statement illustrative of the development of the telegraph department of the Caledonian Railway Company has been prepared. It shows that in January of the present year the mileage of telegraphic wire on the Caledonian Railway was 10,063 miles; in 1870 the mileage was only 3,597 miles. In January last the number of telegraph block signalling, tablet, telephone, and other electrical instruments in stations, signal-boxes, &c., was 6,076; in 1870 there were only 412. The number of battery cells provided to work the railway electrical appliances is 39,700; in 1870 2,884 were sufficient. In 1892 the number of business telegrams forwarded from stations on the Company's wires was 1,106,278. These messages averaged about 20 words each, representing, at the public rate of ½d. per word, the sum of £46,120. Telephonic messages, which are not included, would bring the total up to £50,000. Train departures signalled from station to station and signal-box to signal-box are not included.

Inter-Urban Electric Cars.—"From Spokane, Wash., to the beautiful Cœur-d'Alene lake, 32 miles distant, an electric railway," says the *Street Railway Review*, "will soon be transporting the delighted citizens of that famous city." For this purpose the chief engineer of the Spokane and Cœur-d'Alene Railway and Navigation Company has designed an entirely new type of car. This car, which is about 40ft. in length, will have a seating capacity of 60 persons, with a separate compartment for baggage. A speed of 40 miles an hour on levels is contemplated, the gradients not exceeding 1 per cent., and curves also being very light. The driving wheels are 42in. diameter paper wheels with steel tyres. The smaller wheels are 30in., of same make. A 45 H.P. single reduction motor will be used on each axle. Each car and its motor equipment will weigh 9 tons. The central portion of the cars is provided with a sort of tower, from which passengers may view the country. Power will be derived from two water-power stations, one in Spokane and the other on the line 22 miles from Spokane.

The Bureau de Contrôle.—The Bureau de Contrôle des Installations Electriques, which has been started by the Syndicat Professional des Industries Electriques, is assured of an annual subsidy of £600 for two years. M. Picou, the head of the Bureau, estimates the annual expenses at £640. Subscribers to the Bureau are entitled to have their wiring and meters tested twice a year, and the causes of short circuits, &c., investigated. The following are the annual rates of subscription:—

For an installation comprising	Per lamp per annum.	Min.
Less than 20 lamps	0·50fr.	5·00fr.
From 20 to 50 ,,	0·45	10·00
From 51 to 100 ,,	0·40	22·50
From 101 to 200 ,,	0·35	40·00
From 201 to 500 ,,	0·30	70·00
From 501 to 1,000 ,,	0·25	150·00
More than 1,000 ,,	0·20	250·00

Each arc lamp is to count as five glow lamps, and each motor or dynamo as 10 glow lamps. For various extra jobs there are various extra charges. Non-subscribers will be charged for a wiring test two-thirds of their equivalent annual subscription, with a minimum of 5fr.

Railway Companies and Free Telegrams.—In answer to Mr. John Ellis, the Postmaster-General stated in the House of Commons on Monday last that the question of free railway messages had engaged his close attention. Statistics of the number of telegrams sent free of charge for the railway companies in 1871 could, he said, only be given as regards the companies of England and Wales. In the case of these companies the number sent in 1871 was 87,201; in 1892 it had risen to 1,329,531, an increase of more than fifteen-fold. During the same period telegrams of all other descriptions rose from 9,573,548 to 57,871,429, an increase of about six-fold. Negotiations had, however, resulted in the commutation of the privilege into a right to send a fixed number of messages and words per annum in the case of the Midland, and Manchester, Sheffield, and Lincolnshire Companies. Negotiations with other companies were in progress, and it was hoped that all the companies would recognise that it was desirable, in their own as well as in the public interest, to accept the principle of commutation. As regards private Bill legislation, Her Majesty's Government would, of course, watch closely any Bills introduced into Parliament tending to the extension of the privilege.

Bradford.—A Local Government Board Inquiry was held last week with reference to the application for a loan of £30,000 for the purposes of extending the electricity supply system. The Town Clerk stated that the Council had decided to extend their area of supply in all directions from the centre of the town, and the loan was wanted for the expenses of that extension. There were now 250 private consumers. There was no intention of utilising electricity for the public street lamps, as those were supplied with gas by the Gas Committee free of cost. At one time the Gas Committee was making a profit on gas of £30,000 a year, but they preferred to supply gas for nothing for the streets and charge lower prices. The Inspector pointed out certain risks in regard to the electric light, and suggested that it might have been better that it should be in the hands of a company. The Town Clerk said that was just what the Corporation did not wish. If a private company had a hand in it the company was king of the town, but the Town Council preferred that it should itself be that. It was pointed out that the works were making a profit, and the charge was only 5d. per unit. The Town Clerk added that at Leeds, where a company was at work, the charge was 8d. per unit. Mr. W. W. Wilkinson, a ratepayer, opposed the application.

Municipal Regulations relating to Electric Light Mains in Paris.—It may be interesting to note the regulations issued by the Municipality of Paris, governing the laying of wires of private electric companies. These regulations entirely prohibit the placing of wires in sewers or other underground conduits located between the kerbs, and demand the laying of such wires under the sidewalks. The materials used in the conduits must be approved by the proper municipal officers, who are also to specify the position, exterior diameter, and required depth of the conduits. The most favourable positions, near the surface of the streets, are reserved for the municipal electric light conduits. In order to avoid crossing streets to make house connections a conduit must be carried under the sidewalk on both sides of the street except in very narrow streets. Whenever a conduit crosses a street it is to be made accessible by a manhole on one side. In very important thoroughfares each side must be furnished with a manhole. If several companies are laying wires in the same street, a common conduit must be employed, the accruing costs to be shared equally between them. Electric wires of private companies are not to be carried closer than 3ft. 3in. to the front walls of houses, which space is to be reserved for the laying of municipal wires.

Blackpool, St. Anne's, and Lytham Tramways.—This Bill has been brought in by the Right Hon. Sir Matthew White Ridley and Mr. William Coddington, for incorporating a Company with a capital of £100,000, in £10 shares, with power to construct a series of tramways from the Blackpool Promenade, passing along the Lytham-road and St. Anne's-road, and terminating in Westley-street. The Bill provides that during a period of seven years after the opening of the tramways for public traffic, and with the consent of the Board of Trade, during such further periods of seven years as the Board may from time to time specify, they may be worked by electric power, or other mechanical power than steam or cable power, subject to such regulations as the Board of Trade may think fit to secure to the public all reasonable protection against danger. A penalty of £10, with £5 per day for a continuing offence, is provided for in case the company use other than animal power, contrary to order or

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regulations. If other than animal power is used, the contract with the road authorities is not to be for a longer period than two years at a time, and power is given to the company to lease or purchase and work tramways belonging to the Corporation. The period for the completion of the works named in the Bill is two years.

High Frequencies from Direct Currents.—It is rumoured from America, says *Industries*, that Prof. E. Thomson has discovered a new way of producing high-frequency discharges. There is one method which, so far as we know, has not been tried yet. It was suggested by us before Tesla experiments became fashionable as a convenient method of producing Hertz vibrations continuously and regularly. A direct-current circuit has a resistance and an arc gap. In shunt to the arc gap is a circuit containing both capacity and self-induction in series, and the oscillatory current is produced in this circuit. The frequency varies inversely as the root of the product of the capacity and self-induction, and the main resistance can be adjusted to suit the circuit—that is to say, to make the current uniform from period to period, instead of having merely a succession of oscillatory discharges. Different currents of a given frequency can be produced by altering the capacity and self-induction without altering their product. The electromotive force is controlled by the length of the arc, but is, of course, greatest in shunt to the self-induction or to the capacity. Of course, this arrangement can be modified, but it seems to us, says *Industries*, to be much better than using a series of oscillatory discharges at short intervals, as is now customary with alternating transformers.

Trent (Tyrol).—The picturesque town of Trent, in the Tyrol, has for some little while been possessed of a Municipal electricity supply which presents one or two features of interest. A waterfall is, of course, the source of power. While the gas works, after ten years existence, have only succeeded in securing about 2,000 lights, the electrical works, after two years operations, have some 7,500 glow lamps, 64 arc lamps, and 30 motors of a total of 175 H.P. connected to the mains. These lamps are divided amongst no less than 1,070 customers, of whom 300 are workmen. This unusual state of things may be explained in a large measure by the still more unusual method of charging which obtains at Trent. The tariff is 10d. per "candle year." To prevent waste of current the Municipality reserves to itself the right of lamp renewals, and makes a heavy charge for the same. The charge for power is 17s. per horse-power per annum; all motors to be switched off during the hours of maximum lighting. It is said that this low price for power has attracted several small industries to the town. Latterly the Municipality has also undertaken wiring and its maintenance in return for an annual payment of 1s. 8d. per 16 c.p. lamp installed. Distribution is carried out on the five-wire system, of which complication there are now several instances in Europe, viz., Koenigsberg, Paris (Secteur de la Place Clichy), and Manchester.

The Electricity Supply Business in Madrid.—Referring to the appointment of a new manager in Madrid by the Electrical Supply Company for Spain, the *Revista Minera* states that, although the Company sells current at the high price of $1\frac{1}{4}$ pesetas per kilowatt hour (11d. per B. T. U.) the demand is fully up to the capabilities of the Company with its present installation, and it is obliged to refuse orders. The same journal estimates that should the Company double its instalment it would be easily able to increase its business to the same extent. Another paper, referring to the success of the Company, looks forward to the time when gas will have entirely disappeared from Madrid. There is great opposition to the gas company owing to what is described as the absurd charge of 40 centimos per cubic metre (about 8s. per thousand). The consumers of electric light will, in the opinion of the Madrid paper, have little reason to complain of the present charge made by the English electrical company until the gas company reduces its charge to 25 centimos per cubic metre (about 6s. per thousand). At the same time the consumers of electric light are looking forward to the time when they will be able to obtain a supply at a charge of 80 centimos per unit (7d. per B. T. U.) instead of the present charge of $1\frac{1}{4}$ pesetas. The *Economista*, referring to the subject, says consumers of light in Madrid need not look to the Madrileña Electric Light Company to help them in their efforts to obtain gas at a lower price, and remarks that if consumers understand their business they will give the most decided support to the English electrical company as being alone able to entirely drive gas in Madrid out of the field.

The Heilmann Electric Locomotive.—There has been much talk in the French technical journals, and still more in the non-technical, about an electric locomotive designed by a M. Heilmann, and in course of construction by such a sober, old-established railway company as the Compagnie du Nord. This locomotive comprises a Lentz boiler, a Brown engine and dynamos charging accumulators; these are to supply current to motors placed direct on the axles. It was, of course, inferred by the French public that the Compagnie du Nord had some "through by lightning" scheme under weigh. A very simple solution of the puzzle is, however, found in the fact that the Compagnie du Nord has in view a couple of extensions from its terminus into the heart of Paris, and has, in consequence to look about for locomotives capable of working on its suburban lines, and at the same time available for long tunnel traffic. For this purpose M.M. Francq et Mesnard have built a special type of steam locomotive. The Compagnie du Nord, however, whilst quite satisfied with its performance, decided, in view of the popular prejudice in favour of electrical methods, to build an experimental electric locomotive fulfilling the required conditions. The Heilmann locomotive is three-axled, and two 4-pole Gramme-ring 30 H.P. motors are placed with their armatures direct upon each of the two end axles. A battery of 80 Laurent-Cély storage cells is provided, weighing 14 tons, and having a total storage capacity of 148,400 ampere hours. It is not, however, proposed to run the motors entirely off the accumulators; they are merely intended to assist the generators when inclines have to be negotiated. The motor magnets are excited by a battery of four storage cells, and it is proposed to vary the speed by regulation of the excitation. A small motor, driven off the main battery, actuates the air-compressing apparatus for the brakes and whistle.

The Comparative Cost of Gas and Electricity.—Mr. J. M. Turnbull, chemist, of Edinburgh, who last winter prepared a most exhaustive report for the Edinburgh Merchants' Asssociation upon the gas supply of the city, has, says the Scotch correspondent of the *Journal of Gas Lighting*, turned his attention to electric lighting, and has begun the reading of a Paper before the Association on "The Comparative cost of Electric Lighting and Lighting by Gas." Mr. Turnbull, we are told, does everything thoroughly, and his Paper is said to be a most complete *exposé* of some of the positions taken up by the promoters of electric light. Mr. Turnbull quotes from a prospectus issued in December last of a company which proposed to undertake the supply of electricity in Coatbridge. In that prospectus, quotations were given from an address to the effect that "1lb. of coal distilled into gas will give a light of 17·2 c.p., whilst, if converted into electrical energy, it will give 48 candles with a glow light, and 288 candles with an arc light." Mr. Turnbull points out that gas is not the only thing derived from coal; and that in Edinburgh last year $26\frac{1}{4}$ per cent. of the cost of coal was returned in the revenue derived from residuals. Proceeding to compare the cost of the two lights, he finds the average charge for electricity in fifteen towns to be $7\frac{1}{2}$d. per unit. The charge for 16 c.p. for 1,000 hours, at $7\frac{1}{2}$d. per unit amounts to £1. 15s. To that figure he adds 2s. 6d. for renewals, and 1s. 6d. for hire of meter, which makes the total £1. 19s. The charge for gas of 16 c.p. Mr. Turnbull averages at 2s. 6d. per 1,000 cubic feet; and of it 5,000 cubic feet will require to be burned in 1,000 hours to produce the same light as is given by a 16-candle incandescent lamp. Edinburgh gas is of 26 c.p.; and the equivalent light by it is obtained for 3,100 cubic feet, the cost of which is 12s. Electric lighting will thus be $3\frac{1}{4}$ times dearer than gas in Edinburgh. Taking into account deterioration of the incandescent lamp, the cost for electric lighting cannot be less to the consumer than four or five times that of gas. It will be difficult, says our contemporary's correspondent, to controvert these figures.

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REVIEWS.

William Gilbert of Colchester, Physician, of London, on the Loadstone and Magnetic Bodies, &c. A translation by P. FLEURY MOTTELAY. (London: Bernard Quaritch [Printers: Ferris Bros., Pearl-street, New York], 1893, 8vo, pp. liv.—368. With translator's preface, biographical memoir, and annotations.)

Of all living men none possess a wider or more comprehensive knowledge of early magnetic and electrical literature than Mr. P. Fleury Mottelay, unless perhaps Mr. Latimer Clark, the veteran telegraph engineer. And no single man could have been found better qualified than Mr. Mottelay to prepare notes and comments to illustrate, by reference to early authorities and to modern commentators, a new edition of the famous *De Magnete* of William Gilbert. It is with the notes, the biographical memoir, and the translator's preface, that the present review is concerned.

Mr. Mottelay has laid under contribution for his annotations not only such standard authorities as Humboldt, Whewell, Hallam, and Herschel, but has collated passages in obscure early writers, such as Albertus Magnus, Simon Stevinus, Joannes Taisnier, Baptista Porta, and many others. To the thoroughness with which all such authorities have been tracked down a single example will attest. Gilbert, in Chapter xiv. of Book I., dealing with the alleged medicinal value of the loadstone, refers to one Gartias ab Horto, who narrated how the Eastern Indians declare the taking of loadstone in small doses to preserve youth. Mr. Mottelay at once identifies this obscure writer with the Portuguese author, Garcia del Huerto, who wrote in 1563 on herbs and drugs, and he gives references not only to Garcia's original book, and to its subsequent Latin editions, but to the passages in it which are referred to in the work of Gilbert. He even gives the references to Garcia in the writings of Sir T. Browne (*Vulgar Errors*), of Antoine Colin, and of Hakewill. All this is most excellent. So are his notes on p. 7, on the claims of Marco Polo to be regarded as the introducer into Europe of the art of the compass. The claims of Goia of Amalfi to the invention of the compass are, however, passed without commentary. Mr. Mottelay quotes largely from Thomson's "History of Chemistry" to elucidate the obscure passages in the chapters relating to the nature of the loadstone, and from Hakewill in those that touch on the astronomical relations of the magnet. He is equally at home in making references to the alchemists and to the astrologers, as notes such as those on the Metonic cycle, on p. 351, show.

Amid such a wealth of erudition it is no wonder that there arise obscurities. In the note on p. 2 relating to the alleged effect of diamonds in counteracting magnets, a passage of ten lines and-a-half is put into quotation marks, of which only the half is quoted from Rohault's "System of Natural Philosophy," the remainder being apparently Mr. Mottelay's own reference to other authors. Again, on p. 15, apparently following Whewell, Barlowe's rare work of 1597 is referred to as Barlowe's "Supplement." Whewell's inaccurate translation of the word no doubt arose from his ignorance of the existence of Barlowe's volume bearing the title of "The Navigator's Supply." It was also unknown to Ronalds.

There are a few errors for which the printer's devil must be blamed. The author of the Cyclopædia was Abraham Rees not *Ree* (p. x.). The famous collector of electrical books was Sir Francis Ronalds, not *Ronald* (p. 9). The Latin name of Amsterdam is not *Amstelrodami* (p. 357). The eminent scholar and critic, Jan Gruter, who is said to have edited Gilbert's "Philosophia Nova" in 1651 (p. xxv.), died in 1627. The pole that points northward is not called by the French the *astral* (p. 283), but the austral pole. Sir John F. W. Herschel is not properly described as *F. W. Herschel* (p. 365). The author of "The Theoriques of the Seven Planets" was not *Blunderville* (p. 363), but Blundevile. The date of Barlowe's "Magneticall Aduertisements" is 1616 (the first edition), though 1618 is given on p. xiv. as the date of the preface to the book. The Nicolas Cabeo mentioned on p. 9 is, of course, the same as the Nicolao Cabeo quoted elsewhere, and as the Cabaeus mentioned on p. xix. The English mathematician referred to by Humboldt was not Edward *Knight* (p. xl.), but Edward Wright. But these are trifling inaccuracies, for which one cannot hold so accomplished and erudite a scholar as Mr. Mottelay to be responsible. Neither is he responsible for the unfortunate circumstance that the cut of Gilbert's house at Colchester on p. xi. is reversed right for left—for the cut seems to have been reproduced (though nothing is said about it in the letterpress) from Dr. Richardson's article in the *Asclepiad*, which has the same defect.

Mr. Mottelay has further enriched his edition with a (reduced) facsimile of the title-page of the folio edition of 1600, and with those of the two later editions of 1628 and 1633, as well as with the title-page of Gilbert's posthumous work, "De Mundo Nostro." A point of novel interest arises respecting the engraved title-page to the edition of 1828. As reproduced (on p. 359) the last line before the date is simply the word *Authoris*. In the copy which has been for many years in my possession this word does not appear, and instead there has been engraved the name *Joh: Hallervordij*. In other respects the plate is precisely the same. This change of publisher's name on the title-page does not, of course, constitute a separate edition. Otherwise the copies of Mr. Mottelay's book that bear on the title-page the name of Mr. Bernard Quaritch would have to be regarded as of a different edition from those that bear the name of Messrs. John Wiley and Sons. With respect to the "facsimile" title-page of the "De Mundo Nostro," it is technically not such, since all the lines of the original, both those printed in scarlet as well as those printed in black, are there reproduced in black. In all other respects it is an excellent reproduction.

The biographical memoir which Mr. Mottelay has drawn up embodies, without adding a single new fact to those already known, a readable summary of Gilbert's life. It quotes considerably from the biographical notes which Mr. Conrad Cooke contributed three years ago to the columns of *Engineering*.

Mr. Mottelay does me the honour to refer to me in his notes. He accredits me on p. 283 with having introduced the term "north-seeking" pole to avoid the ambiguity of the commoner "north"-pole. The term did not, however, originate with me: I learned it from my master, the late Prof. Guthrie, who did not (so far as I know) claim to be its originator. I certainly have never claimed to have invented the term. Mr. Mottelay quotes from my monograph on Gilbert (written in 1890, not 1891) some remarks about the supposed handwriting of Gilbert, and comments on my not having seen a notice, in a second-hand catalogue of 1889, of an inscribed copy of *De Magnete*, the same from which the title-page has been reproduced by Mr. Mottelay in reduced facsimile. It happened that I did not hear of this copy until it had passed into the hands of Mr. Chas. L. Clarke, of New York, who very courteously wrote me about it, and subsequently had the kindness to send over to several British members of the Gilbert Club photographed facsimiles, and the negative from which they were produced. It is a matter of congratulation to all Gilbertians to find that the handwriting of this inscription is in accord with that of the other known inscribed copy.

There is but one single passage in the whole of Mr. Mottelay's editorial addenda that I could wish otherwise than it is, or would pronounce unsatisfactory: it is the part on pp. xix. and xx. relating to the various editions of *De Magnete*. Of these I maintain that there are three—those of 1600 (London), and of 1628, 1633 (Stettin),—copies of which have been in my possession for many years. Mr. Mottelay quotes other writers as speaking of four or five editions, and himself says, "Thus there are eight distinct editions referred to." This is entirely misleading. The alleged 1600 Amsterdam has never been seen. Ronalds evidently did not believe in it. Kuhn's reference to it is doubtless an error for the London folio of 1600. The alleged Frankfort editions of 1629 and 1638 were never heard of before the mention of them in the biographical note in the ninth Encyclopædia Britannica; and I have in vain challenged the author of that note to produce any such editions. They are quite unknown in Frankfort. The "five editions published in Germany and Holland before 1628" which Professor Robison stated that he had

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"seen" are utterly unknown in Germany and Holland; and his alleged second British edition is equally unknown to *every* other writer. Lastly, the supposed eighth edition "Republished at Ferrara in 1629 with a commentary by Cabaeus" is nothing else than the *Philosophia Magnetica* of the Jesuit Father, Nicolao Cabeo, to which Mr. Mottelay himself makes such frequent reference in his footnotes, which was published at Ferrara in 1629, and consists mainly of a commentary on the "original work," that is to say, on the original researches of Gilbert, and in which many of the cuts even are reproduced. There are more than forty existing copies known of the *De Magnete*: amongst these there are but the three editions. If Mr. Mottelay can discover a fourth I shall be the first to congratulate him. No doubt it is a generous view to credit all the mistaken references of prior writers with being immaculate: but it leads to their being repeated again, if quoted without a hint of their doubtful character. As to the two Stettin editions, Mr. Mottelay is equally generous to the well-intentioned writers, whose scholarship was insufficient to enable them to distinguish, as Mr. Mottelay does with so much pains, between Sedini, Sedani, and Seduni, which are as remote from one another as Stettin, Sedan, and Sion (in Valais). But is not generosity misplaced where it quotes as of weight the uncritical writers who confused these names together?

In all the above it will be noted that, for reasons that will be appreciated, not one word has been said as to Mr. Mottelay's translation itself. Of that others must be left to judge. I will only remark that, without saying anything in praise or dispraise of the text for which Mr. Mottelay is responsible, the book comes as a surprise and a pleasure. The paper and print are alike far superior in quality to the vast majority of electrical books, whether English or American; and if we except the rather unfortunate reproduction of Clamp's engraved portrait of Dr. Gilbert, the reproduced illustrations are also well and satisfactorily executed. So that Mr. Mottelay may be congratulated on the high degree to which he has realised his own expression of hope, quoted from Gilbert himself, that his efforts will "find the heartiest approval among all intelligent men and children of magnetic science."

SILVANUS P. THOMPSON.

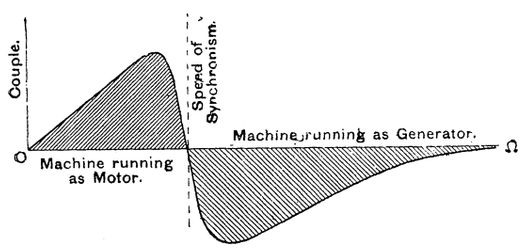
THE BROWN AND HUTIN-LEBLANC ALTERNATE CURRENT MOTORS.

In *The Electrician* for January 27, 1893, Mr. C. E. L. Brown described a non-synchronous motor for ordinary alternate currents, the principle of which was based upon the following phenomenon observed by the inventor:—

A conductor placed in an alternating field, and set rotating with a certain velocity, will increase its velocity to practically synchronous speed, and has a tendency to keep to this speed against a load. Currents are induced in the conductor by the alternating field, which, so long as the conductor is at rest, are neutral as regards their effect on the inducing field, and give rise to no twisting couple. But as soon as the conductor is set in motion this condition ceases, a turning moment is produced, the value of which increases as the speed rises till synchronism is nearly attained. The direction of rotation of such a motor is quite indeterminate, as the conductor tends always to synchronous rotation in the direction in which it was first set in motion. Several methods of making a motor on this principle are described by Mr. Brown in the article referred to. These motors have, like the Tesla and multiphase motors, the advantage of being non-synchronous, but, unlike these motors, they are not self-starting.

Shortly after the publication of Mr. Brown's article, MM. Hutin and Leblanc claimed priority for the discovery and application of this principle; and, in the current number of our contemporary, *La Lumière Electrique*, they refer to former articles by them in that journal, in which they state that the complete explanation was given as long ago as May 30, 1891. The articles in question are highly mathematical in character, but the chief result of their work appears to be as follows:—Imagine a machine with an even number of magnet poles, the magnetising coils being so wound that a steady current flowing through them would magnetise the poles alternately north and south. Let the armature, which is to be the movable part of the machine, be provided with two sets of coils, the coils in each set being as numerous as the pole pieces of the machine, and being wound alternately in opposite directions in the usual manner. Also suppose the coils of the first set to be situated on the armature half way between those of the second set, so that if the machine were used as an alternator with a double-wound armature the electromotive forces in the two armatures would differ in phase by a quarter of a period.

In order to use such a machine as an alternate-current motor, MM. Hutin and Leblanc propose to pass an alternating current through the *field magnets* after short-circuiting each armature circuit. If the armature be revolving with an angular velocity Ω, it is shown that the mechanical power developed by the motor is a complicated function depending on Ω, the frequency of the alternating current through the magnets, the resistance and self-induction of each armature, and the number of field-magnet poles. This power is fairly proportional to the speed of the motor Ω until synchronism is nearly attained; it then falls off, and becomes negative, the machine acting as a dynamo. A curve (reproduced) is given by MM. Hutin and Leblanc, showing how the power developed varies with the angular velocity Ω of the



machine. With the object of obtaining a more constant turning moment, the writers propose to double the number of the field magnets, forming a double set corresponding with the two sets of armature coils. Two alternate currents round the field magnets are then required, the phase of one current being different from that of the other, and under these circumstances the writers assert that the turning moment is more constant.

WHAT IS A DYNAMO MACHINE?

BY J. A. KINGDON.

Recent and threatened patent litigation render the answer to this question one of considerable commercial importance. The term dynamo machine, or, shortly, dynamo, is used in one or two different senses, sometimes being restricted to electro-magnetic generators which excite themselves, while sometimes it is understood to include all classes of electro-magnetic generators, and occasionally it is taken to mean electro-magnetic apparatus in general, and to include motors, dynamotors, and induction coils as well as generators. It is not unlikely that the ingenuity of expert witnesses and leading counsel may be exercised to prove that a dynamo is not only a machine for transforming mechanical energy into electrical currents, but that the term includes any source of electricity such as primary or secondary batteries, and thermopiles, and attempts may even be made to give the word a still wider meaning. It therefore becomes important to the electrical profession to ascertain exactly the meaning of the term dynamo machine, both in the exact scientific sense and also in the popular sense, and it would be a matter of satisfaction if the term were authoritatively defined in the same way as the different units—*e.g.*, volt, ampere, ohm, and watt—at an International Congress, such as is likely to be held at Chicago thi year.

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It is probable that the term was first introduced by the late Dr. Werner von Siemens in January, 1867, when he described the first self-exciting continuous-current machine to the Berlin Royal Academy of Science.* After describing the manner in which a small amount of residual magnetism may be used to induce currents, so as to excite the field magnets of the machine more strongly, Dr. Siemens continues, "The action described must occur, indeed, with every electro-magnetic machine which is based on the attraction and repulsion of electro-magnets, the coils of which are included in its own circuit, still special considerations are required to construct such *electro-dynamic* machines of great power."† The term dynamic electricity appears to have been used about this time to denote continuous currents of electricity as distinguished from static charges and perhaps vibratory currents. At all events, whether it was introduced by Dr. Siemens or no, the term dynamo-electric machine began to be used within a few years of 1867 to describe a machine by which continuous currents were generated by means of mechanical power.

In 1875, in a paper by S. C. Tisley, in the *Journal* of the Society of Telegraphic Engineers, Vol. IV., on a "New Form of Dynamo-Magneto Electric Machine," the author states that, "The armature is constructed specially to prevent the accumulation of heat, to which every class of *dynamo machine* is liable." The drift of the paper indicates that the author referred to a self-exciting machine for generating continuous currents. The illustration shows a small dynamo to be driven by hand through a jack-in-the-box gearing. In 1876, Edward Weston, in the United States Patent Specification No. 182,977, alludes to "That class of machines, known as dynamo-electric machines in which currents induced in a revolving armature are passed round the electro-magnets, strengthening the magnetic field, this, again, increasing the strength of the induced currents in the armature, and so on, until a maximum is reached." There is no doubt that in the early years of electrical engineering the term dynamo was applied to a machine which excited itself through the cumulative action and reaction between the armature and field magnets, and that a dynamo was regarded as a different machine from either a magneto machine with permanent steel magnets or a separately excited machine, such as Wilde's, described to the Royal Society in 1866 (*Phil. Trans.*, Vol. 157, p. 101). In later years the term came to include all classes of machines for transforming mechanical energy into electrical energy by the displacement of conductors in magnetic fields, and it has also been taken to include electromotors.

A few years ago Mr. Mordey introduced the very convenient and expressive term "alternator" to describe machines for generating alternating currents, and this name is coming gradually into general use. It will be generally admitted that a short word denoting simply and solely a "*continuous-current machine*" would be very convenient. It is unlikely, however, that electrical engineers would look with favour on the introduction of a new term to describe a perfectly well-known machine. But if the term dynamo machine were restricted to its original meaning of a continuous-current self-exciting machine, it would probably soon be recognised as a great convenience, as well as being scientifically more accurate.

With a view of eliciting criticism and suggestions the writer ventures to submit the following definitions:—

1. A Dynamo Machine is a self-exciting machine for transforming mechanical energy into electrical energy by the generation of continuous currents.

2. An Alternator is a machine for transforming mechanical energy into alternating current electrical energy.

3. An Electromotor is a machine for transforming electrical energy into mechanical energy.

The term electro-magnetic generator might be used to include both dynamo machines and alternators, and these as well as dynamotors and induction coils would all be comprehended in the general expression—electro-magnetic machinery.

* "Monatsberichte der kon. Preus. Akad. der Wissenschaften zu Berlin." January, 1867.

† "Scientific Papers, &c., of Werner von Siemens." Translated from the second German edition, Vol. I., page 218. John Murray, London.

A DOUBLE POLE VOLTMETER SWITCH.

The accompanying sketch shows a very simple, easily constructed, and exceedingly convenient double-poled voltmeter switch, designed by Mr. Malcolm Sutherland, for testing secondary batteries, &c. It consists of a split brass ring, a number of brass clips, or contact pieces, and a vulcanite arm with a handle. The number of clips depends on the number of points at which it is required to measure the potential. The

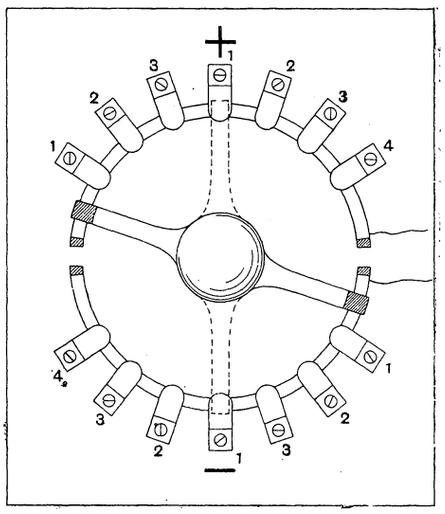

illustration shows one which was made to read the voltage of three sets of accumulators and four circuits. The wires from the voltmeter are connected, one to each half of the ring, and the wires from the cells and circuits are brought to the clips which are ranged round the ring. The clips are clear of the ring, and as long as the arm is in the position shown in the sketch the voltmeter is entirely disconnected from the cells and circuits. When it is necessary to take a reading, all that has to be done is to turn the handle, so as to bring the brass contact pieces between the ring and the clips Thus the dotted line shows the arm in position for taking a reading from circuit No. 1.

THE SCOTT-SISLING SYSTEM FOR COUNTRY HOUSE LIGHTING.

Small plants for private house lighting and similar purposes are rapidly increasing, and it is important that they should be arranged so that their operation is simple and efficient in practical work. A battery is naturally antagonistic to these conditions, owing mainly to the fact that it requires a considerably higher pressure for charging than it will give when discharging, whilst its expense generally necessitates the use of the smallest size which will answer everyday requirements. The generating plant has, therefore, frequently to run for long hours at light load to charge the battery. Various devices have been adopted to avoid this. In central station work, probably, the best way is to use a small dynamotor, driven from the main, the secondary being put in series with the battery circuit to give the extra pressure required for charging. This arrangement is used at Liverpool and elsewhere. Another device, which is more clumsy and expensive, consists in the use of larger cells at one end of the battery, so that the full dynamo current may be sent through them without injury, after which the greater part of the current is taken off to the lamps, while the smaller portion charges the smaller cells of the battery. Neither of these devices is suitable for a private plant, and for this reason Messrs. Laurence, Scott and Co. (Limited), of Norwich, have introduced an arrangement known as the Scott-Sisling System. This has been already described in *The Electrician*, Vol. XXVII, p. 556, but one or two improvements, recently introduced, deserve further notice.

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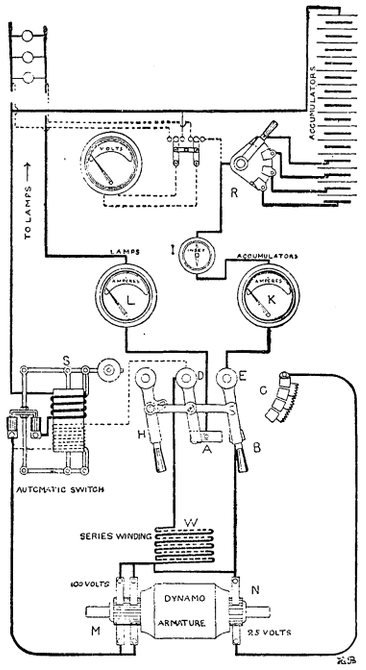
A special dynamo is used, having two windings on its armature and two commutators. The lamp current is taken from the principal commutator through series coils on the dynamo magnets, thus securing the advantage of constant driving speed which is not often associated with the use of accumulators. The battery charging current is also taken from the principal commutator, but through the extra winding on the armature



A is connected to lamp main through the ammeter L. B is a contact for running cells in parallel with dynamo. C is the contact for charging cells. It is divided into sections connected by resistances. D is the dynamo switch. H is the handle for closing dynamo switch. E is the battery switch connected to cells through the current index I, and the ammeter K. R is the regulating switch for adjusting the number of cells in circuit. W represents the series winding of dynamo.

FIG. 1.—Diagram of General Arrangement of the Scott-Sisling System.

instead of through the series coils on the magnets, so that its pressure is increased, whilst there is no risk of the dynamo being reversed. The arrangement is shown in Fig. 1, and it will be seen that the switches, shown on a larger scale in Fig. 2,

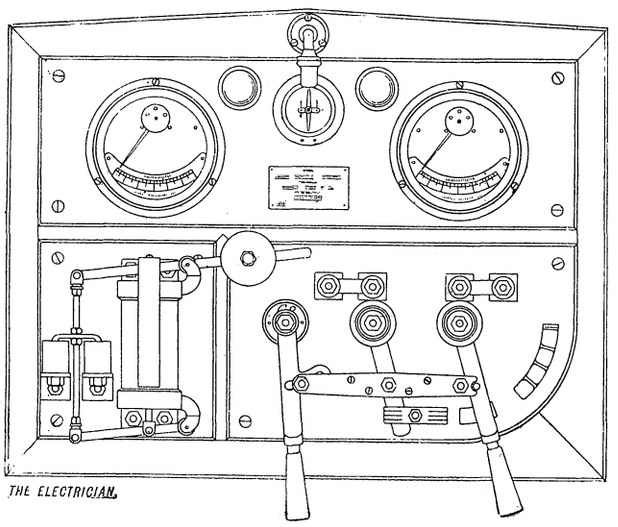


FIG. 2.—Switchboard for Scott-Sisling System.

are interlocked in such a way that the battery is always connected to the dynamo *inside* the compound winding, whether it is being charged or discharged to assist the dynamo. In the latter case, the battery current traverses the series coils of the dynamo, so as to strengthen its field, thus tending to minimise the discharge of the battery so long as the dynamo is able to give the output required.

The usual procedure with this arrangement is to start the dynamo about dusk and use its spare power for charging the battery. As the load increases towards the full output of the dynamo, the charging current is first diminished and then stopped, the battery being coupled to the principal brushes of the dynamo ready to discharge if neccssary. As the load falls off the charging is again commenced and increased as spare power becomes available, thus maintaining an almost steady load and a good average efficiency with a proportionate shortening of the hours of running. Messrs. Laurence, Scott and Co. inform us that this arrangement is in use in several country houses, and is operated without trouble by the regular engine-driver or carpenter on the estate.

THE CHRISTIANIA CENTRAL STATION.

(COMMUNICATED.)

The Christiania three-wire station came into operation on December 13th last, when certain streets were lit up. The electrical station was decided upon in April, 1891, and 500,000kr. were voted towards the undertaking (1kr. = 1s.). The response to the circular invitation was, however, so large that the plans had to be materially extended, and they finally involved an estimated expenditure of 1,165,000kr. The station capacity amounts to 24,000 lamps of 8 c.p., with a cable network sufficient for 40,000 lamps. Power is supplied by four compound condensing direct-coupled engines, two of 600 h.p. each, and two smaller ones respectively 260 h.p. and 130 h.p. Only a small battery of accumulators has been installed. It has a capacity of 685 ampere hours at 240 volts, that is to say, an output of 154,800 watt hours. This battery will thus be able to supply current to 774 incandescent lamps for four hours. It will be seen that this battery is comparatively small, but it is only intended for night and midday service and as a reserve. The station is in a central position, the maximum radius of the area of consumption being about half a mile. Twelve main feeding cables proceed from the station to a corresponding number of points of distribution. The cables are lead-covered, made by Messrs. Felten and Guillaume, and are laid directly in the ground in a layer of fine sand, covered with a layer of bricks. The contract stipulated for 15 megohms per kilometre of cable laid, immediately after laying, and at least 5 megohms per kilometre during working and after the lapse of a year. At the test, when all the cables, large and small, were laid, the insulation resistance of the whole network was about 8·6 megohms. The following cables have been laid :—Main cables, 19,600 metres ; distributing cables, 32,500 metres ; service cables, 5,000 metres ; street-lighting cables, 6,700 metres—in all, some 64 kilometres, or about 40 miles. Hence the insulation resistance, after laying, was about 550 megohms per kilometre ; or 343 megohms per mile.

In the boiler-house there are at present three Babcock and Wilcox boilers, with an aggregate heating surface of 645 square metres These are guaranteed to have a normal capacity of 14 kilogrammes of water per square metre of heating surface, so that the three boilers can give 9,030 kilogrammes of steam per hour, which, with forced draught, can be increased to 11,610 kilogrammes per hour. The guarantee for the steam engines is a normal steam consumption of 7·3–8·5 kilogrammes per indicated horse power per hour, according to size. Worthington pumps are used for feeding the boilers. In the basement under the boiler-house there is a reserve water tank, holding 15 cubic metres (3,300 gallons). Before entering the boiler the feed water is passed through an economiser. Coke is used as fuel, and with ordinary working the boilers are guaranteed to evaporate eight kilogrammes of water for a kilogramme of coke, the steam pressure being ten atmospheres (147lbs. to the square inch). The condensing water is taken from the harbour through a pipe 300 metres long and 400 millimetres in diameter. The steam-engines have been supplied by G. Kuhn, of Stuttgart, and the electrical equipment proper has been done by Messrs. Schuckert and Co., of Nüremberg. The accumulators (Tudor) are from the Accumulator Company of Hagen (Wiesbaden).

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The 14-ampere street arc lamps, 40 in number, are of Schuckert make, and are distributed in six streets or squares. The lamps are run off the distribution cables in the streets, and the regulators are placed in wooden boxes, fixed on to the nearest house wall. The price of the kilowatt hour is 75 öre (10d.), and the current consumed is measured by Aron and by Schuckert meters. The dynamos are multipolar shunt machines; the two largest having 14 poles each, the next two have 12 each and the smallest 8 poles. The two large engines run at 110 revolutions, the two small ones at 150 and 170.

It may be mentioned that the latitude of Christiania being 59° 56′ N., its daylight curve is exactly the same as that of St. Petersburg which appeared on p. 476 of *The Electrician* of February 24th. Thus in summer time the sun is below the Christiania horizon for six hours only (9 p.m.—3 a.m.), but in January it sets about three in the afternoon, and does not rise again until past nine o'clock, that is to say, the night is 18 hours long; a variation of 200 per cent., which can hardly be conducive to economy.

THE MOISSAN ELECTRIC FURNACE.

M. Henri Moissan makes some more interesting announcements in the last number of the *Comptes Rendus* with regard to the latest results obtained by means of his electric furnace.

At ordinary temperatures the oxides of uranium are practically irreducible, but they have yielded to the heat of the electric furnace. M. Moissan prepares a mixture of uranic oxide ($U\ O_3$), and of the green oxide of uranium (U_3O), adding a little powdered carbon and strongly compressing the whole. Placed in M. Moissan's furnace, and exposed for a few minutes to a current of 450 amperes at 60 volts, one can obtain a metallic ingot, the pieces of which, if agitated, will emit sparks from the combustion of traces of foreign matter. The yield of uranium is fairly good, from 200 to 220 grammes may be obtained in twelve minutes, the average composition of the ingots being 90 per cent. uranium and 10 per cent. carbon. These carbides of uranium slowly decompose water at ordinary temperatures, and their melting point is much higher than that of platinum (1,780°C.).

Chromium and manganese have also been prepared by M. Moissan. Pure protoxide of manganese is mixed with carbon and exposed to 300 amperes at 60 volts, and in five or six minutes there is at the bottom of the crucible an ingot of carbide of manganese (89 per cent. manganese), weighing 100 to 120 grammes. With less power smaller quantities can be obtained in a little longer time. If the reduction is effected in presence of an excess of oxide the percentage of carbon is greatly diminished, and in some samples it is possible to get 95 per cent. manganese. When the proportion of carbon is small, the metal may be easily preserved in an open vessel, but as soon as the proportion of carbon increases the humidity of the air decomposes the substance.

A mixture of calcined sesquioxide of chromium and carbon is reduced in eight to 10 minutes by a current of 350 amperes at 50 volts, leaving an ingot weighing 100 to 110 grammes adhering to the crucible. The average composition of M. Moissan's samples was about 89 per cent. chromium, and the rest carbon. By a further attack in the furnace practically pure chromium may be obtained. Not only may the sesquioxide be reduced in this way, but also the natural chrome iron ore $Fe,\ O,\ Cr_2,\ O_3$.

BOVET MAGNETIC ADHESION APPARATUS.*

BY R. V. PICOU.

The adhesive force which comes into play between two pieces of iron forming part of the same magnetic circuit has up to the present received but a limited application. It has only been utilised in a few lifting machines, and the necessity for slinging the pieces of iron to be transported from one place to another in this way avoided, and in a few drills which it thus became unnecessary to bolt down to the objects to be drilled, such as armour plates and ships' hulls. Magnetic adhesion, nevertheless, seems destined to render valuable services to industrial mechanics.

A few months ago, whilst studying a mechanical problem in which electricity seemed to have no likelihood of taking part, M. A. de Bovet, Manager of the Compagnie de Touage de la Baisse Seine et de l'Oise, hit upon and carried out one of the most remarkable applications of electricity, utilising it in connection with chain-towing. All the riverside population of the Seine know "the chain," and have seen the boats of the Company hauling themselves along by means of a chain running along the bottom of the Seine from Paris to Rouen. Without going into details as to the reasons which have gradually resulted in the Company's material no longer being in touch with the state of things which has been brought about by long years of work on the Seine, suffice it to say that the desideratum in the Company's new boats was that they should work with short lengths of chain. The old craft, which made use of natural adhesion, required enormous lengths of chain. All manner of mechanical and hydraulic solutions had been considered, but they only secured the desired result at the risk of grave inconveniences. M. de Bovet, who had long been familiar with the resources of electricity, had the happy idea of employing it as panacea to cure all his ills. It is only right to say, however, that, with a prudence which the prevailing uncertainty justified, he, at first, only argued the matter out somewhat as follows: However small the increased adhesion obtained by magnetisation may prove to be, it will in any case enable me to reduce the length of chain taken aboard; and that is an advantage the exact magnitude of which it is worth experimenting upon to discover.

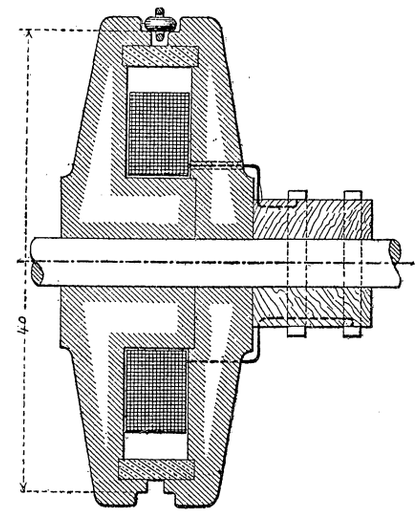

FIG. 1.—Bovet Magnetic Pulley for Chain Towing.

First of all a small cast-iron pulley was constructed, and then a large, soft steel pulley of the general shape shown in Fig. 1. The towing chain is, it will be seen, employed to complete the magnetic circuit of a rotating electro-magnet.

It is difficult to calculate the probable effect *a priori*. First of all the chain is not absolutely comparable to a cord rolled round a drum. Then the magnetic effect is somewhat difficult to bring into a formula, so long as it is not known exactly what terms it affects. However, all this, notwithstanding, experiment showed that the idea was a good one, and that a pulley 1·2m. in diameter embraced for two-thirds of its circumference, gave a towing effort equal to that of an angle of embrace of 5π or 6π in the case of the smooth pulleys, 1m. in diameter, used in the old boats. A tow-barge, named the Ampère, was ordered and constructed, and recently came into operation.

In the course of his investigations, M. de Bovet was struck with the number of applications which might be made of magnetic adhesion on the condition that it was systematically studied, and all doubts as to the magnitude of the effects obtainable were removed from the minds of its many opponents. Amongst other applications, that of couplings may be noted. The problem is one well known to mechanical engineers and the multitude of methods which have been proposed is a proof that none of them completely fulfilled the conditions of the problem. When it is a question of transmitting small powers friction is generally used. For large amounts of power friction must be given up, and recourse had to claw clutches; but these have the great defect of not being operable during working, and when this condition is imperative as in certain apparatus, such as variable speed rollers, the problem is almost insoluble.

* From *L'Industrie Électrique*.

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The Bovet coupling (*see* Fig. 2) affords a complete and perfect solution of the question, and possesses marked advantages over its mechanical congeners. It consists of a block A in cast or wrought iron, around the face of which a groove is made, in which the wire B is placed. It terminates in rings *a b*, on which brushes bear. The whole is keyed to the power shaft. The shaft to be clutched is provided with a block F, capable of sliding along and approaching *c d* until it is in contact. It follows, therefore, that when the wire B is traversed by a current, F is attracted against *c d*, and participates in the motion of A. The chief advantage of the system resides in the fact that, contrary to that which takes place with all kinds of friction clutches, adhesion is obtained without any external reaction. The magnetic forces in a closed circuit are all internal, and there is no thrust on the journals nor reaction of

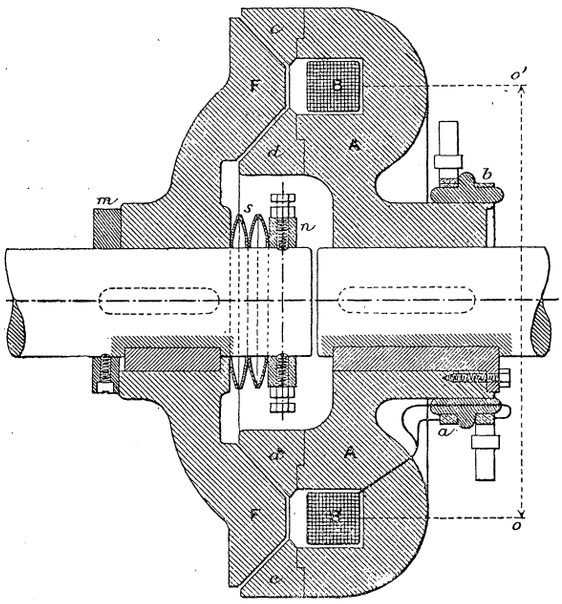

FIG. 2.—Bovet Magnetic Clutch.

elastic parts on supports. It will be observed, that the magnetic circuit is cut across in the shape of a wedge. This is another very important point, which gives the apparatus the valuable property of limiting the maximum transmitted effort, and permitting slipping when this amount is exceeded. Experiment shows that if the resisting effort becomes too great A slips, but does not release F. This property enables one to entirely avoid injury to apparatus connected to F, such as chains, gearing, &c., since it is only necessary to regulate the value of the current in order to ensure that the required maximum effort is not exceeded. If the contact surfaces of A and F were flat, the same result would not be attained; there would no longer be merely slipping, but complete disconnection, which might often give rise to grave inconveniences.

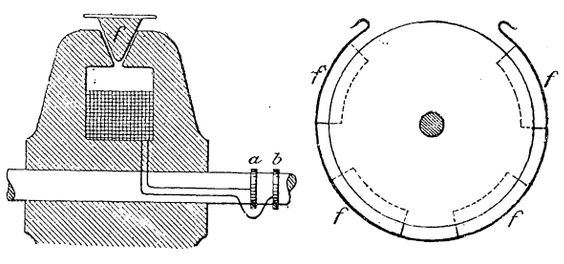

FIG. 3.—Bovet Magnetic Railway Brake.

With very small dimensions this clutch can be used for very large powers. A 400 or 500 H.P. clutch running at an average speed is only 1m. in diameter.

All these qualities open a vast field for the application of such apparatus. One field is the braking of railway trains. Here the great advantage results from the simultaneous action of all the brakes due to the instantaneous propagation of the current from one end of the train to the other. The low price of the apparatus, the small expenditure of energy, and its complete adaptability are so many things in its favour, to which may easily be added, if necessary, automatic action in case of uncoupling of carriages.

Several forms of brakes have been devised by M. de Bovet. In most of them the brake is not applied to the rim of the carriage wheel, but to the circumference of a special wheel carried on the axle, the general shape of which recalls that of the tow-chain wheel. The groove, however, is cut V-shaped (*see* Fig. 3), instead of having the special shape required by the chain. The brake shoes *f* are wedge-shaped, and are fixed to a steel band, the normal tension of which keeps it a little way away from the wheel. This band is fixed to the body of the carriage after having embraced the brake wheel for an angle of from 1800deg. to 270deg., according to the character of the carriage. When a current passes, the wheel is magnetised and attracts the shoes, which make contact. The pressure exerted only depends upon the value of the current, and varies with it within very wide limits. In addition, the apparatus acts as a band-brake, and gives a direct pressure, at least in the case of the first shoes, much superior to that corresponding to the current strength. Moreover, the apparatus appears to possess considerable power and flexibility.

In closed magnetic circuits, such as those we are concerned with, the expenditure of electric energy may be extremely small, so that a small source of current, such as a few accumulators for instance, is enough for a number of operations. Automatic action in case of rupture of coupling is easily obtained by means of an auxiliary wire, which, traversed by a small current obtained from the accumulators, actuates the electro-magnetic apparatus in the guards' vans commanding the main circuit. So long as the current is flowing these electro-magnetic devices keep the main circuit open and the brakes free. If a carriage coupling breaks, the auxiliary current being interrupted, the brakes are thrown into action in front and behind. The two halves of the train are thus automatically braked from the battery in its guards' vans. The different brake-wheels being all in parallel, the rupture of the main circuit does not in any way interfere with the working of the apparatus.

These few remarks are only a glance at a few of the applications of magnetic adhesion. There are many others, only touched upon as yet.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 3rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "The American Experiences of an Embryonic Electrician," by J. M. Barr.

OLD STUDENTS' ASSOCIATION.

8 p.m. Meeting at the Central Institution. Lecture "Mountaincraft," by Clinton T. Dent (illustrated by lantern views).

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Sculpture considered apart from Archæology," by George Simmonds.

SATURDAY, March 4th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Sound and Vibrations," by Lord Rayleigh, F.R.S.

JUNIOR ENGINEERING SOCIETY.

3 p.m. Ordinary Meeting at the Westminster Palace Hotel. Papers to be read and discussed: (1) "Expansion Curves," by W. J. Tennant. (2) "Feed-Water Heaters," by Walter H. DeRitter.

MONDAY, March 6th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ARTS.

5 p.m. Cantor Lecture (1): "Alloys," by Prof. W. Chandler Roberts-Austen, F.R.S.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting, at the Town Hall, Westminster.

TUESDAY, March 7th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read, with a view to discussion: "On Plant for Harbour and Sea Works," by Walter Pitt, M.Inst C.E. At this meeting the monthly ballot for members will be taken.

WEDNESDAY, March 8th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Music in Elementary Schools," by W. G. McNaught.

THURSDAY, March 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be discussed: "Notes on Testing Alternators," by W. M. Mordey.

FRIDAY, March 10th.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "The Application of Lagrange's Equations of Motion with especial reference to a Perforated Solid in a Liquid," by Dr. C. V. Barton; (2) "On the Magnetic Field of a Circular Current," by Prof. G. M. Minchin, M.A.; (3) "On the Differential Equation of Electrical Flow," by T. H. Blakesley, M.A.

ROYAL INSTITUTION.

9 p.m. Evening discourse: "Early Myth and Late Romance," by Sir Herbert Maxwell, M.P.

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The Electrician.

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THE ELECTRIC FURNACE.

In the Forest of Dean, the Romans, following no doubt the practice of the British iron-workers, built conical furnaces, and set them on the hill-tops to catch the wind. Probably one of the first improvements was to supply an artificial blast, and, but for the hot blast, which may be called a modification rather than an improvement, no essential change has since then been made in the commercial method of reducing ores. The oxyhydrogen blowpipe was an obvious improvement on an atmospheric blast, seeing that the nitrogen was worse than useless. DEVILLE and DEBRAY, using a lime furnace, both to retain the heat and to absorb the more fusible and volatile impurities, achieved the true smelting of platinum and aluminium. But here, for many years, metallurgical progress stopped. No higher temperature was known, and the rarer metals were reduced and fused with extreme difficulty.

The electric furnace may be said to have been discovered with the electric arc, and in the hollow crater of a reversed arc lamp, minature metallurgical experiments may be easily conducted. The most notable result of the commercial use of the electric furnace has been the production of aluminium in considerable quantities; and, quite recently, M. MOISSAN has produced uranium, chromium, and manganese. M. MOISSAN's experiments, a brief account of which will be found in another column, add one more testimony to the immense value of the electric furnace as an instrument of research. The possibility of reducing the most refractory metals, not in fractions of a gramme but in quantities amounting to many grammes at a time, cannot but materially aid the examination of some of those which are only imperfectly known. It is perhaps to be regretted that the affinity of uranium for carbon should be so marked at this high temperature that the winning of the pure metal is far from

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easy; but it is probable that a re-treatment of the carbide with an oxide of uranium would eliminate the carbon, in a manner analogous to that in which the same element can be removed from iron when it is required to prepare the latter in a state of purity. Manganese might have been expected to form a carbide under the conditions prevailing during its reduction, not only on account of its similarity to iron, but also because it is known to be associated with large quantities of carbon in spiegeleisen and ferro-manganese. Seeing that the diamond form of carbon has been obtained by suddenly cooling under pressure a solution of carbon in iron, it would be interesting to ascertain whether a similar result would occur when manganese is substituted for iron. There is no reason why cobalt, palladium, iridium, and other useful, but not easily fusible, metals should not be produced at reasonable prices.

The history of aluminium during the last few years has shown that ingenious processes by which this metal might be made at a cheap rate are of little use, if a demand cannot be stimulated. This metal has been surrounded with a remarkable glamour ever since it attracted the attention of NAPOLEON III. In 1860 aluminium fetched £18. 10s. per lb.; in 1887 about £1 per lb. In 1889 it was offered by the half-ton at Pittsburgh at two dollars per lb., and in 1891, as the production of the Hall process, it was sold at one dollar per lb. Early in 1892 the price at Neuhausen was said to be 2s. 3d. per lb., and in May of last year 7½d. per lb. was talked of in America. In June, the price at Neuhausen was 2s. 6d. But not only is aluminium still a curiosity, but the lowest quotation elicited by some enquiries last week was 5s. per lb. for sheet, and we are inclined to doubt whether any real business has ever been done at 3s., excluding, of course, transfer between agents or associated companies. For most purposes, the bulk and strength is wanted rather than the weight, and allowing for its specific gravity aluminium at 4s. 8d. per lb. would be equivalent to sheet brass at 1s. 6d. The chemical process of reduction by the use of sodium yielded a very pure quality, but it was found that the alloys made in the Cowles' furnace were sufficiently useful, and as other electrical furnaces produce aluminium of 97 per cent. purity, there is no room whatever in commerce for the chemically pure metal. Platinum, as originally made by WOLLASTON'S process from chemically prepared spongy platinum carefully welded and forged into the solid, was of considerable purity, but platinum produced by an electric furnace by a smelting method contains several rare and refractory metals, notably iridium. The presence of iridium is useful, both in the manufacture of crucibles and in wire for electrical purposes, and is not, as many people suppose, added to platinum as zinc is added to copper in making brass. The electric furnace, whether used merely for the purpose of obtaining a very high temperature, as in the COWLES and MOISSAN patterns, or whether introducing at the same time electrolytic action, is likely to yield important results. The many uses found for tungsten-steel, nickel-steel, manganese-steel, chrome-steel, silicium-bronze, aluminium-iron or mitis metal, manganin, and other very useful alloys, depending, in many cases, on the presence of a very small proportion of a rare metal, offer encouragement for the discovery of new mixtures, even if the production of rare metals in their pure state is not as yet warranted by any known qualities and properties. So little, however, is known about metallic chromium, that the news of its successful reduction in the electric furnace, and of the ease with which it forms a carbide akin to those of uranium and manganese, were best received in grateful and respectful silence, qualified by a definite tendency to "ask for more."

SPARKING AT COMMUTATORS.

BY F. M. WEYMOUTH.

(*Continued from page 324.*)

Lastly, we arrive at the fifth in our order, the plane of maximum and minimum potential through the armature. This applies to the armature as the fourth applies to the commutator. It is indicated by the letters *M M* in the diagrams. When the brushes are at the non-sparking points on the commutator, this plane would come just slightly behind the plane of commutation, and consequently still further behind the plane of requisite reversal, as shown in Figs. 10 and 12. As with the second and third planes, so the coincidence of this fifth plane with the fourth is a pure matter of construction, and would, in fact, take place when the second and third coincided, as in Fig. 8. In Fig. 12 they will be seen to be at right angles with each other, similarly to the planes of non-sparking and requisite reversal. Though what we have termed a normally fixed plane, yet this and our second, third, and fourth planes may all be in some degree affected by moving the brushes, in so far as such movement may disturb the ratio of the strength of the self-excitation of the armature to that of the field. But this would only be, so to speak, an indirect effect, as compared with the directness of the effect on the plane of commutation caused by shifting the brushes.

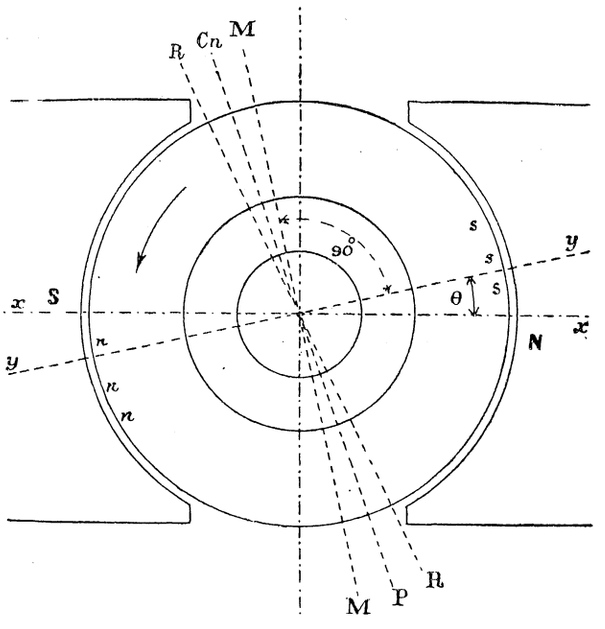

FIG. 10.—Armature Planes.

This last, or fifth, plane, however, we may here define somewhat more closely. For it may be understood to be that plane through the armature in which, when the coils arrive in it, they cease to *generate* the main current. It is the plane wherein, on the positive side of the armature, and supposing this to be symmetrically wound, as is usual, the currents from either half of the winding will meet, and, so to speak, form a "head;" though it might be more correct to say that it is the two electromotive forces from either side that so meet, except that the latter are not added together as are the two currents. When carried beyond this plane, the coils commence generating the reverse current. It is the plane which is normal, or at right angles, to the lines of magnetic induction traversing the armature core; and thus is the plane wherein the coils are neither excluding nor including lines of magnetism, and so cannot generate any electromotive force. This plane, moreover, is that which, perhaps, may be said to be the most important. For being itself directly governed by the field, it exercises control, as it were, over all the other planes. Having its position necessarily at right angles to the lines of magnetic induction running through the core, if these latter alter their angle with the horizontal, then this plane must follow suit. This is

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made clear in the diagrams, Figs. 10*, 11*, and 12*, where the line $y\,y$ indicates the centre or mean plane of the lines traversing the armature, forming an angle θ with the horizontal centre line of the field $x\,x$. By the angle θ is thus represented what is known as the "distortion of the field"; and the more powerful the field in proportion to the self-magnetisation of the armature, the smaller will be this angle, and *vice versâ*. Hence, any

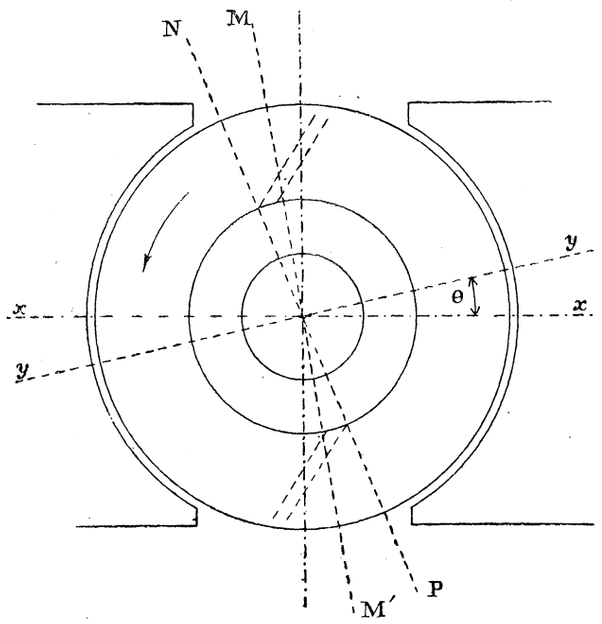

FIG. 11.—Commutator Planes. Brushes above and below.

cause affecting the angle θ will immediately produce a displacement of the plane M M, which in turn will also affect all the other planes. A dissertation on the self-excitation or polarisation of the armature, more especially in connection with drum winding, and the generation of current and potential, may be found in another article. (*See The Electrician*, Vol. XXIII., p. 273).

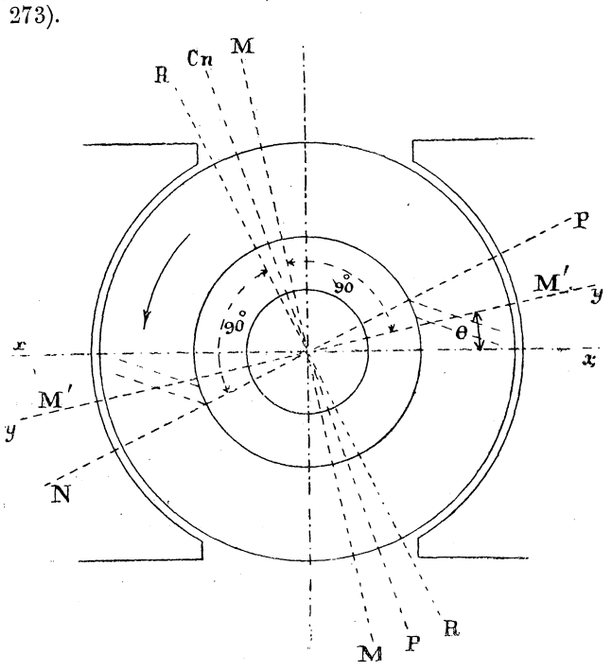

FIG. 12.—Armature and Commutator Planes. Brushes at the sides.

Having thus distinguished between the various planes, we may now turn our attention to Fig. 13. As may be perceived, this represents the top of a commutator, three of whose segments are lettered respectively r, s, and t; the armature coils

* Reproduced from *The Electrician*, January 20, 1893.

are represented between c and d, two of them being lettered b and f; and three of the lugs are lettered g, h, and i. The neutral plane of the commutator is assumed coincident with the plane of requisite reversal of the armature, and these are jointly indicated by the line R R. The point of the brush being just on this line, no sparking takes place. Two of the coils, b and f, are short circuited by the brush, and so are shown thicker; and the short circuits through the brush point are indicated by thick dotted lines. While the large

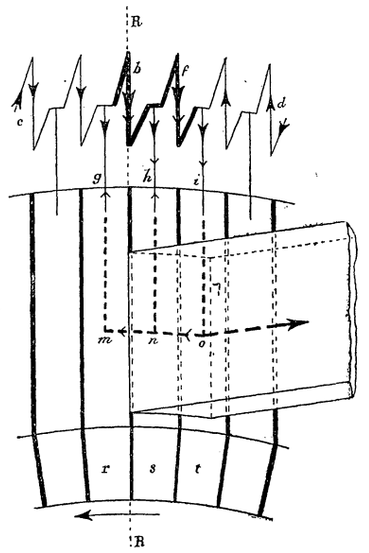

FIG. 13.—Non-Sparking Position. Short-Circuited Coil b in Plane of Requisite Reversal.

arrowheads show the main current arriving from the two halves of the armature winding, c and d, the small arrowheads represent the short circuit currents. It will be noted that the b and f coils have just left the series d, and are passing into the series c. Having passed the M M plane, the d current that was circulating within them, has first been stopped as they each arrived into the plane of commutation, and then a reverse short circuit current has been set up within them by the c electro-motive force. At the moment shown, this short circuit, or as for brevity we may term it, the $s.\,c.$ current, in coil b, exactly equals the c current. Meeting each other in the lug g, these two currents neutralise each other: hence there is no current flowing either way between the brush and the receding segment r. There thus being no current to break at the recession, there is no sparking. The positive brush being

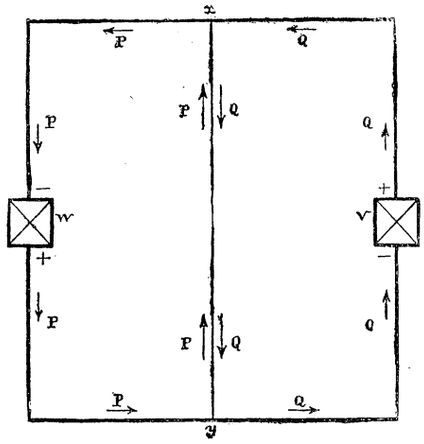

FIG. 14.—Two Circuits with Currents opposed in Common Conductor.

here shown, for the negative brush it is simply necessary to reverse all the arrowheads.

Now, in the above diagram there are *two* short circuits, namely, $g\,b\,h\,n\,m$ and $h\,f\,i\,o\,n$. In this connection we may turn to Fig. 14. We here find two circuits, P P and Q Q,

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having a common conductor, $x y$. The generators are represented at w and v; and it will be seen that the currents oppose each other in $x y$. If the two currents are equal there will be no current in $x y$; while if they are unequal $x y$ will carry the difference. This, in fact, illustrates the essence of what is termed the "three-wire system," $x y$ representing the "neutral" main. It will be noted further that the P current leaving w, and the Q current leaving v, checking each other in $x y$, they each continue in the other's circuit. More accurately, it may now be said that there is only *one* circuit with the two generators in series; and, in fact, the two currents may be said to be *assimilated*. None the less, if the Q current be, say, 250 amperes, and the P current, say, 200, the Q current will split at x, 50 passing down to y and 200 only continuing by w. Uniting at y, 250 will enter the negative at v. Thus, though *assimilated*, the two currents taken separately retain their original values. Reverting to Fig. 13, we find that the two short circuits have in like manner a common conductor, $h n$, which will carry the difference between the currents generated respectively by b and f; for the latter will not be generating so large a current as the former.

We may now consider cases where sparking takes place. The most simple cases will be when the brushes are shifted too far forward or backward; or, again, which amounts to the same thing, if the brushes be at their right places, a cause of

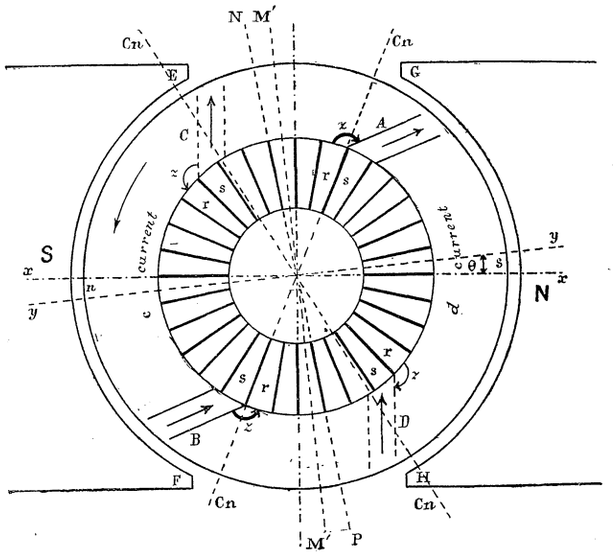

FIG. 15.—Diagram showing Brushes with too much Positive or Negative Lead.

sparking may be the oscillation of the neutral plane. This latter, however, trenches on ground which we cannot now enter upon, so we confine our remarks to the simple displacement of the brushes.

Fig. 15 herewith shows an armature revolving in a field, and a commutator, together with brushes. These latter are shown in positions A and B too far back, and at C and D too far forward. We now propose to deal with these four positions in detail, and consider the nature of the sparking that occurs in each one. Fig. 16 thus shows the brush at A (in Fig. 15). It must here be remarked that in these four diagrams, for the better elucidation of our subject, we have assumed a current output of 400 amperes, as shown on the brushes. Further, the conditions represented are *those that are broken* by, and so are *not* the results of, the recession of the segments r from the brushes. Short circuit (or s.-c.) currents of 500 and 450 amperes are assumed in the coils b and f, according as the one or the other is in the better position for generating E.M.F. The main armature currents c and d, of 200 amperes each, are indicated by the large arrowheads, and the s.-c. currents by the small arrowheads, as before. The double arrowheads represent *resultant* currents, whether by difference or addition.

It will now be seen, on reference to Figs. 15 and 16, that the brush A being on the d side of the commutator, up to the moment of the recession of segment r, there has been nothing whatever to reverse the current and polarity of the coils b and f. Hence their s.-c. currents will circulate in the same direction as the d current. As indicated by the large arrowheads, the latter still flows in these coils; though this is to anticipate. The two s.-c. currents, as explained in connection with Fig. 14, will become assimilated with each other, their difference only, 50 amperes, entering by lug h; and there will be a *normal* outflow of 500 s.-c. amperes through lug i, and a *normal* inflow of 450 s.-c. amperes by lug g. But now to consider the d and c main currents, we may take the former first. This would naturally attempt an inflow through lug i. It is, however, met there by the normal f s.-c. 500 outflow. The resultant 300 outflow is thus what remains. In this and the following diagrams it will be observed that the two amounts, which together produce a resultant, are struck out by a line drawn through. But the *whole* f s.-c. 500 is reduced by this same act. The 200 d, blocked back in i, takes the place of the missing 200 in f, or, in other words, becomes *assimilated* in that coil; and the b and f s.-c. currents being already assimilated, it becomes assimilated with both these currents. Now to consider the c main current, we find this inflows through lug g in the same direction as the b current. These thus *augment* each other, forming a united or resultant current of 650 amperes. To analyse this amount accurately, we observe that it is composed

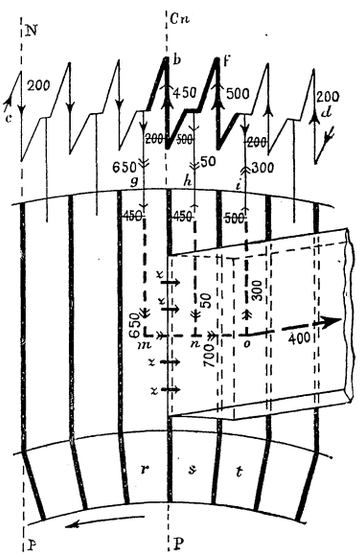

FIG. 16.—Positive Brush too far back. Heavy Forward Sparking. (Position A in Fig. 15.)

of 200 c + 200 assimilated d + 250 assimilated s.-c. currents; for, as pointed out, the d current is assimilated with the s.-c. currents. At the point n this amount is further augmented by the inflowing 50 down h, thus making a total of 700 from n to o. Of this total 400 goes up the brush, being the sum of the c and d currents, while the remaining 300 forms the 300 s.-c. current in lug i. We thus find the cycle of events completed.

Now, from the above we note that the actual current that is broken is *more than* the main output, being 650 amperes instead of only the normal 400. Furthermore, we observe that the spark which will occur at the recession will be due to the self-induction of both the c and d series of coils *plus* the additional effect produced by the short circuits, that is, to the self-induction of the whole of the armature-winding. Hence the sparking will be heavy, and will be in the same direction as the main current, as indicated by the thick arrows $z z$. A large current, moreover, being broken, there will be considerable burning with the arcs, especially of the segment r, which is here the positive electrode.

(*To be continued.*)

A Large Accumulator Order.—The Brussels Municipality is said to be contemplating the purchase of £20,000 worth of accumulators; £4,000 worth have already been ordered.

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ON TESTING AND WORKING ALTERNATORS.*

BY W. M. MORDEY.

In connection with the testing of large dynamos, the provision of the necessary power is often a very serious matter; and the driving plant for this purpose is a heavy item in the equipment of a dynamo factory, especially as, in order to get the full output from machines of sizes that are now often made, much larger boilers and engines are required than for the works where the machines are made. Very little has been written about the actual testing of alternators, and, so far as I am aware, they have always been tested in the manner commonly followed with direct-current dynamos—that is to say, they have been run on circuits of lamps, or on wire or other resistances, either directly or through transformers. Where it is desired to test the prime motor as well as the alternator there is no need to do more than this; but when engine and boiler powerful enough are not available, or when it is desired to carry out long runs at the least cost in plant and fuel, other methods have to be sought for, and we naturally turn for assistance in this matter to the method of circulating power first devised and described by Dr. Hopkinson. It may be of interest to first glance briefly over the subject of testing by this method.

In Dr. Hopkinson's tests, published in 1886,† two similar dynamos were mechanically and electrically coupled. One ran as a generator supplying current to the other, which then acted as a motor and helped to drive the generator. It was necessary that the coupled machines should be driven by some source of power sufficient to provide for their internal losses. It was further necessary, in order that the circulation should take place, that one machine should have a higher E.M.F. than the other. When similar machines were used, this was readily arranged by weakening the field of the motor. Dr. Hopkinson introduced this arrangement with the special object of attaining a high degree of accuracy in determining the efficiency of dynamos. It is comparatively easy to obtain accuracy in measuring the electrical output or input of generator or motor. To measure the input or output of power mechanically is more difficult. Dr. Hopkinson reduced this difficulty by reducing the power required to be measured mechanically to less than one-tenth of what it would be under ordinary circulation. Lord Rayleigh‡ proposed to supply power to the coupled dynamos by an accumulator or small dynamo instead of by a belt, thus making the method completely electrical.

This method, in one form or another, has been frequently used for testing the efficiency of direct-current dynamos. When two similar dynamos are available it is very useful, although the positive coupling is rather a drawback. If a belt is used, then the loss in the belt is included in the power required to be furnished to the combination. By running with and without belt or other gearing we have a simple way of finding belt or gearing losses—a matter that is involved in some obscurity. For this, as for other purposes, the method has the advantage that the losses in the mechanical transmission of large powers may be tested without the absorption or generation of large power.

But quite apart from the testing of efficiency this method has a good quality of a very solid kind, as it enables large dynamos to be run at full load by small engines. To the manufacturer this is often of great importance. It is necessary or advisable to run machines at or over their full load for a sufficient time to ascertain their mechanical qualities and how much they heat, and so on. And on the principle of Dr. Hopkinson's method small engines may be used, as it is only necessary to circulate the power by placing motors or resistances on the dynamo circuit instead of lamps, and causing these motors to drive back on the engine, countershaft, or dynamo. The engine then has to supply only power sufficient to cover the conversion and transmission losses. I do not think advantage is taken of this as often as it should be.

In the case of dynamotors or of high and low-pressure machines, the method may be applied by coupling the armatures together, high pressure to high pressure, and low pressure to low pressure, and supplying only power to cover the losses. In some cases large direct-current dynamos have been made with two armature windings and two commutators. It will be seen that a complete test may be taken with a single machine of this kind by circulating the power within the machine, adding an E.M.F. sufficient to enable the generator half to force the full current against the E.M.F. of the motor half. The power so added gives the internal losses, and the efficiency is, of course, readily ascertained. A single dynamotor cannot be tested in this way, as the two windings are usually very dissimilar.

So far as I know, the first application of Dr. Hopkinson's method to alternate-current work was by Dr. Sumpner,§ who, some months ago, worked out and published a very interesting plan for testing transformers in pairs by circulating the power. When it is remembered that the full-load efficiency of transformers is something like 96 or 97 per cent., it will not be necessary that I should dwell on the economy of this plan.

Dr. Hopkinson's method may be applied to two alternators coupled mechanically and driven as in his original test of direct-current dynamos. It is, however, much more convenient to be able to run machines singly. The necessary conditions for this are readily realised in an alternator, especially if the armature is stationary; and in this way I wish to show, in the first place, that it is possible to run an alternator under all the essential conditions of full load with only a small absorption of power. This may be done simply by dividing the armature circuit into two portions,

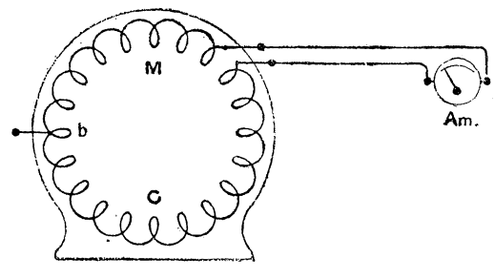

FIG. 1.

and so connecting them together that one has a higher E.M.F. than the other, the stronger portion acting as a generator, absorbing power, and driving the current through the weaker portion, which acts as a motor, returning the power to the generator portion, less the losses. The two portions of the armature may be made of unequal E.M.F. by dividing the armature into unequal portions, as shown by Fig. 1, which represents the armature of an alternator. The coils are joined up so that the portion M is opposed to the portion G. By making G greater than M, and by running with the field magnet excited, any required current may be made to circulate round the whole armature. This current is measured by an ammeter put in at any part of the circuit. The volts of each coil, or the volts across the junction of the portions M and G, may be taken in the usual way. When the full current is circulating, with the full field and full speed, the machine will be working at full load, so far as mechanical strains and electrical losses are concerned, and the power to drive it will be merely that required to make up for the mechanical and electrical losses. The efficiency is then simply found.

Test of an "A 20" 250-Kilowatt Alternator.

The machine was driven by an engine from which indicator diagrams were obtained. It was found that the indicated kilowatts were 3 kilowatts more when excited than when not excited. This is lost in eddies. The armature was then joined up in two portions, as in Fig. 1, and a current of 60·25 amperes circulated, with a potential difference of 1,656 volts across the junction of the two.

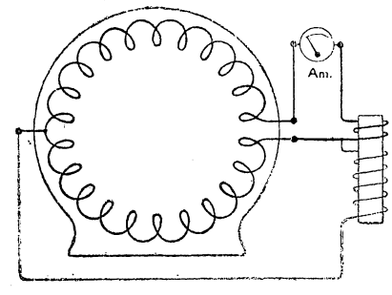

FIG. 2.

This was equivalent, so far as internal losses were concerned, to an output of $1656 \times 60{\cdot}25 \times 2 = 199{\cdot}5$ kilowatts. The power absorbed was 6·37 kilowatts more than when not excited. As the power wasted in eddies was 3 kilowatts, the loss due to the circulation of the current is $6{\cdot}37 - 3 = 3{\cdot}37$ kilowatts. To check this, we may examine the resistance. The armature has a resistance of 0·23 ohms when the two sides are parallel, but as all the coils were in series in this test, the resistance was $0{\cdot}23 \times 4 = 0{\cdot}92$ ohms. We will call this 1 ohm to allow for a slight increase due to heating. The C^2R loss thus would be $60{\cdot}25^2 = 3{\cdot}63$ kilowatts. This is a very fair confirmation. As a matter of opinion, I have very little doubt that the eddies are less under load than on open circuit.

To ascertain the efficiency we have to add the excitation and the friction. The excitation was 1·365 kilowatts. The friction is the

* Paper read before the Institution of Electrical Engineers, February 23, 1893.

† *Phil. Trans.*, 1886, Vol. II., p. 347.

‡ *El. Review*, Vol. XVIII., p. 242.

§ *Electrician*, Vol. XXIX., p. 223, July 1, 1892.

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only quantity not determined, as it could only be obtained as part of the total friction, including engines, ropes, and alternator. But I have put down 3 kilowatts for alternator friction, and this will no doubt be considered fair, as there was scarcely any perceptible warming of the bearings. A good deal of air is moved by the magnet, but we know that in this very little power is spent. The losses are :—

	H.P.	K.W.
Friction	4	3
Excitation	1·83	1·365
C^2 R and eddies	8·54	6·37
Total	14·37	10·735
Output	267·47	199·5

Commercial efficiency—

$$\frac{199\cdot5}{199\cdot5+10\cdot735}=0\cdot9489.$$

The "electrical efficiency"

$$=\frac{3\cdot63+1\cdot365}{199\cdot5+3\cdot63+1\cdot365}=0\cdot9675.$$

In the above I have expressed power in kilowatts instead of horse-power, not merely out of deference to the President, but because almost all the quantities are actually determined and required to be known in kilowatts, and because I think it the most simple and convenient way.

Another way to upset the balance between the two portions of the armature is shown by Fig. 2. The secondary of a transformer is interposed in the armature circuit, the primary of this transformer being connected across the junction of the two portions, or wherever convenient. The two portions of the armature have equal and opposite E.M.F.'s and the transformer secondary provides the E.M.F. necessary to cause the circulation. It is only necessary, as in the first case, to run the machine with a full field to produce in it all the conditions of full load. I have only tried this plan to see that it works, but have not used it for any actual tests. The unbalancing E.M.F. may of course be supplied by another alternator instead of by the machine under test.

In these methods of running and of testing, the power required to drive the alternator has to be supplied and measured mechanically. This may be done by a transmission dynamometer, or by indicator diagrams of the engine. Neither of these methods is quite satisfactory, or quite direct enough. Transmission dynamometers are not always at hand, and, when available, a good deal of careful preliminary work is needed to get accurate results. Indicator diagrams are not very satisfactory. The power which is required to be known may be only a small part of that actually developed, and, especially with large engines running on light load, diagrams are not easily read with any high degree of accuracy. A better plan would be to use an electromoter to drive the alternator, especially if directly coupled so as to avoid the use of belts. The power supplied to the motor may be measured electrically, and the necessary deduction made for the motor.

A direct electrical measurement of the whole of the losses is, however, the only one that can be considered fully satisfactory. One way in which this may be obtained is shown by Fig. 3. This arrangement reduces the power necessary to test a machine at full load to rather more than half the usual amount.

An alternator armature, A′, is divided into two portions, M and G. The machine is run up to synchronism with another alternator, A, which may be of about half the capacity of the machine to be tested. The part M of the machine A′ is then run as a motor, while the part G is used as a generator doing work on an external circuit, R. The belt is thrown off. The machine acts, in short, exactly in the manner of an ordinary direct-current dynamotor. The input and output are measured by wattmeters or otherwise across the respective terminals.

The total losses = input + excitation − output.

The efficiency as a dynamotor $=\dfrac{\text{output}}{\text{input}+\text{excitation}}$.

When the generator portion is working at half the normal output of the alternator, the motor half will be working at a little more than its full load, and the internal losses will be the same as if the machine were working at full output (the only difference being that the friction losses are put in electrically instead of mechanically). The full-load efficiency under these circumstances

$$=\frac{\text{output}\times 2}{\text{input}+\text{output}+\text{excitation}}.$$

It will be noticed that this involves the assumption that the efficiency of the machine as a motor is the same as when used as a generator—an assumption that is fair.

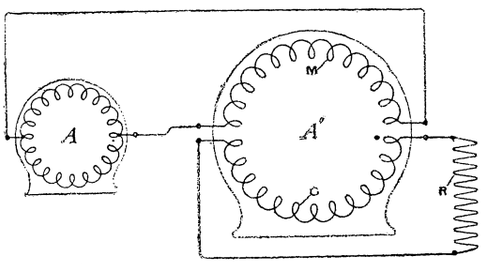

Fig. 3.

Some particulars of a test of an "A 10" 50-kilowatt alternator arranged in the manner shown in Fig. 3 are given below. The machine was separately excited and driven up to synchronism with a 25-kilowatt alternator. One half, M, of the armature was then run as a motor, and readings were taken of the current, volts and watts—the latter by a modified Siemens electro-dynamometer, used as described by Dr. Fleming, and having an added resistance of 1,000 ohms of non-inductive platiniod wire capable of easily carrying a current of 2 amperes. The generator portion, G, was run on a circuit of straight platiniod wire, and the output was measured in amperes and volts. The circuit was one that had been in use for a long time, and had been carefully tested and found to be non-inductive and without sensible capacity. The test of this circuit, as of others in which a similar quality was desired, consisted simply in ascertaining that a given potential difference, whether alternate current or continuous current, gave similar current readings on a Siemens dynamometer. True watts are therefore correctly given by $C'\times V'$. The field was separately excited, and the current and volts measured. Speed was constant at 600 revolutions, = 100 ∿.

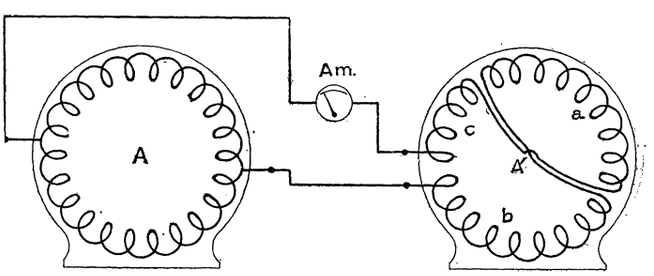

Fig. 4.

Another way, arising naturally out of Fig. 3, is to circulate the power given by the portion G back to the circuit of A to M instead of wasting it on the resistance R. This may be done by putting one winding of a transformer of suitable size in place of the resistance R, and a second winding of the transformer in the circuit between A and M. In order that this should succeed it is necessary that the transformer should be capable of allowing a sufficient current to pass through one winding alone to run the machine as a motor lightly loaded. Then the portion M will be traversed by a current larger than that produced by G, otherwise the machine would not run as a motor.

Test of "A 10" Alternator.

Motor Portion.					Generator Portion.			Excitation.	$W+w$.	Dynamotor Efficiency, $\frac{C'\times V'}{W+w}$	Losses, $W+w-(C'\times V')$	Commercial Efficiency, $\frac{2\,C'\times V'}{W+(C'\times V')+w}$
C.	V.	Watt-meter. W.	C × V.	Power Factor $\frac{W}{C\times V}$	C′.	V′.	C′ × V′.	Watts, w.				
8·023	2,000	15,344	16,046	0·95	6·9	1,960	13,584	420	15,764	0·868	2,180	0·9257
9·278	2,000	17,628	18,556	0·95	8·1	1,950	15,855	427	18,055	0·878	2,200	0·935
10·5	2,000	19,950	21,000	0·95	9·3	1,940	18,102	427	20,380	0·89	2,278	0·941
10·22	2,000	19,418	20,440	0·95	8·6	2,040	17,604	465·9	19,884	0·885	2,280	0·938

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Another way, which has the advantage of being a complete electrical method, is shown by Fig. 4. The armature, A′, of the alternator to be tested is divided into, say, three portions—*a*, *b*, and *c*—which are so joined up that the portions *a* and *b* neutralise one another so far as E.M.F. and power are concerned. Then the machine is run up to synchronism with the generator A, which is made to supply current to A′, and the belt is thrown off. It will be evident that A′ runs as a motor purely by virtue of the power of the portion *c*. The portions *a* and *b* do nothing. If the field of A′ is suitably excited, and the portion *c* is correctly proportioned, the full working current may be forced through the whole armature, and all the internal conditions of full load will be observed, with the exception that the torque will not be in the same sense all round the armature—a matter that does not interfere with the accuracy and value of the test. A single wattmeter reading taken at the terminals will then give the whole of the power expended in the machine, including mechanical and electrical friction and eddies, as well as excitation if the exciter is directly driven.

Other ways of driving the alternator electrically, and of testing it under the conditions of full load, will readily suggest themselves. For instance, a portion of the armature may be separated from the remainder and supplied with power from an external synchronous source sufficient to run the whole machine, and the portion not so used may be used, as in Fig. 1 or Fig. 2, to circulate power within the machine. In such an arrangement, however, the different portions of the armature are not equally loaded. Running at full current and small power may also be done by using simple choking

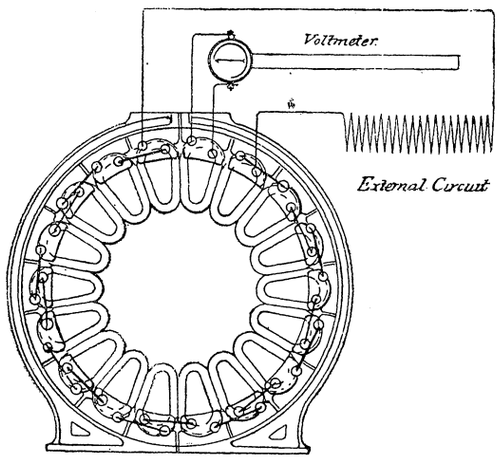

FIG. 5.

coils for the external circuit, but this introduces disturbing influences which make it of very little use. Another way of testing alternators economically may be mentioned. Two years ago* I described an experiment made with one of my alternators, showing that if one coil of the armature is left out of circuit (as shown in Fig. 5), the E.M.F. of that coil remains constant whatever load may be imposed on other portions of the armature, so long as the speed and excitation remain constant. I found also that the true load characteristic for the whole armature might be taken by loading one coil only. This being the case, it follows that an alternator may be fully tested by an engine or motor capable of running only a very small portion of its load. Such a test, although giving all needed electrical information, does not cover the practical considerations that render advisable the long-continued running under the conditions of full load. But it may sometimes prove to be useful. It follows from this that if a portion of the armature be used as a motor, another portion may be loaded as a generator and the full-load characteristic of the machine obtained, while another portion may be run on a voltmeter only and the open-circuit characteristic ascertained. I will not occupy further time by alluding to other modifications of this kind. Those I have described suffice to show how useful results may be obtained.

(To be continued.)

Compound Telephone Wires.—A new kind of telephone wire is being experimented with in Germany, consisting of an aluminium-bronze core with a copper-bronze envelope. It is said to have a low resistance and to have great tensile strength.

* *Journal*, Vol. XX., p. 236, March, 1591.

THE ROTATING ELECTRIC FIELD AND THE ROTATIONS DUE TO ELECTROSTATIC HYSTERESIS.*

BY RICCARDO ARNÓ.

In his well-known researches on "The Electrodynamic Rotations produced by Alternating Currents,"† Prof. Galileo Ferraris demonstrated that by means of two simple alternating currents flowing in fixed coils a rotating magnetic field could be generated, and by means of the resultant induction phenomena, Arago's historic and classic experiment, the rotation of a copper cylinder placed within a magnetic field could be obtained. Moreover, in one of his fundamental experiments Prof. Ferraris showed that an iron cylinder rotates in a rotary magnetic field, even when it is cut in such a way that no Foucault currents are produced. In this case he remarked that the rotation was due to magnetic hysteresis, viz., to the lagging of the magnetisation of the iron behind the rotation of the magnetic field.

My experiments‡, following this line of thought, show that when electric forces are substituted for magnetic forces, and magnetic bodies are replaced by dielectric bodies, phenomena similar to those observed in the case of the cut iron cylinder occur. Even before Mr. Steinmetz's§ experiments on the simple fact that in the dielectric of a condenser, inserted in the circuit of an alternating electromotive force, a consumption of energy takes place which shows itself by the heating of the dielectric, it was already evident that in a dielectric medium under the influence of an alternating electrostatic field electrostatic hysteresis took place, as did magnetic hysteresis, in magnet bodies placed in an alternating magnetic field. It was then easy to predict that a phenomenon similar to the rotation of a cut cylinder of some magnetic material would be obtained with a cylinder of some insulating material placed in a rotating electric field. In this case, also, the rotation of the cylinder should be caused by the lag of the polarisation of the dielectric body behind the rotation of the electric field to which it is due. It was, therefore, natural that, in order to experimentally verify these predictions, I should have recourse to arrangements similar to those used by Prof. Ferraris in his experiments on electro-dynamic rotations. In fact, if at a point O (Fig. 1),

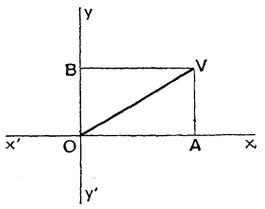

FIG. 1.

instead of two magnetic fields, as in Ferraris' case, two *electric* fields are superimposed in the directions O*x* and O*y*, they will also cause a resultant electric field, whose intensity O V is obtained by composing, as if they were two forces, the intensities O A, O B of the two electric fields, provided, however, that the space occupied by the two fields be filled with a substance whose dielectric constant has the same value at every point. If, moreover, the two electric fields vary according to the sine law, have the same period and a difference of phase, then the point V describes an ellipsis with a centre O, which is reduced to a circle if the amplitudes of the two component fields are equal, and, the directions of the two fields being normal if the angular value of the phase difference amounts to 90deg. In this particular case the resultant electric field has a constant intensity, and its direction revolves with uniform velocity. In the same that the two magnetic fields intended to generate a rotary magnetic field can be obtained by means of two alternating currents traversing two fixed crossed coils, the two electric fields required to produce a rotary electric field can be obtained by means of two alternating potential differences between two couples of fixed metallic crossed segments.

In order to obtain the two potential differences necessary for my experiment, without being obliged to have recourse to a dynamo or a polyphase electrostatic machine, I had recourse to an arrangement like one of those used by Prof. Ferraris in his classical experiments, in which it was necessary to derive from a single circuit the two alternating currents he required for the production of his rotary magnetic field. The arrangement consists in using

* Rendiconti della R. Accademia dei Lincei, Vol. I., 2nd Half-year, 5th Series, No. 8.

† *Comptes Rendus* of the Royal Academy of Sciences of Turin, Vol. XXIII., p. 360.

‡ The research was carried out in the Electrotechnical Laboratory of the R. Museo Industriale Italiano (Turin).

§ See *The Electrician*, Vol. XXVIII., April 8, 1892, p. 602.

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the currents in two branched circuits, in which equal apparent resistances are constituted, in one case by a great ohmic resistance, and the other by a great inductance. The same considerations which hold for two parallel circuits can, in fact, be made to hold for two series circuits; provided the differences of potential at the ends of these circuits be considered, instead of the currents as in the Ferraris method. While in Prof. Ferraris' experiment the main current divides itself into two currents, presenting necessary the difference of phase for the production of the rotary magnetic field, in mine the given difference of potential sub-divides itself in two differences of potential, which are also displaced in phase in the manner required for the generation of a rotary electric field It is needful, however, to remark at once that in this, as well as in the other cases, the required difference of phase can be obtained by means of condensers. Nay more, the employment of condensers, which, in the experiments on rotary magnetic fields is not without practical difficulties, turns out to be very convenient here, where it is a case of very high potentials and very feeble currents, and therefore but little electrostatic capacity is needed.

In Fig. 2 is shown the arrangement of circuits in my experiments. In M a Siemens' low voltage alternator is represented, r is a commercial rheostat, E Siemens' electro-dynamometer, V a Cardew voltmeter; P Q, R S respectively are the primary and secondary wires of a large Ruhmkorff coil deprived of its commutator, and used as a simple transformer intended to produce a considerable difference of potential between the two points R and S. In the secondary circuit are inserted a large ohmic inductionless resistance A B, a condenser C D, the electrostatic capacity of which may be very little. The four points A, B, C, D, are respectively put in communication with four slightly curved vertical copper segments, a, b, c, d, arranged as shown. A mercury commutator I reverses the connections of the two segments c and d, with the points C and D. A Thomson electrostatic voltmeter, not shown on the drawing, serves as a measure of the differences of potentials between A B, and C D. In Fig. 3 we have a perspective drawing of the

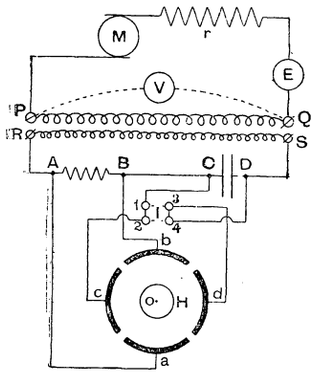

Fig. 2.

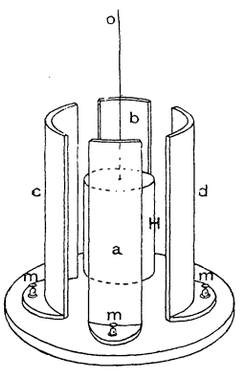

Fig. 3.

arrangement of the four segments a, b, c, d, enclosing the space in which the rotating electric field is to be produced. In order to make the figure clearer the segments are shown much narrower than they really are. The axis of the apparatus is shown at O, and the terminals by means of which the four segments are connected with the points A, B, C, D (Fig. 2) are shown at m.

Once things are thus arranged, it is easy to predict what was actually verified by experiment. In fact, let us consider the secondary circuit of the transformer, comprising the secondary wire R S of the same, the resistance A B and the condenser C D, and let us call i the current in the circuit, V_1 and V_2 respectively the potential differences between the ends of the resistance A B and between the plates of the condenser C D. We know that, while between the current i and the potential difference V_1 there is no difference of phase, the current i is ahead by one quarter of a period of the potential difference V_2. Then V_2 lags a quarter of a period behind V_1. A glance at Fig. 2 is then sufficient to enable us to foresee that the electric field generated by the two differences of potentials V_1 and V_2, in the space enclosed between the four segments a, b, c, d, must turn in the direction of the hands of a watch, when the commutator I is in the position 12, 34, shown in the drawing, and in the opposite direction when the connections of the segments c and d with the points C and D are reversed by means of this commutator. If, however, the resistance A B and the electrostatic capacity of the condenser C D are properly determined, so that, as may always be obtained by trial, the two differences of potential V_1 and V_2, and consequently the mean intensities of the two component electric fields, may be made equal, the resultant field has a constant intensity and revolves at a uniform speed.

In a first experiment I suspended a little hollow mica cylinder, H (Figs. 2 and 3), in the rotary electric field by means of a silk thread. As long as only one of the two pairs of segments, a b and c d, is in communication with the points A B or C D, the little cylinder remains motionless; but when both pairs of segments are respectively in communication with the points A B and C D, the little cylinder immediately begins to turn round its axis and in the direction of the arrow shown in Fig. 2, if the commutator I is in the position 12, 34, which is exactly as was foreseen. If, while the cylinder is spinning in such a direction, the position of the commutator I is reversed, the rotation rapidly ceases and begins in the opposite direction. The experiment was repeated with the same result when the little mica cylinder was replaced by little hollow cylinders of paraffined paper, glass, ebonite, wax, and other insulating substances.

In another experiment I devised a little electrostatic motor, working by means of alternating differences of potential. Fig. 4 is a section normal to the vertical axis of rotation O. The fixed part of the apparatus is constituted by four vertical copper segments, a, b, c, d, like those used in the previous experiments. They are separated, the one from the other, by means of four ebonite strips S, and fixed by screws to an ebonite disc Z. The copper segments and the ebonite strips together form a cylinder 20cm. in height, with an inside diameter of 10cm. The moveable part consists of a hollow closed ebonite cylinder H, which is moveable around its axis O, and supported on two steel points turning in glass holes. The cylinder weighs 40·33 grammes, is 18cm. long, and has an outside diameter of 8cm.

To put the above described little motor in action I arranged the experiment exactly as in Fig. 2, joining the terminals 1 and 1′ (Fig. 4) of the segments a and b with the points A and B, and the terminals 2 and 2′ of the segments c and d with the points C and D. The condenser C D was constituted by a wine-glass 1mm. thick, containing mercury and covered on the outside with tinfoil having a superficial area of about one square decimetre; its electrostatic capacity was therefore very small, about $3 \cdot 10^{-4}$ microfarad. In order to have the resistance A B, which must be very great, free from self-induction, I first had recourse to a little boxwood bar, sufficiently dried, in which, at different distances, little holes containing mercury had been sunk. Afterwards, with much better results, I had recourse to a column of distilled water, 3·5mm. in diameter, the length of which might be varied in order to obtain such conditions of current as would meet the requirements of the best working of the apparatus. The effective alternating current in the primary circuit was

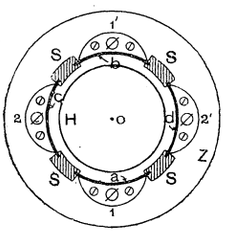

Fig. 4.

seven amperes, the frequency 40, and the effective volts of the primary coil were 27. The experiment showed that the little motor worked best when the effective difference of potential between the points A and B was equal to that between the points C and D. This difference of potential, measured on the Thomson electrostatic voltmeter, was 3,800 volts, and the column of water inserted between A and B, which had in that case a length of 54cm., had, at a temperature of 22·5°C, a resistance of 13·5 megohms. In these conditions the ebonite cylinder started itself and acquired after a few minutes a speed of about 250 revolutions a minute.

In other experiments I also arranged a condenser, made of one or more Leyden jars, in parallel with the secondary coil of the transformer. By so doing I was able to notably increase the difference of potentials between the ends of the resistance A B and between the plates of the condenser C D, so that the strength of the two electric fields was increased, and greater effects could be obtained.

At last, to have an idea of the order of magnitude of the moment of the couples of rotation, I suspended an ebonite cylinder, 139mm. long. and 61mm. outside diameter, in the electric field by a bifilar suspension. A little plane looking-glass attached to the cylinder served to make the angular movement visible. An approximate measure of this angle could also be had by means of an index and a graduated circle. This circle, fixed on the upper ends of the segments a, b, c, d, so as completely to cover the cylinder formed by them, had, at the same time, the effect of eliminating the disturbances produced by air currents. The weight sustained by the bifilar suspension was 23·053 grammes = 22,615 dynes. The distance between the two threads was 4·6 cm.; their length was 155cm.; the deflection 3° 17′. Therefore the moment of the couple was 176 centimetre^2 gramme/second^2.

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The experiments can be used to show in an experimental way the phenomenon of electrostatic hysteresis in dielectric bodies, and to make evident the existence of the difference of phase which can be obtained from two alternating differences of potential of equal period. They offer, moreover, a means of quantitative research on electrostatic hysteresis, and on its influence in the case of various differences of potential and various dielectrics. With this idea in view I am continuing my investigation. Meanwhile I must express my best thanks to Prof. Galileo Ferraris, whose advice assisted me so greatly.

M. JANET'S EXPERIMENTS WITH HIGH-FREQUENCY CURRENTS.*

The interesting experiment of Elihu Thomson, which consists in lighting an incandescent lamp by shunting it with a few turns of copper (Fig. 1) traversed by a high-frequency current, is well known. At the exhibition of the Société de Physique, M. Janet

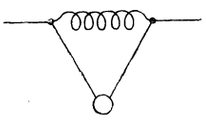

FIG. 1.

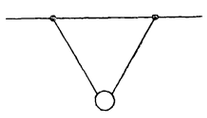

FIG. 2.

repeated this experiment with success, but replaced the spiral by a simple rod of copper (Fig. 2). The phenomenon appeared explicable, as in the case of Elihu Thomson's experiment, either by the self-induction of the rod, or by an actual increase in its resistance. M. Janet has, however, recently shown in a simple manner that the effect should be attributed to mutual induction. He brought one of the wires of the lamp circuit parallel to the principal circuit, as shown in Fig. 3, insulating it by a glass tube ; the lamp

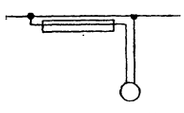

FIG. 3.

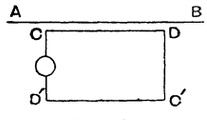

FIG. 4.

went out immediately. If a rectangular C D C' D' is brought up to the rod A B, a lamp in the circuit C D C' D' lights up (Fig. 4). If the circuits are arranged as in (Fig. 5) and a condenser is introduced into the circuit C D C' D', the lamp brightens up if the con-

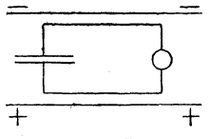

FIG. 5.

conditions are suitable. In fact, if we have a variable inductance in the circuit C D C' D', the capacity being fixed and the inferior to a certain value, the brilliancy of the lamp attains a clearly marked maximum for a certain value of the self-induction. This maximum occurs when the period of the secondary circuit is equal to that of the primary current. On the other hand, if the capacity of the primary circuit is altered, it is found that in order to obtain the maximum brilliancy either the capacity or the self-induction of the secondary circuit must be similarly altered. This circuit, therefore, reassumes for such frequencies its true *role* of resonator of which the experiments of MM. Sarassin and De la Rive have deprived it in the case of Hertzian oscillations. It may probably be concluded that in the case of frequencies such as those employed by Elihu Thomson damping out is much less rapid than for Hertzian oscillations.

THE THEORY OF DIELECTRICS.†

BY A. HESS.

The author presented some results which he had arrived at after an investigation of a particular case of Maxwell's theory of heterogeneous dielectrics.

A dielectric sheet may be compared to two condensers of different specific capacity and resistance arranged in series. Assuming that one of the condensers possesses an infinite resistance, and that the other possesses a certain conductivity, it is found that by charging this system by a constant electromotive force the difference of potential ε between the plates of the insulating condenser increases continuously, whilst the pressure ε' of the conducting condenser passes through a maximum, and finally tends to zero. The result is that the charging current falls but slowly. During discharge through a resistance the variations of the potential differences are reproduced in reverse manner, the conditions being the same ; ε' becomes negative, and passes through a minimum. The sum of the pressures $(\varepsilon+\varepsilon')$ falls very rapidly, so that the discharge current is almost extinguished, whilst in the interior of the system there still exist considerable but mutually equilibrating pressures. Whilst the condenser is insulated ε remains constant, but ε', which is negative, diminishes in absolute value according to the ordinary exponential law. Hence the important consequence that the total pressure increases during rest, and may then give rise to a residual discharge.

The ratio E/I (observed electromotive : charging current) at a given moment is often assumed to represent the insulation resistance. As a matter of fact, this ratio has nothing in common with the insulation resistance, it being infinite in the case under consideration. It has been observed that the insulation diminishes when the temperature rises. This fact is explained by the increase of the charge when the resistance of C', which generally behaves like an electrolyte, diminishes.

Again we represent a dielectric in a more complex manner by adding to the two condensers in cascade a third condenser in parallel. Heterogeneity does not involve a residual discharge where the products of the resistances into the capacities of the various condensers are equal. From this it can be seen that for every mixture of two dielectrics there is a temperature at which the phenomenon of the residual charge disappears.

M. Hess then described an experiment carried out to verify the accuracy of his calculations. He coupled two Carpentier condensers of 0·1 and 0·5 microfarad respectively in series, and shunted the latter by a 100 megohm resistance formed by a pencil mark on a sheet of roughened glass. He thus obtained a system which only charged very slowly, and which furnished after a first instantaneous discharge a large number of residual discharges.

The hydraulic analogue of a condenser was, the authors said, a U-tube, the two legs of which represented the plates, the level of the liquid corresponding to the potential. The author showed a device which rendered possible the production of phenomena analogous to those obtained with two condensers in series. The apparatus consisted of three branches, two of which communicated at the top by a narrow tube, acting as a conductor between the plates of one of the condensers. The system was charged by exerting pressure in one of the extreme branches. The instantaneous discharge corresponded to the instantaneous expulsion of the air when this branch was opened. On insulating the condenser, this branch was closed in the model; on again opening it, there was a fresh expulsion of air. In these various phases the levels of the liquid varied like the potentials in the system of condensers.

THE POSITION OF ALUMINUM.*

The great advance that has been made in the metallurgy of aluminum within the past ten years is one of the most hopeful signs of the application of scientific principles to commercial problems. When one recalls the status of this matter in 1880, when aluminum was but little more than a plaything, and an expensive one at that, and then refers to the present condition of the industry, he is impressed with two considerations. First, that so much has been done to cheapen the processes for the extraction of this metal from its ores, and, second, that in all probability the methods now in use will be discarded before 1900. A great deal of laborious and costly work has been done, and the result is that aluminum can be bought for 50 cents per pound as against $12 in 1886. This is indeed a great achievement, and one of which any man may well be proud. It is often quite as useful to point out the way in which a desired result is *not* to be reached as to show how it may be attained. It is in this direction that a great deal, if not most, of the work that has been done on the commercial extraction of aluminum is valuable. In spite of the wonderful cheapening of the product, in spite of the outlay of hundreds of thousands of dollars, in spite of the beautiful pictures that are held up to view of the future of this magical metal, what have we to show for it all ? So far as concerns the future of aluminum, it may said that unless it can be made in large quantities, just as lead or copper or zinc, it cannot hope to enter as an important factor in the great industries. It must be smelted in large quantities direct from its ores, or obtained as a bye-product in the preparation of some widely consumed substance, ere it will take in trade the position its qualities command.

* From *La Lumière Ele trique.*

† Abstract of a Paper read before the Société Française de Physique.

* From the *Engineering and Mining Journal* of February 4, 1893.

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A great deal of nonsense has been written about aluminum, and a great deal of vital force expended in prophesying its brilliant influence upon civilisation. The truth is that the industry is but little beyond the experimental stage, and may be compared to the manufacture of iron in the days of Tubal-Cain. It is not likely that at the present time the greatest producer of aluminum is making regularly one ton per day, and the total daily output of the world is short of five tons per day, and this result has been reached after a quarter of a century of constant investigation, and at a cost of vast sums of money. It is, nevertheless, a result to be proud of, for it has brought into use, if not on a large commercial scale. at least on an important one, a valuable metal. But we do not think that the further prosecution of electrical methods, by which alone aluminum is now made, will bring the cost of it to the point at which it will become a prominent metal, *unless*, and we desire to lay especial stress on this, they proceed along the line of direct reduction. Even here it is by no means certain that they can make it cheap enough. Aluminum is cheap now compared to the prices of ten, or even five years ago, but the plea we make is that it is not cheap enough. One reason why the prominent metals are cheaper now than they have ever been is because of the immense output, and this in turn is conditioned by modern methods, the use of improved machinery, and better management.

Looking at the matter from a standpoint of practical results and the cost of them it would seem that there is too much reliance placed on electrical methods, whether electrolytic or electro-chemical. It may be urged that inasmuch as by means of electrical methods aluminum has been reduced in price from $12 to 50 cents per pound, and inasmuch as large investments have been made in such plants, it were better to attempt the solution of the problem in this way; that, in fact, more is to be expected from methods that have already done so much than from others that have accomplished nothing. And this is sound reasoning so far as it goes, but it does not go far enough. It proceeds on the assumption that electricity is capable of indefinite cheapening. There is a very inviting field for research here, and one that to the earnest metallurgist is as attractive as the refining of cast iron was to Kelly and Bessemer in the early fifties.

While we would not be understood as condemning the electrical reduction methods, we would encourage those who seek by other means to make cheaper aluminum. Those who have brought the present methods up to their known efficiency are probably best qualified to investigate possibilities that lie in other directions, for they know the commercial limitations affecting the employment of the current for large and regular products, and have the skill and energy and professional training that will be needed. Let us have cheaper aluminum, and after that, perhaps, still cheaper aluminum. Tubal-Cain's furnace did very well for his day and time, but would be now somewhat out of date, not because it could not make good metal, but because it could not make enough of it, or make it cheaply enough.

THE COST OF AN ALTERNATE-CURRENT SUPPLY.

The following figures, taken from the *Elektrotechnisches Echo* of January 7th, will be of interest, the details given being very full. They relate to the Cologne Central Station,* which is in the hands of the Municipality, and are for the half-year, October, 1891, March, 1892.

The station is about a mile and a quarter from the central point of the system, and contains two 400-kilowatt machines and one of 100 kilowatts, driven by horizontal condensing engines, running at 85 revolutions. The alternators have a pressure 2,000 volts at 50 ∿, and run in parallel. The boilers, of the water-tube type, are six in number, and are shared with the waterworks alongside. The concentric cables are laid underground, in wooden troughs filled with asphalte. Transformation is accomplished on the consumer's premises, and the lamps run at 72 volts. The lamps (8 c.p.) connected were 3,776 on October 1, 1891, and 21,414 on March 31, 1892.

The following items are of interest: average burning hours per lamp connected per day 1·93, which, considering that nearly all (85 per cent.) the custom consists of shops, offices, clubs, and restaurants, is very low. The average number of 8 c.p. lamps per consumer is 138. The units generated amounted to 233,712, of which 23,452 were used experimentally. The nett production was therefore 210,260, and the measured and estimated units delivered to consumers were 154,909, which gives losses from every source equivalent to 26·4 per cent. The number of units delivered to paying consumers was 145,483. The amount of coal used was about 600 tons, and coke 540 tons (coal 14s., coke 7s. per ton).

* For description of this station see *The Electrician*, Vol. XXVIII. November 13th, 1891, p. 35.

The following table gives the expenses and receipts per unit delivered to consumer:—

Expenses per B.T.U.	d.	Receipts per B.T.U.	d.
Coal	0·93	Sale of current	9·0
Wages	0·55	Sundry receipts (meters, &c.)	0·72
Upkeep of machines	0·45		
Water	0·145		
Upkeep of transformers and cables	0·27		
Repairs	0·044		
Staff	0·41		
Rents	0·12		
Sundries	0·36		
Total	3·036	Total	9·72

As the interest on capital amounts to 1·94d. per B.T.U., the profit realised is about 4·7d. per unit delivered or a total profit for the half-year of about £3,000.

LONG DISTANCE TELEPHONE LINES AND THE "K R" LAW.

The editorial columns of the *Electrical World* of February 18th contain the following remarks on the above subject:—

In this issue we print part of the inaugural address delivered last month before the institution of Electrical Engineers by Mr. W. H. Preece, the new President of the Institution. In his address Mr. Preece makes some remarks on long distance telephony, with special reference to the New York Chicago line, and goes out of his way to give American telephone engineers a lesson in their own business, which we scarcely think they need or will profit by. Mr. Preece's dogmatic statements on the theory of long distance telephony will probably not arouse much discussion in England, where long distance telephony (as we understand it here) is not, and, from the nature of the case, cannot be. But in this country his statements will not satisfy those familiar with the subject, especially as the figures he quotes in their support are most infelicitously inaccurate. For Mr. Preece with his pet K R in one hand and the £ of the British Treasury in the other, to talk of building telephone circuits with a ton or so of copper to the mile is all very well; but the telephone companies here are expected to earn dividends, and why a 600lb. wire should be used when good results and a safe margin were assured with a 435-pound wire it is difficult to see. The use of a 600-pound wire between New York and Chicago would have increased the cost of the line by nearly $50,000 for copper alone. The fact that good talking is obtained between Boston and Chicago over a line 1,200 miles long is ample proof that the size of wire used was quite large enough. Mr. Preece implies that the talking over the New York-Chicago line is not so good as that over the London-Paris line. There are those in this country who have tried both, and find the transmission on both, practically, equally good. The day that the New York-Chicago line was opened conversation was carried on between the two cities in a whisper without any difficulty whatever.

The formula for telephonic transmission, which Mr. Preece clings to so fondly and calls a law, has never met with general acceptance, nor attained the dignity of being classed with fundamental laws or formulæ from which absolute values can be determined. From the first there have been many who have denied its applicability to the case. It is an empirical formula, deduced from experiments made in the early days of telephony, before the later improvements in apparatus, lines, and methods. Undoubtedly the resistance and capacity of the circuit are factors in considering the limitations of telephonic transmission, but they are not the only ones, and we opine that the real law has yet to be discovered. Mr. Preece laid down in his law that when K R (total capacity × total resistance) reached 15,000, speech was impossible. He says that the law has enabled Paris to talk with London. If it had been applied here in the manner in which it has generally been applied up to the last year or two, it would certainly have prevented New York (to say nothing of Boston) from talking with Chicago. The original method of calculating the K R of a metallic circuit was to multiply total capacity into total resistance and divide by 4, as the capacity of an insulated loop is taken as one-quarter the capacity of the entire length of line measured against the ground. The same result is arrived at by multiplying the total capacity of one wire into its total resistance. Calculated in this way the K R of the London-Paris line is about 7,500, that of the New York-Chicago line about 33,000, and that of the Boston-Chicago line nearly 54,000. Yet New York and Boston talk with Chicago

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practically with the same ease and facility that London has in talking with Paris.

Any faith that might originally have been placed in the K R law has been exploded by Mr. Preece's own modifications of it. It was originally based on Thomson's well-known formula for determining the size of conductor and dielectric of a submarine cable core with relation to the possible speed of signalling. This formula, however, has no bearing on telephonic transmission; as telephonic impulses, even little understood as they yet are, are known to be of a very different character from telegraphic signals. The original method of calculating K R, as we have already said, was to multiply total measured capacity into total measured resistance; and to allow of speech the result had to come well within certain well-defined limits. For a circuit with cables in it Mr. Preece put the limit of K R at 8,000. But when the London-Paris line, with a K R nearly approaching that figure, gave surprisingly good transmission, he saw there was something wrong with the formula. The trouble he found was that in an evenly balanced metallic circuit (especially a twisted one) electro-magnetic inertia might be neglected entirely, and, moreover, a kindly, helpful quality, M, due to extra currents from the high capacity of the submarine cable, came forward to partially eliminate K. Mr. Preece gave M a value of 0·0075 microfarads per mile, subtracted it from K and brought K down at one jump from 0·0156 to 0·0075 microfarads per mile. Since this discovery, which a little over a year ago brought the K R of the London-Paris line down to about 5,000, M has evidently increased, as Mr. Preece now gives 0·005 microfarads per mile for the K of that line. The R meets with no eliminating factor, and the Wheatstone bridge is not to be cheated of its ohms, but Mr. Preece can evidently do what he likes with K, and he places the capacity of the New York-Chicago line at 0·004 microfarads per mile, cuts that in half again, and arrives at a K R of 7,500, "which gives a result that quite accords," &c. That Mr. Preece should say that 0·0158 microfarad is "absurdly high" is rather surprising, in view of the fact that in his Paper on the London-Paris line, read before the British Associationmeeting at Cardiff in August, 1891, he gave a capacity of 0·0156 microfarad for the 400lb. wire from London to Dover. That was, of course, before M emerged from the English Channel and set to work demolishing K. It is worth noting in his Paper Mr. Preece ascribes M to the large capacity of the submaring cable in the middle of the London-Paris line. But in the New York-Chicago line there is only a mile or two of submarine cable, almost all of it at the extreme New York end. Where, then, in this case, where it cuts K down from 0·0156 to 0·004, does M come from? Of course it is very easy to keep a formula or law on its legs by introducing new factors to meet each special case, and this is what Mr. Preece has done. But at the rate he has maintained so far he will soon reach a point where he will to give K a minus value in order to keep K R within his limit, and that would be a *reducio ad absurdum*. Mr. Jacques had adopted the more simple if less scientific plan of multiplying his limit by ten, and now places K R at 45,000 for good transmission with a Hunning transmitter. In this way it will always be easy to keep a little ahead of the longest circuit operated. It is quite evident that K R is not a formula for telephonists to be guided by. The principles underlying telephonic transmission have not yet been the subject of really painstaking original investigation, or at all events no concrete results of such investigation have been published. There is a splendid field here awaiting the discoverer, and doubtless some day the fundamental laws of telephonic tranmission will be given to the world.

The telephone line between Boston and Chicago, which was successfully inaugurated last week, passes through New York, and comprises over two miles of submarine cable and about three miles of underground. The aerial line, slightly over 1,200 miles long, is of No. 8 S,W.G. copper, weighing 435lb. to the mile. The K R, by the old method of calculation, is about 54,000. By the new, we cannot say what it would be; to determine that, it would be necessary to obtain from Mr. Preece the proper value of K, which he would probably place at 0·003 microfarad per mile, or less. The transmission over the line is very good, and at the opening ceremonies even those unaccustomed to frequent use of the telephone were able to talk with Chicago without any difficulty whatever. The New York-Chicago line has several times been used for lecture purposes when it was connected to underground cable circuits several miles long, materially adding to both resistance and capacity, and bringing up the K R accordingly. Yet at these lectures as many as 40 receivers were connected in circuit and as many of the audience were enabled to listen together to speechifying from Chicago. Any metallic circuit subscriber in New York can talk through to Chicago with perfect ease, notwithstanding the length of some of the underground cables. It is worth bearing in mind that in calculating the K R of these lines no account is taken of the capacity and resistance of the switching apparatus at the terminal offices, the strong current protectors, &c. Taking these into account the K R would be considerably increased.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF COMMONS—THURSDAY, MARCH 2.

THE BARRY ISLAND ELECTRIC RAILWAY BILL.

The Court of Referees, Mr. J. Shiress Will, M.P., in the chair, yesterday considered the objection of the promoters of the Barry Railway Bill, whose object is to construct a new dock, railway, tramway, to be worked by electricity, and other works, to the *locus standi* of the National Telephone Company, who petition against the Bill. Mr. Cripps, Q.C., appeared for the promoters, and Mr. Pember, Q.C., for the National Telephone Company.

Mr. PEMBER said the National Telephone Company was carrying on a business all over the kingdom. So delicate were their instruments that they would be liable to interruption if tramway companies, or similar companies, used "earth." The Post Office could tell them that the passing of a train in the electrical subway of the City and South London Railway had absolutely interfered with their instruments as far away as North Walsham in Norfolk. That being so, the Company, as licensees of the Company, were bound to come and protect themselves, and in protecting themselves protect the public, against any attempt on the part of tramway companies to use electrical power without proper precautions not to interfere with these wires.

Mr. CRIPPS: Part of this tramway would be along a public road where there are now National Telephone wires, and my friend is clearly entitled to his *locus* so far, but the rest would be on the private property of the Barry Dock Company, and there we think there should be no restriction.

Mr. CHANDOS LEIGH: We have got several cases of tramways worked by electricity, and the National Telephone Company say it might be ruination to them.

Mr. PEMBER: It is so. I cannot understand how the *locus* is disputed. There is a certain circuit round the Barry Dock, where the property belongs to the Barry Dock Company, but the Telephone Company have numerous exchanges; we lay down our wires on their property under an agreement, no doubt terminable by a certain number of weeks notice and it might be said their interest was a slight one, because they could be turned out of it at so many months notice, but this was no ground of argument.

Mr. CHANDOS LEIGH: I think the *locus* ought to be granted; I feel very strongly about it.

Mr. CRIPPS said that, taking into consideration the strong view expressed, they would not pursue their objection.

The Court thereupon allowed the *locus standi* of the Telephone Company.

LEGAL INTELLIGENCE.

Lang v. House-to-House Electric Light Company (Limited).

This was an action, at the Brompton County Court, arising out of the fatal accident to a labourer, which was referred to in our issue of November, 1892. The plaintiff was the widow of T. Piercy Lang, the labourer who was killed whilst at work on some wires belonging to the House-to-House Electric Light Company, the defendants. The plaintiff claimed £300 damages, and alleged that the cable which the deceased was handling when he met his death was insufficiently insulated.

Mr. Lyndell Bell, in stating the Plaintiff's case, said the deceased was assisting in running a service wire from the main to a house in Roland Gardens. Whilst so engaged his hand came in contact with a "live" wire, the result being death. [Counsel produced a specimen of the cable.] The husband of the Plaintiff was, he said, an ordinary labourer, and had no special knowledge of electricity. There was no doubt, whatever that his death was caused by electric shock, and the question for the jury to consider was whether it was due to any neglect on the part of the Defendant Company. The Plaintiff alleged that the cable was not properly insulated. At the inquest it was proved that some of the indiarubber had been rubbed off, but as the accident occurred after 4 o'clock on a November afternoon, it was quite impossible in the darkness for a man to discover this. The high-pressure system while doubtless more economical was more dangerous. Hence it became not merely a moral but a legal duty on the part of employers to take every possible precaution for the protection of their workmen. In this case, moreover, the poor man had no very clear knowledge, and was nevertheless entrusted with a dangerous task. The answer of the company would include a charge that the man did not obey orders and wear indiarubber gloves when handling the wires.

Mr. W. R. Payne, an employe of the Company up to October last, gave evidence to the effect that leather gloves were provided in June last, but that there was only one pair of rubber gloves available. Mr. E. C. de Segundo gave emphatic evidence as to the danger of allowing men to handle "live" 2,000 volt wires even with rubber gloves on; moreover, he thought that there was no necessity for so doing. The cable in question did not appear to him to be up to the mark, and he was surprised to hear that it had an insulation resistance of 5,000 megohms per mile. He had never had to specify for a 2,000 volt cable. Mr. C. H. Yeaman stated that on no account would he allow a workman at 25s. a week to handle a "live" 2,000 volt wire, though he had done so himself with due precautions. Mr. G. L. Addenbroke was of opinion that it was most dangerous to handle a "live" cable as had been stated. There was no difficulty in avoiding the handling of "live" wires and their handling ought to be avoided. He did not consider the cable in question properly insulated in view of the mechanical strains and atmospheric influences, it was likely to be subjected to.

For the defence Mr. Albert Gay, engineeer and manager to the Company, said the cable was of Silvertown manufacture, it was of the best

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quality and had an extra covering. A letter prohibiting the touching of "live" wires without using rubber gloves was sent to the men whose duty it was to deal with the mains. Gloves had been in use two years. It was entirely inaccurate to say that only one pair was available. He believed there were half a dozen. He himself had worked on "live" cables and made joints with rubber gloves on. Lang was not a mere labourer, he was an assistant joiner. Mr. James Swinburne said that to him the cable seemed well protected. Its makers were of the highest repute. It would be perfectly safe to handle a "live" wire like it with rubber gloves, and it was continually done. No doubt there was some risk; but so there was in most things electrical. The gloves were made for the express purpose, and he himself always used them, as did his assistants. A joint could be made in a "live" wire, but it was not advisable to do it. Mr. H. M. Taylor stated that Lang could make a joint. The joint in question was made shortly after three o'clock. He then put the current on and went away, leaving Young and Lang to finish off. There were two pairs of gloves available at the time he went away. The current was put on about 3:15; the accident took place a little after four. Lang himself saw the joint done and the current put on. David Young gave evidence of Lang's knowledge of jointing, and alleged that Lang on receipt of the circular *re* rubber gloves tore it up and laughed. In cross-examination witness said he could not be positive Lang tore up the circular; it might only have been the envelope. Mr. Bell then pointed out that the Judge held Lang's copy of the circular in his hands. At this stage the Court adjourned until Thursday, March 2nd.

Yesterday (Thursday) the Court was addressed by Mr. Ruegg for the defendant, and Mr. Lynden Bell for the plaintiff. The facts were practically admitted by both sides. Upon these facts Mr. Lynden Bell for the plaintiff argued that there was negligence on the part of the Company, which entitled the widow to recover under the Employers' Liability Act; whilst Mr. Ruegg for the defendants contended that there was no negligence on the part of the Company, but that there was contributory negligence on the part of the man Lang in disregarding instructions given to him.

His HONOUR left the following questions to the jury:—Was there negligence on the part of the defendants or their servants by reason of a dangerous system of working? Did such negligence cause the accident? Was Taylor guilty of negligence in superintending the work in which the man was engaged? Was the man guilty of contributory negligence in not using the gloves? Did such negligence mainly or partly cause the accident?

After a retirement of about an hour the jury returned into Court with the following answers to the questions put to them. To the question as to whether there was negligence on the part of the defendant Company, they answered in the affirmative. To the second question—did such negligence cause the accident?—the answer was Yes. To the question as to Taylor's negligence, No. As to Lang's contributory negligence, they answered affirmatively; and as to whether his negligence mainly or partly caused the accident, they replied, Mainly.

Mr. RUEGG? That is a verdict for the defendants?

His HONOUR: Yes.

Mr. RUEGG applied for costs, urging that the case might go to appeal, and in that event it was necessary that there should be a ruling as to costs.

His HONOUR said the jury had found that there was negligence on the part of the defendants, and he should certainly not allow costs.

Donovan v. The Laing, Wharton and Down Construction Syndicate (Limited).

This was an appeal, heard before the Master of the Rolls and Lords Justices Lindley and Bowen, from a judgment delivered by Mr. Baron Pollock, in opposition to the verdict of the jury. The plaintiff claimed damages for injuries sustained through the negligence of a servant of the defendants, who, whilst in charge of a crane at a wharf, set it in motion before receiving the usual signal, knocking plaintiff down and seriously injuring him. The defence was that the crane-man, although really in the employ of the defendants, was at the time lent to the firm of Jones and Co., whose work it was that was being carried out when the accident happened. The jury gave a verdict for the plaintiff, but the judge, on further consideration, gave judgment for the defendants, on the ground that they were not liable.

The case was argued on Monday and Thursday, and eventually their lordships dismissed the appeal.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Feb.* 17, 1893.

Boston-Chicago Telephone Trunk Wire.—On Tuesday, February 7th, the long-distance telephone line connecting Boston and Chicago was formally opened by the Governor of Massachusetts, the members of his staff, and many other notables, who congratulated their Chicago friends, over 1,200 miles of wire, upon their being at last within speaking distance of the "Hub of the Universe." The success of the line was most marked.

The K R Law.—In view of this recent success, Mr. Preece's remarks in his inaugural address on long-distance telephony (advance sheets of which have just reached this country) have been read with considerable interest, and have received some severe criticism by American telephonists. The *Electrical World*, for instance, devotes more than a column and a-half of its editorial page in discussing Mr. Preece's views on this subject and the K R law, as enunciated by him. It would seem from the reports received in this country of Mr. Preece's remarks, that he was misinformed in regard to the details of the long-distance line between New York and Chicago, and that some of his conclusions were therefore erroneous, and have been flatly contradicted by the results obtained.

The Lamp Question.—The lamp situation remains unchanged, as Judge Colt has not yet rendered a decision in the proceedings instituted by the General Electric Company for a restraining order against the Beacon Vacuum Pump and Electrical Company, of Boston, alleged infringer of its patents. Electricians on your side of the Atlantic, where consolidation of interests have removed the cause for litigation in regard to the incandescent lamp cannot appreciate the intense interest which is aroused in this country by the questions involved; but here it evidently means either the absolute closing up of all but the Edison lamp factories at Harrison, N.J., or the total overthrow of the Edison patent. The testimony introduced by the Defendants, if proved to be true, will be the most remarkable that has ever figured in patent litigation, from the fact that it will show that Heinrich Göebel, an humble watchmaker, anticipated all that is essential of the Edison patent by 30 or more years, and this at a time when the incandescent lamp was impracticable from a commercial standpoint, by reason of the expense of generating the current by the only methods then in vogue. The Westinghouse Company has commenced an attack on the General Electric Company in the courts, and has asked for an order to the General Electric Company to show cause why the Westinghouse "separable" lamp is an infringement of the Edison patents. This is an effort on the part of the Westinghouse Company to compel the General Electric Company either to cease their claims or to prove them. The Westinghouse Company has also applied to the courts for an order to restrain the General Electric Company from bringing suit elsewhere, that is, against the Westinghouse Company's customers, pending the argument upon the order to show cause.

[According to the *Electrical World* of February 25th, a decision was given by Judge Colt on February 18th in the action brought by the General Electric Company against the Beacon Vacuum Pump and Electrical Company, of Boston. The Judge held that it was doubtful if some of the lamps alleged to have been made by Goebel were practical lamps, whilst others enveloped "with a cloud of suspicion the whole Goebel story." The prayer for a temporary suspension of the injunction was not, therefore, granted. Similar actions were to be tried at Chicago on February 20th, and at St. Louis on February 21st.—ED. *E.*]

CORRESPONDENCE.

THE YEAR-BOOK OF SCIENCE FOR 1892.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the review of the above book in your last issue it is complained that "The index is by no means as complete as it should be in a book of reference of this kind. The names of authors or investigators are not given in it; a very serious omission."

In justice to the publishers, who have provided the book with a very copious index of the names of the authors referred to in the book, as well as an index of the subjects treated of, I think this statement should not be allowed to pass uncontradicted. I can only suppose that the reviewer referred only to the list of subjects, and omitted to notice the index to the names of authors which immediately follows it.—Yours, &c.,

H. H. HOFFERT.

20, Hastings-road, Ealing, W., February 25, 1893.

[We regret that the second index was unaccountably overlooked by the reviewer.—ED. *E.*]

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THE KELVIN WATTMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In last week's issue of *The Electrician* you make the suggestion that a transformer might be used with advantage in the shunt-circuit of the Kelvin wattmeter. Without going into the general question of the use of transformers in the fine-wire circuit of wattmeters, it may be pointed out that the advantages in this particular case are by no means obvious. In the first place the current used in the shunt-coil is so small that the making of suitable non-inductive platinoid resistances is a comparatively simple and cheap matter. If a transformer were used it would be still necessary to have a large portion of the resistance in the fine-wire circuit non-inductive, and of platinoid or other alloy with small temperature variation, as otherwise the inductance error and the temperature error would both be serious and would be difficult to estimate.

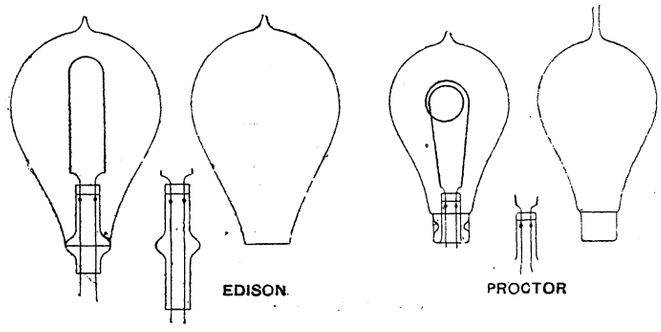
Another difficulty introduced by the use of a transformer would be the difficulty of maintaining insulation due to the large difference of potentials between the fine wire and the main coils. At present one end of the fine wire movable coils is joined directly to the main coils, and the difference of potentials between them is therefore reduced to a minimum. Another point which is apt to be overlooked is the fact that unless the moving parts of an instrument on a high tension circuit are at the same potential as the surrounding metal large errors may be introduced due to electrostatic attraction. In the Kelvin wattmeter it has been found necessary to have the movable coils in direct metallic contact with the scale and supports.—Yours, &c., ANDREW W. MEIKLE.

Cambridge-street, Glasgow, March 1, 1893.

PLATINUM IN THE CONSTRUCTION OF INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I think, in connection with your leaderette concerning the importance of platinum in the construction of incandescence lamps, it may interest your readers to know that about the beginning of 1891 I made several experiments with iron conducting wires for incandescence lamps. It is well known that an enamel can be made, which adheres most firmly to iron pans, &c. I thus hoped, by getting fine iron wires well



enamelled, and then bedded in a glass as nearly approaching the enamel in composition, or by bedding them in a cup-shaped piece of enamel, to which the bulb would be sealed, it might be possible to get a lamp which would maintain a good vacua. I succeeded in making one or two lamps which retained their vacua; but a little consideration of the commercial aspect of the question, which unfortunately is the stumbling block of almost all inventions, soon showed that at the present price of incandescence lamps, if the new lamp gave, say, 10 per cent. more loss by bad vacua and defective lamps, this loss would be more than sufficient to pay for the whole platinum in the lamp as then made.

The copper-tin alloy, which you quote from a German journal, seems to be much the same as Captain Walters' metal, which I have tried but with only very unsatisfactory results.

From the platinum point of view, the Edison American lamp has always seemed to me as nearly perfect as possible; but, unfortunately, the difficulty in making what is technically termed the improved joint (the form of joint by which the stem is joined to the bulb) has been more than sufficient to counteract the economy in platinum, it thus has, to a great extent, been superseded by the late Mr. C. H. Gimingham's lamp, although this contains three or four times as much platinum.

It is often found that this latter lamp, when used in factories where there is much vibration, is liable to shake loose from its support; and in 1891 I was requested to investigate whether it was not possible to alter the lamp in such a manner as to enable the collar to have a better hold on it, with the result that in September, 1891, I registered a lamp which has since been adopted by this Company.

From the enclosed sketches you will see that I have succeeded in so modifying the original Edison form of lamp as to retain the advantage of only requiring a very small amount of platinum, and have adopted a joint between the inner glass stem, and the bulb, which is not only extremely easy to make, but also enables bulbs with a relatively large difference between their coefficients of expansion, and the interior glass stems being used without cracking, a fact which, in many cases, is of great convenience.

I think, considering the very small amount of platinum used in the above lamp, there is very little room for economy unless a substitute is found in every way equal to the platinum.—Yours, &c., C. FARADAY PROCTOR,

Ingénieur et Chef de Fabrication, Cie. Générale des Lampes Incandescentes, (Edison and Swan), Paris.

Rue de l'Orme, Ivry sur Seine, February 25, 1893.

"ELECTRICAL REVIEW" AND "SCIENCE SIFTINGS" DEFENCE FUND.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In view of the litigation now pending between the respective proprietors of the two newspapers, the *Electrical Review* and *Science Siftings*, on the one hand, and C. B. Harness and the Medical Battery Company on the other, arising out of criticisms in these papers on the proceedings of Mr. Harness and the Company before mentioned, there is a widespread feeling in the medical and electrical professions that the proprietors of these papers should receive ample pecuniary assistance in their public-spirited endeavour to have the issues raised fully investigated in the Law Courts, which will necessarily involve a considerable expenditure.

A Committee, consisting of the following gentlemen, has been formed for the purpose of raising a fund for the before-mentioned purposes:—Lord Armstrong, F.R.S., Mr. Latimer Clark, F.R.S., Prof. G. Carey Foster, F.R.S., Dr. John Hopkinson, F.R.S., Prof. G. B. Howes, Mr. W. M. Mordey, Prof. J. Perry, F.R.S., Mr. W. H. Preece, F.R.S., Sir David Salomons, Bart., and Major-General Webber, C.B.

Hon. Trustees, Mr. A. P. Trotter, B.A., 2, Victoria-mansions, 28, Victoria-street, Westminster, S.W.; and Mr. J. H. Thornton, Chartered Accountant, 227, Winchester House, Old Broad-street, E.C.

Hon. Secretary, Mr. James Swinburne, 49, Queen's-road, Wimbledon, S.W.

The issues raised are of the greatest possible importance, both to the public and to the medical profession, involving as they do, the question of the *bonâ*, or *malâ*, *fides* of certain methods of treating disease by electrical or alleged electrical processes, which have been and are now being carrried out and extensively advertised under the auspices of Mr. C. B. Harness and the Company with which he is identified. A preliminary action has already been brought by Dr. Tibbits, at Mr. Harness's expense, against the *Electrical Review* for alleged libel, as he had been strongly censured in that paper for associating himself with the system alluded to. The proprietors of the *Electrical Review* obtained a verdict with costs against Dr. Tibbits, but even if the *Electrical Review* succeeds in recovering the costs from Dr. Tibbits, the costs recoverable will only meet a portion of the expenditure necessarily incurred. It is intended to devote a portion of the amount subscribed to the payment of these expenses, which have been the result of a disinterested—and, so far, a successful—attempt to protect the

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public. The Committee further intend to apply such portions of the amount as they may, in their discretion, consider advisable, to pay, or contribute to the payment of, the expenses which have been, or may be, incurred by the proprietors of the *Electrical Review*, or by those of *Science Siftings*, in connection with this litigation. Any surplus remaining after such payments have been made, may, at the discretion of the Committee, be employed as the Committee may determine in connection with any further proceedings that may be taken in the matter.

It is believed that members of the medical profession especially will be glad of the opportunity of expressing, by a liberal support of the fund, their disapprobation of the view put forward by Dr. Tibbits's counsel, that the article, in censuring Dr. Tibbits's, was, in his person, attacking the medical profession generally. If your numerous readers are willing to subscribe to the fund, and to give it the benefit of their influence and support, they are requested to forward the amount of their subscription by cheque, payable to Mr. James Swinburne (Defence Fund), and crossed London and South-Western Bank, Wimbledon Branch.—Yours, &c.,

JAMES SWINBURNE, Hon. Secretary.

49, Queen's-road, Wimbledon.

GRAPHITE RESISTANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of February 24th you mention as novelties resistances made of plumbago, and mixtures of plumbago and clay. May I draw your attention to the fact that a Paper (notice enclosed) was read before the Ashmolean Society of Oxford, February 11, 1889, on high resistances made of different mixtures of plumbago, carbon, oxide of lead, plaster of Paris, and crucible clay, by Mr. Frederick Smith, M.A., Trinity College. Mr. Smith's earliest resistances were made by compressing the composition in steel split tubes in the hydraulic press. Also a short note on his powder resistances was published in the *Telegraphic Journal* for 1879, page 86.—Yours, &c,

J. M.

A NEW ELECTRIC HORN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In yesterday's *Electrician* I notice an article suggesting that electric bells might be worked from an electric lighting current. In connection with this subject I beg to bring before your notice an "electric horn," with which I have recently carried out a series of experiments, to take the place of electric bells or gongs, &c., where an alternating current of electricity is available. The apparatus is based upon the principle of the telephone receiver, and consists, in its simplest form, of a disc of sheet iron placed in front of one of the poles of an electro-magnet, the coil of the latter being arranged to take an alternating current of 100 volts.

The method of working is as follows:—When the current is switched on the reversals of magnetism produced in the iron core by the current cause a corresponding number of vibrations in the disc. Thus, if a current with 200 alternations per second be employed, the disc gives 200 complete vibrations per second, and produces a note corresponding in pitch with this number of vibrations. With a current of a given number of alternations, the pitch of the note is constant, no matter what the diameter or thickness of the disc, since the latter, in all of these, is obliged to vibrate at the same rate. The timbre and intensity of the sound, however, can be made to vary in a number of ways. In order to obtain an intense sound with a small amount of current, the diaphragm, or disc, must strike, whilst vibrating, the iron core or some other body.

In one form of the apparatus that I have, a sound, loud enough for domestic purposes is obtained with about one ampere of current. It will be observed that in this apparatus there is no break in the current, as occurs in the ordinary electric bell.—Yours, &c.,

A. B. WOAKES.

Harley-street, W., February 25, 1893.

USEFUL FORMULÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the letter you published from me on February 3rd, about the loss of energy in copper conductors, a slip occurred which I hasten to correct. When a current density (amperes per square inch) different from 1,000 is used the result obtained from the rule must be multiplied by the *square* of the current density and divided by the *square* of 1,000.

Let me add another easily remembered fact, which is useful in approximate calculations:—

The double conductor of a light or power circuit at a current density of 1,000 uses up the electric pressure at the rate of 5 volts per 100 yards, or about 90 volts per mile; and the volts used up in the conductor, per 100 yards or per mile, vary directly as the current density.

Yours, &c., GEORGE FORBES.

R.M.S. "Majestic," February 10, 1893.

"THAT BLESSED WORD, 'INSTALLATION'!"

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My first thought on seeing Mr. Selby-Bigge's letter was to make fun of it, but it would perhaps be better to treat his communication seriously; and, as he has "found this much-abused word most useful" at University College, Oxford, I think we ought to petition the authorities for its retention there for Mr. Bigge's sole use and benefit.

A "whole installation consisting of these items [wiring, fittings, lamps, holders, and glass ware] at a fixed price per light" is evidently intended to mean something definite at Oxford; but in other parts of the country the word, which my pen refuses to put on paper except in a quotation, may include all Mr. Bigge's "items" plus underground mains, plus dynamos, plus secondary cells, plus steam-engines and boilers, or turbines or water wheels!

I have known many cases where it was proposed that a "whole installation at a fixed price per light" should consist of wiring only; and, even in these circumstances, I was not satisfied till I had particulars of wires, casings, cut-outs, switches, ceiling plates, and blocks, &c. Sometimes cutting away and making good form no part of the whole ————; and I hope Mr Bigge realises that the word which answers his purpose so well at Oxford has a vagueness about it elsewhere, which his exposition does not help us to get rid of; and, to borrow his words, "I do not know what single word we could have employed" to describe his contribution to the debate!—Yours, &c.,

Twyford, Berks, February 28, 1893. WM. H. MASSEY.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This useful book contains over 1,000 pages, and several new and handy features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

TENDERS INVITED.—Moodie's Gold Mining and Exploration Company (Limited), of Pietermaritzburg, Natal, invite tenders for the supply and erection at Barberton, S. A. R., of plant and machinery for generating and transmitting 250 H.P. by electricity to various sub-companies. Plans can be seen at the various offices of the Company (in London, at 8, Old Jewry, E.C.), and tenders must be sent in to the head office at Pietermaritzburg by noon on May 3rd next, and a duplicate copy lodged with the London office as above. Further particulars will be found in our advertisement columns.

———— Tenders are invited by the Trustees of the Town and Harbour of Whitehaven for the supplying and laying insulated conductors, required in connection with their central electric lighting station. All information can be obtained of Dr. John

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Hopkinson, 5, Victoria-street, Westminster, S.W., and from Mr. John Collins, Secretary to the Trustees to whom tenders must be delivered by 10 a.m. on the 22nd instant. Further particulars appear in our advertisement columns.

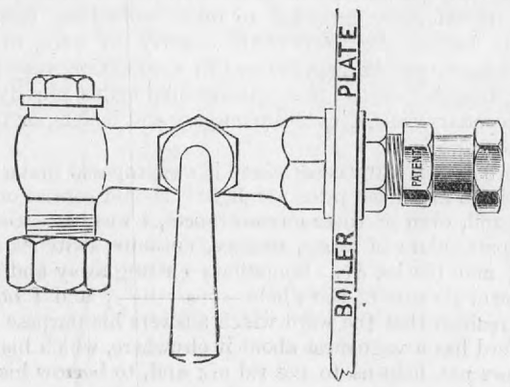
——— It will be seen by our advertisement columns that the Corporation of Dewsbury invite tenders for the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the borough. Tenders are to be delivered at the office of the Town Clerk not later than the 23rd inst.

——— The Wallasey Local Board invite tenders for diverting the route of the telegraph line used in connection with the water-level electrical gauge at the Wallasey Waterworks, and for renewing the wire for a distance of 1,220 yards. Tenders must be in by 5 o'clock on the 14th instant.

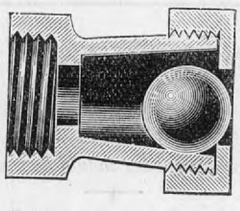
Tenders Accepted.—Messrs. Norman and Son, of Glasgow, have obtained the contract for the electric lighting of the new Glenburn Hydropathy at Craigmore, Buteshire.

Messrs. Crompton and Co.'s Motor Catalogue. — Uniform with their recently issued dynamo catalogue, Messrs. Crompton and Co. have compiled a very useful book of notes, data, and specimen estimates of costs relating to the electric transmission of power. The design of the plant for different purposes and selection of the best size of conductor are discussed in a very practical and business-like manner, and examples showing the effect of different sizes of conductors on the loss in the line, and on the cost of the plant are very clearly compared.

Automatic Water-Gauge Stopper.—Mr. James Baldwin, of Keighley, has introduced an automatic valve which may be fitted inside the boiler to any water gauge. Should the water gauge glass inadvertently burst, or the gauges themselves by any means be broken off, the escape of steam and water is at once stopped by the



safety automatic stopper, thus preventing the engineer and stoker from being seriously injured, and the immediate blowing down of the boiler and consequent loss. When the glass breaks the escape



of steam and water is instantly stopped, and after the taps are closed and the gauge glass refixed, the automatic stopper, not being perfectly steam and water tight, the consequent small leakage causes an equal pressure on each side of the balls, and they then roll back to their former position automatically.

Messrs. Rashleigh, Phipps and Co. (102, Oxford-street, W.).—This firm have recently secured contracts for a number of lighting installations, including the new works at Canning Town of the Lamson Paragon Paper Supply Company (complete plant), Messrs. Mooney and Co.'s new depôt at 19, High Holborn, W.C.; W. G. Curryer's boot depôt, 69, Oxford-street, W.; the new depôt for Messrs. Hudson Brothers, 40, High-street, Kensington; Mr. L. S. Myers, 5, Grafton-street; Dr. Luff, 31, Weymouth-street; Dr. Hutchinson, 1, Park-crescent; Dr. Dolamore, 37, Queen Anne-street; Dr. W. Adams Frost, 17, Queen Anne-streeet; and for new batteries at Messrs. Marshall and Snelgrove's large premises in Oxford-street, to supply additional lighting. Additional City work includes the Buenos Ayres Great Southern Railway Company, 6 and 7, Finsbury-circus, and Messrs. Shepheards, 31 and 32, Finsbury circus.

Messrs. Ernest Scott and Mountain (Limited).—This firm inform us that they have obtained the contract for the electric lighting of Craig House, Edinburgh, which is described as one of the largest private lunatic asylums in the kingdom. The firm also report sustained activity in their electrical department, a number of important contracts having recently been secured.

Lamp-Holders.—Messrs. Henry F. Shippey and Co. notify that they are in a position to supply some well-known types of lamp-holders to Continental and other users (where patent rights do not apply) at much under ordinary prices. Further particulars are given in our advertisement pages.

Revolving Sprinkler.—Messrs. Edwards Brothers' patent automatic revolving sprinkler, with elastic compensating valve, was shown in the library of the Royal Institution on Friday last. This fire extinguishing apparatus depends upon the action of fusible metal and a rubber valve, and seems to present several advantages.

Britannia Company.—This Company are introducing a new speciality in radial drills, illustrated particulars of which can be obtained on request.

Messrs. Swinburne and Co.'s Catalogue.—We have received a catalogue and price list of Messrs. Swinburne and Co.'s manufactures which now include both dynamos and alternators. We note that the latter are "wound for 100 volts and 100 P. P. S." Messrs. Swinburne and Co. evidently avoid the symbol ∿ lest it might be imagined that they are offering Mordey machines. While not abating in any degree their advocacy of Hedgehog transformers, backed up as they are by a sheet of testimonials giving unqualified approval of them, a "Cylinder" transformer has been brought out to meet the requirements of those who prefer closed-circuit transformers. It is claimed that the weight of each type is very small. Wattmeters with ebonite bodies, electrostatic voltmeters, central-station voltmeters, and numerous laboratory instruments, are described. Amongst these is an electrostatic voltmeter, or watt-meter, which is said to read to half a volt in 2,000, the Bourne galvanometer, switch resistance box, and cable-testing plant. A 120-kilowatt set of the latter, capable of testing cable up to 40,000 volts, has been supplied by Messrs. Swinburne and Co. to the Silvertown works.

Calendar.—The Postal Telegraph Cable Company, of New York, whose service is in connection with the Commercial Company's cables, send us a hanging pad calendar for 1893, giving a map outline sketch of the Company's system throughout the States.

Aberdeen.—The Town Council have approved the plans of the new buildings for the central station, to be erected in Cotton-street, adjoining the gas works. The buildings will cost about £3,500.

Batavia Exhibition.—We learn that British electrical firms are holding aloof from this exhibition; it may be because exhibitions have been somewhat overdone. It is, however, regrettable to learn that the exhibition at Batavia is likely to prove an exclusively German advertising medium. German electrical firms offer to supply the electric lighting plant, and to provide sufficient petroleum motors to drive the whole of the machinery at the exhibition. Should the exhibition ultimately prove a profitable medium for the introduction of German goods, British manufacturers will have, of course, themselves only to blame. Plans of the exhibition, grounds, and buildings, and all available particulars can be obtained of Messrs. J. Birch and Co., 10 and 11, Queen-street Place, London, E.C. Some particulars of the scope of the exhibition, and exhibits likely to prove acceptable, we gave on page 490 of our last issue. Group XV., Class 3, is for electrical machinery and motors, dynamos, lamps, electric tramways, lighting apparatus, telephone and telegraph materials, bells, and accessories.

Bombay.—The Government Dockyard has recently been lighted by electricity, under the supervision of Mr. G. F. Mackrow, of the Royal Indian Marine. The generating plant consists of two Siemens dynamos, driven by a Marshall 32-H.P. engine, and the installation includes 64 L31 type E.P.S. accumulators. The fittings and accessories have been arranged by Mr. H. Gill, electrician to the Dockyard authorities, and the light has proved a complete success. A 7,000-c.p. lamp, fixed 70ft. from the ground, will also be erected at the head of the Duncan Dock as soon as the works at the dock are completed.

Bournemouth.—A tender has been received by the Town Council from Messrs. Goddard, Massey, Warner and Co., for the additional works required for the electric lighting of the pier and gardens, the tender amounting to £1,453. 10s. The Financial Committee of the Council recommended the postponement of the question of supplying 70 lamps for the inside of the pier shelters, but recommended that the extra-sized mains necessary to carry the current should be provided at a cost of £178, that the necessary mains for lighting the fountains be supplied at a cost of £184, that two dynamos be supplied at a cost of £161, and that a lamp be

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provided for the pier at a cost of £12. 10s. A member of the Council having complained that the electric lighting expenses were becoming excessive, the Mayor reminded him that £4,000 was the original estimate, and that up to the present, although additional work had been approved, only £3,600 had been ordered to be expended. The recommendations of the Committee were approved.

BRISTOL.—The Electrical Committee of the Town Council on Friday last, in conformity with the powers conferred upon them by the Local Government Board, decided upon borrowing £16,000 for electric lighting purposes at 3½ per cent.

CAGLIARI.—At the last meeting of the Cagliari Gas and Water Company the Chairman, Mr. John Aird, M.P., stated that they had authorised their manager in Sardinia to endeavour to make arrangements with the authorities for dealing with the matter of the electric light.

CARDIFF.—A deputation, consisting of the Mayor of Cardiff, Alderman Jacobs, and Mr. Harpur, borough engineer, have waited upon the Local Government Board for the purpose of inviting the Board to hold an inquiry in Cardiff, with the object of authorising the Corporation to borrow the necessary money to carry out their electric lighting scheme. It is most probable that the Great Western Railway Company will give the Corporation facilities for sidings into their Central Station at the works at Canton Common.

DUNDEE.—The Corporation's central station was illuminated for the first time on Wednesday last week by the electric light, and the effect is represented to have been excellent. The light was supplied from the battery installation which has been put down.

FARNWORTH.—On Saturday last the extensive premises of the Farnworth and Cursley Industrial Societies in the Market-street, Farnworth, were lighted by electricity. Messrs. Royce and Co. supplied and erected the plant for the installation, which comprises a Royce compound-wound dynamo and Marshall engine and boiler, On the occasion of the inauguration a variety of cooking and heating appliances were shown and, as usual, created considerable interest.

HULL.—It is in contemplation to considerably extend the electric lighting installation which the Corporation have recently inaugurated, as the demand for the light has considerably exceeded expectations. New mains will shortly be laid on the west side of the Whitefriargate Bridge, in order to supply the light over a considerably extended area. A report, prepared by Mr. F. Harman Lewis, the borough electrical engineer, estimating that the extensions would cost between £9,000 and £10,000, has been, after discussion, approved, and power has been given to the Chairman of the Lighting Committee and the Borough Electrical Engineer in future to dispose, without consultation with the Board, of all applications for the light within a distance of 60 feet from the main distributors.

HUNTLY.—The Board of Commissioners have been in negotiation for the purchase of the rights of the gas company, but there is a general feeling that it would be an unwise step for the Commissioners to become owners of the Company's rights, seeing that electric lighting is making such rapid progress. At the last meeting of the Board it was decided to leave the matter over for further consideration at a future date.

ISLINGTON.—The Vestry at their last meeting adopted the report of the Special Lighting Committee recommending the Vestry to decline to give its consent to the promotion of the Islington Electric Lighting Order (1893) by the County of London Electric Lighting Company (Limited), and also against the promotion of the St. Mary, Islington (North), Electricity Supply Order (1893) by the Holloway Electricity Supply Company (Limited).

KENSINGTON.—The Highways Committee have reported upon the Hammersmith electric lighting scheme promoted by the local authorities, and state that they have submitted some few amendments to the Board of Trade. It is proposed to except Hammersmith Bridge from the area of supply. In reference to the proposed transfer of powers possessed by the Chelsea Electricity Supply Company, under their South Kensington Electric Lighting Order of 1889, to the Kensington and Knightsbridge Company, the Committe propose to insist upon provision being made that the Chelsea Company shall not have power under their transfer scheme to break up the roads to obtain access to their transformer station at Egerton-gardens-mews; and the Committee further propose to insert a clause with this object in the transfer arrangements. The London County Council have ordered a petition to be presented against the Bill. The proposal by the Kensington and Knightsbridge Company for an extension of mains has received sanction.

LECTURES.—Lectures on electricity and its various applications have recently been delivered by Dr. Joseph M'Grath at Dublin, Rev. A. C. Henderson, at Dundee, Mr. S. Vyle at Nottingham, Mr. C. P. Goode at Buxton, Mr. F. G. Baily at University College, Liverpool, and Mr. T. C. Fulton at Glasgow.

LEGAL.—An action was brought on Friday last at the Clerkenwell County Court against Messrs. H. and J. Read and J. Bailey, amusement contractors at the Agricultural Hall, Islington, N., for £15. 14s, for 31 weeks' hire of 100 yards of electric cable. The case was chiefly interesting from the fact that the plaintiff, a Mr. Trickett, had entered into an arrangement with the Agricultural Hall Company, the particulars of which are shown in the plaintiff's evidence, which was to the effect that from November, 1890, to August, 1891, he had the sole right of fitting electric light at the Agricultural Hall, and he supplied exhibitors at the several exhibitions held there during that time. In December, 1890, he lent the defendants some electric light cable for six weeks, during the run of the World's Fair. He charged them 10s. a week, and that sum they paid. In May, 1891, the Military Tournament was held, and he was engaged in fitting up electric light for exhibitors. He had not sufficient cable, and borrowed some from the defendants. At the end of seven weeks he returned the cable, a sum of £3. 10s. being due to defendants for the loan. He was unable to pay that, and still owed Messrs. Read and Bailey £2. 6s. When the World's Fair was over the defendants did not return his cable, although he applied for it, and they still had it. The judge ordered the return of the cable, and allowed the plaintiff £2. 6s. damages, to be paid over to the defendants. We have frequently alluded to the meagre character of the electrical installations at the Agricultural Hall, where many favourable opportunities present themselves for creditable electrical work being done; but the nature of such work can scarcely be wondered at when primitive arrangements like those disclosed in the proceedings in this action are entered into by a wealthy corporation like the Agricultural Hall Company (Limited).

ROTHERHAM.—A resolution is to be proposed at the next meeting of the Town Council that a special committee be appointed to inquire into and report upon the cost of the electric lighting plant, a suitable site for a lighting station, the probable revenue, and to obtain information likely to assist the Council in deciding whether it is advisable to instal the electric light in the borough.

SHOREDITCH.—The Select Committee of the Shoreditch Vestry have reported upon the advisability of obtaining a site in Pitfield-street, Hoxton, for the combined purposes of an electric lighting station, baths and wash-houses, technical schools, and free library. It is stated that the entire scheme will necessitate an expenditure of more than £34,000. The matter will be discussed at the next meeting of the vestry.

SOUTHAMPTON.—The Free Libraries Committee presented their report at the last meeting of the Town Council, and strongly recommended that the public library be lighted by electricity in accordance with the report prepared by Mr. J. G. W. Aldridge, and that application be made to the Local Government Board for sanction to borrow £400 for this purpose. The report was adopted.——The Harbour Board have accepted a tender from Messrs. Statter and Co. for £25, for giving additional width to the culverts for the electric mains, enabling the mains to be used for lighting purposes if required. It was also decided to light the clock at the pier entrance by electricity.——We understand that it has been decided to light the whole of the Southampton Docks with electricity, and that strenuous efforts are being made to complete a portion of the installation by to-morrow, to celebrate the arrival of the "New York," the first vessel of the new American mail service. The outside lights are to be arc lamps on poles about 55ft. high, and incandescents will be used for the interior lighting. The generating station (which is now practically complete) is on the dock premises. The electric light is to be extended to the new baggage station and refrigerator vaults.

THEATRE LIGHTING.—Messrs. T. L. Hemming and Co. have obtained a contract for the electric lighting of the Queen's Theatre, Snow Hill, Birmingham, which, when completed, will, it is represented, be one of the largest electric lighting installations in the Midlands.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 18, 1893.

2,977. J. BUCHANAN. Basingstoke. Electric communications with light ships and other vessels.

2,992. A. GASCOINE. London. Improvements in bearings for shafts or axles more especially adapted for dynamo electric machines, electric motors, pulley blocks, and similar apparatus.

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February 11, 1893.

3,053. F. W. GOLBY. London. Electric light display system. (Daniel McFarlan Moore, United States.)*

3,071. AUTOMATIC ELECTRIC RAILWAY SIGNAL COMPANY and E. BLAKEY. London. Improvements in or connected with automatic electric signalling on railways.

3,073. M. KOTYRA and W. MOSELEY. London. Improvements in telephones and telephonic and telegraphic relays.

3,092. L. A. HINDLEY. London. Improvements in electric arc lamps

3,101. C. W. JEFFERSON. London. Improvements in armature insulators.

3,118. H. EDMUNDS. London. Improvements in electrical conductors.

3,119. H. EDMUNDS. London. Improvements in the formation of solid ends on flexible or compound electrical conductors.

February 13, 1893.

3,146. G. L. ANDERS and W. KOTTGEN. London. Improvements in dia phragms for telephones.

3,152. E. BEAL. Manchester. An improved electrical pendulum indicator.

3,200. P. R. SCHOMBURG. London. Improvements in fixing electric conducting wires to the insulators supporting same.*

3,210. S. W. MAQUAY. London. Improvements in primary batteries and and in miners' and like portable lamps.

February 14, 1893.

3,225. A. MARR. Manchester. Improvements in and relating to telephonic transmitters.

3,274. W. C. JOHNSON and S. E. PHILLIPS. London. Improvements in electrical transformers and in boxes or casings therefor.

3,278. E. BERRY and F. HARRISON. London. Improvements in electric lanterns and reflectors therefor.

3,285. F. H. CLARKE. London. Improvements in electric signals.*

February 15, 1893.

3,346. F. BROWN. Walsall. Improvements in the application of electric motors for driving sewing and other light machinery.

3,376. J. S. FAIRFAX. London. Improvements in direct current dynamo machines.

3,387. J. R. QUAIN. London. Improvements relating to the utilization of electricity for heating purposes and to apparatus therefor.

3,398. A. GÉNTZCH, J. GOLDSCHMIDT and E. R. VON SCANARI. London. An improved insulating material for electrical purposes and method of preparing same.

3,402. W. CLARK. London. Improvements in electric meters. (Firm of Hartman and Braun, Germany.)

3,412. A. MUIRHEAD and H. A. C. SAUNDERS. London. Improved means for transmitting telegraphic signals through submarine and like cables.

3,413. A. MUIRHEAD and R. H. EDGAR. London. Improvements in recording instruments for electric telegraphs.

February 16, 1893.

3,470. J. A. KINGDON. London. Improvements in electromotors and dynamos.

3,477. H. NEHMER. London. Improvements in constructing and connecting galvanic elements.

3,488. Sir C. S. FORBES, Bart. London. Improvements in telephones.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1891.

18,646. CHITTY. Electric motors, &c.

1892.

1,880. WOAKES. Electrical sound producing apparatus.

4,779. RATHBONE and HOUGHTON. Electric arc lamps.

5,161. VOST and FISHER. Telephone cabinet.

5,526. SIEMENS BROS. AND CO. (Limited) and BAILY. Producing electric flashes.

6,253. CHURCHILL. Electric railways and tramcars.

9,496. FORBES. Telephones.

12,468. EDMONDSON and OULTON. Electricity meters.

22,308. APPLEGATE. Incandescent electric lamps.

23,232. JOHNSON (MICHEL). Secondary batteries.

23,809. HOTCHKISS. Elevated railway systems.

310. ANDREWS. Electric conductors.

4,068. BOOTH AND FALCONER. Telephones.

4,147. KOHLER. Sewing machines.

4,158. EDMUNDS. Electric circuits.

4,258. SPENCE. Dynamo-electric machinery.

6,405. URQUHART and SMALL. Secondary voltaic batteries.

15,933. EDMONDSON. Printing designs on textile fabrics.

18,807. ANDREOLI. Secondary batteries.

23,409. WASHBURN. Storage batteries.

23,421. MILLS (Hutchinson). Incandescent electric lamps.

23,919. CRANEY. Electrolytic apparatus.

23,967. LAKE (Coerper). Electric arc lamps.

COMPANIES' MEETINGS & REPORTS.

Telegraph Construction and Maintenance Company (Limited).

The twenty-ninth ordinary general meeting of the members of the Telegraph Construction and Maintenance Company (Limited) was held at the offices of the Company, 38, Old Broad-street, on Tuesday, February 28th, Sir George Elliot, Bart., presiding.

The MANAGING DIRECTOR (Mr. Wm. Shuter) read the notice convening the meeting and the minutes of the previous meetings, the latter being confirmed and signed by the Chairman as correct.

The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN said: Gentlemen, I am not going to make a long story. I never do at these meetings. I dare say that that part of the report which deals with the reduction of dividend, which we have been able to pay with unusual regularity for many years, has most attracted the attention of some of the shareholders. But while we sympathise with you in these circumstances, there is nothing, I think, to cause surprise or uneasiness. It is mainly due to the exceptional year which we have passed through with regard to cable operations, no large works having been undertaken. It is also in part due to a falling off in our general business. The cause of both, I think, is not far to seek, that is to say, the general depression which has affected trade in all its branches, from the highest to the lowest, but which there is no reason to believe, so far as we are able to judge, will be of a permanent character. There is work on hand at present, and we hope that there is some in prospect during the year. For this the Company has considerable stocks laid in. We have taken advantage of the comparatively slack time to introduce improvements into our plant and appliances at both our factories, all tending to increase their capacity for work, and in the direction of economical expenditure. I now beg to move:

"*That the report and accounts of the Directors to December 31, 1892, submitted to this meeting be, and the same are hereby, received and adopted, and that a dividend of 24s. per share, in addition to the 12s. a share interest or interim dividend, paid to June 30, 1892, be paid on all the shares of the Company, such dividend to be paid free of income tax.*"

Mr. G. W. CAMPBELL seconded the motion, which was carried unanimously, and without discussion.

The CHAIRMAN proposed, and Admiral Sir GEORGE RICHARDS seconded, the re-election of the retiring Directors, Mr. James Pender and Sir Robert G. W. Herbert.

The motion was agreed to *nem. con.*

Mr. GIBSON proposed, and Mr. CROFT seconded, the re-appointment of the auditors, Messrs. John Gane and P. A. Glegg.

The motion was carried unanimously.

Mr. GIBSON proposed, and Sir HENRY GOOCH, Bart., seconded, a vote of thanks to the Chairman, the other Directors, and the officers of the Company.

The vote having been cordially passed, the CHAIRMAN expressed his acknowledgement, and the proceedings ended.

Chelsea Electricity Supply Company (Limited).

The annual ordinary general meeting of this Company was held yesterday at their Central Station, Draycott-place, S.W., Mr. J. Irving Courtenay in the chair.

The SECRETARY (Mr. S. J. Cluer) having read the notice convening the meeting,

The CHAIRMAN said: Before moving the adoption of the report and accounts, I will direct your attention to some points that seem to me worthy of special consideration, and will say a few words on the general position of the Company. The net revenue for the year, after deducting debenture interest, is £1,336. 2s. 7d., out of which it is proposed to pay a dividend on the ordinary shares of 2½ per cent. This is not a large dividend, but it is in addition to the payment of a heavy debenture interest, and may be taken as an earnest of the future. You are aware that a considerable portion of the Company's capital is in the form of debentures. I will point out here that the net profits in 1891 were only 7½ per cent. of the gross, but in 1892 the net profits were 31 per cent. of the gross. The improvement in the Company's position, which we looked forward to, has to some extent been attained, and you will observe that the gross revenue approximates to the estimate I gave last year. The substantial progress made each year in the profits is shown by the fact that the debenture interest provided for in the last three years was in 1890 £530, in 1891 £1,206, and in 1892 £1,843, in addition to the net profit just mentioned. You will notice that as our capital expenditure has increased so also have our profits increased in a much larger proportion. The increase in capital expenditure is moderate in comparison with the figure it may reach before we arrive at the limit of profitable investment in Chelsea. The capital expenditure equals £2. 6s. 6d. per lamp installed, which will compare favourably with the capital outlay of any other electric lighting company. We have increased our lamps during last year without any large extension of the mains, and the percentage of increase in revenue has been nearly as large as the increase in the number of lamps. The other items in which the capital has been laid out have entirely justified the expenditure by the benefit already reaped, and we have the best reasons for expecting a still larger return on this expenditure during the current year. Besides some extension in mains,

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the enlargement of existing mains, and the necessary addition to our stock of meters we have added to our plant two boilers and a pair of feed-water heaters: we built an extra bunker for the storing of coal; also an additional exit from the engine-room in case of accident, and made some additions and alterations to all the boilers which have been productive of large economy in working. We have enlarged the building of our Clabon Mews Sub-station and placed there an additional continuous-current transformer. These transformers were supplied by the Electric Construction Corporation (Limited), and have continued to work in an eminently satisfactory manner. They are used in addition to the accumulator plant and not in substitution for it, and we have found the combination entirely fulfil the expectations formed at the time of the original design of the system by Mr. Frank King, a system which enables us to afford our customers a regularity of supply of a quality nowhere surpassed. The plant has all been maintained in a thorough condition; indeed, the nature of the business is such that were this not done the supply could not be kept up. The storage batteries are in excellent condition, and the mains of Callender's bitumen cable have stood the test of now nearly four years underground, the insulation being still quite satisfactory. On a former occasion when I addressed you I alluded to the heavy consumption of coal, and stated that it was not due, in my opinion, to any fault of the Chelsea system. The words I then used are now being justified. The Directors have continued to give unremitting attention to this point, and have succeeded, with the able assistance of Mr. Frank King, who has been appointed Managing Engineer, in tracing the cause and remedying the defects in the plant. Some of the improvements suggested and carried out by Mr. King were not completed very early in the year 1892, and we are therefore warranted in looking for better results at the end of this year. With the experience gained we do not doubt that further economies can be made, As you will have seen in the report of the Directors, the amount paid for coal in 1892 is 9½ per cent. less than that paid in 1891, although the amount of electricity sold is 23 per cent. more in 1892 than in the previous year. Not only has there been a saving in coal but there has been greater economy all along the line. The cost of coal, water, and engine-room stores, taken together, has been 1d. less per unit of electricity sold, and the total cost of the unit, including all general charges, has been 1½d. per unit less than in 1891. You will expect to hear something from me regarding the decision in the law courts on the three-wire system. In Chelsea our supply is on two wires only, and in the small portion of South Kensington served by this Company the system is such that it is our belief that we cannot be brought under the operation of Mr. Hopkinson's patent. The proposed transfer of the Kensington portion of our area was the cause of the extraordinary general meeting held on the 14th ult., when the policy of the Directors in regard to that matter was unanimously approved. I wish it to be distinctly understood that this transaction is strictly limited to the small portion of our area at Kensington, and does not in any way deal with the Chelsea district. As stated at that meeting, the Directors consider that the transfer will be beneficial to both Companies, owing to the position of the two generating stations relatively to the area. The price agreed upon is a fair one, and the capital thus set free will be of material assistance in extensions in our Chelsea area, so as to cope with the demands arising in the immediate future. The prospects of the Company are now better than ever, both as regards profits and increase of business. The district in which our mains are laid is rapidly filling up with customers, and no one when once supplied by our system cares to discontinue its use. Close around us new houses are everywhere being built, and in many of them no provision is made for gas, such is the confidence earned by careful attention to the quality of the supply. Presidents who have tried several systems say that none is better than that of our Company. You will thus see that we cannot stand still, but must be always moving forward, using strict economy as to the direction in which capital is spent, and continuing to make such additions and improvements in plant as will ensure the largest saving in the every day work of supply. We have a good future before us if we succeed in making judicious use of our opportunities, and I hope that our endeavours will meet with cordial support from our shareholders. I now beg to move—

"*That the report of the Directors and the statement of accounts to March 31, 1892, now before the meeting, be and they are hereby adopted, and that the payment of a dividend for the year 1892 at the rate of 2½ per cent per annum on the ordinary share capital of the Company be and is hereby approved, to be made payable on April 16th.*"

The DEPUTY-CHAIRMAN (Major-General Webber, C.B.) seconded the motion, remarking that he fully endorsed all that the Ohairman had said with reference to what had occurred during the past year, and to the improvements which had been made in the Company's system. These improvements had been the growth of previous years' experience, and had fully come up to their expectations; and he believed they would answer those expectations in the future even to a greater degree than the Chairman had ventured to foretell.

The CHAIRMAN expressed his readiness to answer any questions; but none being put, he submitted the resolution in the usual manner, and it was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. JILLINGS, the retiring Directors, Sir George Prescott, Bart., and Mr. Emile Garcke, were re-elected, as were also the auditors, Messrs. Cooper, Brothers and Co.

An extraordinary general meeting was held subsequently to consider the confirmation of the subjoined resolution, which was passed at the extraordinary general meeting on the 14th ult.:—

"*That the Bill proposed to be introduced in Parliament in the ensuing session, and now laid before this meeting, intituled 'A Bill for confirming an agreement for the transfer to the Kensington and Knightsbridge Electric Lighting Company (Limited) of the undertaking of the Chelsea Electricity Supply Company (Limited), authorised by the South Kensington Electric Lighting Order, 1889,' be, and the same is hereby approved, subject to all such additions, alterations, and variations as Parliament may think fit to make therein.*"

The CHAIRMAN said he did not intend to trouble them with any further remarks on the resolution, having spoken on the subject at the meeting on the 14th ult., and having already made some observations on it at their first meeting that day. He, therefore, formally moved the confirmation of the resolution.

Sir GEORGE PRESCOTT, Bart., seconded the motion, which was unanimously adopted.

A vote of thanks to the Chairman and Directors was then passed, after which the meeting separated.

Liverpool Electric Supply Company (Limited).

The tenth annual ordinary general meeting of the shareholders of this Company was held on Friday in the Exchange-buildings, Tithebarn-street, Mr. A. H. Holme presiding.

In proposing the adoption of the Directors' report (which appears below), the CHAIRMAN said: Gentlemen, you will see from the report that the business of the Company has very largely increased, the number of lamps we are supplying at present being 20,254, as against 14,966 last year, which I am sure it must be a source of satisfaction to you to know, more especially as with the increase of business we are able to give you an increased dividend. We have, of course, to provide for other things out of our gross profit, and we have written off £4,099 for depreciation, and placed £2,000 to the renewal fund, and this leaves us, after adding the balance brought forward, with £11,421. 19s. 11d. We propose out of this sum to pay a dividend at the rate of 5 per cent. per annum, which will take £8,621, to add £1,500 to the reserve fund, and to carry forward £1,300 to next year's account. We think that is as much as we can prudently afford, and we think we have allowed quite margin enough for all contingencies, and that is an honest dividend on the face of it, and not an extravagant one. We do not propose to give you sensational dividends, but a steady dividend, and not to have to go back to 3 or 4 per cent. Looking at the accounts, you may think, probably, that the amount put to depreciation for buildings is a small one—only £160—but we have kept the buildings in thorough repair; they are just as good for the purpose of this Company as they were when they were erected, and we think there is quite sufficient written off, though I may say that under this head, since the commencement of the Company, there has been £2,000 written off. With regard to the mains, some gentlemen, who ought to know better, seem to think that electricity passing through them has the effect of depreciating the copper, but as a matter of fact the mains are practically immortal. The copper always maintains its value as copper, and though repairs are necessary to the covering of the mains, the amount we have written off for depreciation quite covers the repairs to be done each year, and I think the sum we have written off for mains and machinery—£3,868—is really quite enough for that purpose. We propose, with your consent, to pay an interim dividend. There is no reason why we should keep it till this time next year, and probably we shall pay it about September in each year. Then we come to the question of expenditure on capital account—what we propose to do to meet the proposed extension and to obtain the money we want for improvements. We are in such a condition now that it is absolutely necessary, with the demands made upon us by the public, which demands under penalty we are obliged to satisfy, that we should have additional mains, additional machinery, and more powerful engines. and larger dynamos. During last year our expenditure on capital account was £34,786, and was made up of three great items. First, as to the additional mains in our extended area. We have gone on in the direction of Abercromby-square as far as Prince's Park, and up to Falkner-square and London-road. We have spent this money in additional mains for that area, and replacing some small engines by more powerful ones, and in building a new station at Lark-lane. I think the expenditure has been justified; we were obliged to incur this, and we shall be obliged to incur more. We are looking forward, as you see by the report, to raising a further sum of £100,000; but we do not intend to raise it all at once, and the amount we shall raise will be ample with the uncalled money we have to last us for three or four years, as far as we can tell. We do not call up this £100,000 all at once, but we intend to issue 5,000 shares, which will bring in £25,000 which will certainly last till the end of this year. These shares we propose ts issue to our present shareholders; we propose to issue them in ordinary shares, and we shall ask for 10s. or £1 on application, and the rest in a month. Referring to the Sefton Park Station, that is a little thing in the way of an experiment, but we were very much besieged with requests from the inhabitants of Sefton Park and the neighbourhood, and so, after consideration, we secured a piece of land, built our station, and it is practically now at work. I may say that I do not think the Sefton Park Station will pay us any considerable dividend for this year, but I certainly think it will pay its working expenses, and afterwards become a very profitable station when the people have got accustomed to it. After alluding to former difficulties raised by the local authorities, which had now been overcome, the Chairman said they would be able to supply the light more cheaply when the lamp patents expired, and they were able to introduce a new lamp just invented.

The motion for the adoption of the report having been seconded, the CHAIRMAN replied to a few questions from shareholders, and called upon

Mr. A. B. HOLMES, the managing engineer, who said that the price the Company charged last year was regulated by a sliding scale, which averaged about 8d. per unit. That was the same for a large consumer as a small consumer, and the only difficulty about it was that no one understood it.

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The consequence was that the time of his staff was taken up in explanations. They therefore came to the conclusion that they would adopt the simple scale of the gas company, and this, far from being a disadvantage to the consumers, had considerably reduced the Company's receipts. As far as he knew there were only two cases of people giving up the light on account of the new scale. With regard to the reduction in price, they would not be able to lessen the cost of production, but if they could get a lamp which would give them the same light at two-thirds the amount of electricity, the consumer would benefit, and the Company would have to recoup themselves in increased business. One probable source of revenue in the future was in the supply of small power. They were already supplying some people with 30 horse power, and there were others who would doubtless find that with limited space this was the best motive power they could use. Then they had 15 or 20 ventilating fans, which were giving great satisfaction, and he thought they would be able to use electricity for hoists and other work, because in all cases where the power required was intermittent, electricity could beat either steam or water.

The report and statement of accounts were then adopted, and the CHAIRMAN moved the payment of a dividend of 5 per cent. per annum, free of income-tax, and said that this would be paid in a week, which was carried.

Mr. Banner and Sir D. Radcliffe were re-elected to the directorate, and Mr. W. L. Jackson was reappointed auditor, and the remuneration of the Directors was fixed at 750 guineas.

This concluded the business of the ordinary meeting, and an extraordinary general meeting was at once formed, and the following resolutions formally agreed to :—

"*That the capital of the Company be increased to £300,000 by the addition thereto of 20,000 shares of £5 each.*"

"*That provisions of the Forged Transfers Acts, 1891 and 1892, be and are hereby adopted by and made applicable to this Company, and that compensation be made out of the funds of the Company for any loss arising from the transfer of any share or security of the Company in pursuance of a forged transfer, or of a transfer under a forged power of attorney.*"

A vote of thanks to the chairman brought the proceedings to a conclusion.

The report of the Directors referred to above was as follows :—" In presenting their tenth annual statement of accounts the Directors are glad to be able to report a steady increase in the demand for electric light, the number of lamps connected with the Company's mains on December 31, 1892, being equivalent to 20,254 16-c.p. lamps, as against 14,966 on December 31, 1891. The amount to the credit of profit and loss account is £11,421. 19s. 11d., which includes the balance brought forward from last year, and £627. 18s. 8d. received as interest on shares, paid up in advance of calls, to entitle them to rank for dividend as from January 1, 1892. The Directors recommend the payment of a dividend at the rate of 5 per cent. per annum, free of income-tax, absorbing £8,621, the addition of £1,500 to reserve fund, and to carry the balance, £1,300, forward to next year's account. The Directors propose in future, provided the results of the business continue to justify this course, to pay interim dividends about September 1st each year. The expenditure on capital account during the year, including a proportionate charge for general expenses, has been £34,786. 19s. 7d. To deal with the increase of the Company's business, the Directors ask the authority of the shareholders to increase the nominal capital of the Company by the addition of £100,000, making the total nominal capital £300,000. It is only proposed at present to issue 5,000 shares, which will be offered to the shareholders for subscription shortly after the general meeting. During the year Parliament has confirmed the Provisional Order referred to in the last annual report, under which the date for compulsory purchase of the Company's undertaking, authorised by the Provisional Order of 1889, is postponed from 21 to 42 years, the Corporation having the option of taking over the Company's supply business in the City of Liverpool, as a going concern, after December 31, 1897, at a price to be fixed by arbitration. During the year a new supply station has been established in Lark Lane for the Sefton Park district. It was intended to open this station in December last, but unexpected difficulties have arisen which have delayed the laying of the mains ; it is, however, anticipated that these difficulties will shortly be satisfactorily settled."

Birmingham Electric Supply Company (Limited).

The following is the report of the Directors to be submitted to the shareholders at the ordinary general meeting of the Company, to be held at the offices, 14, Dale End, Birmingham, on Thursday next, March 9th, at twelve o'clock :—

The amount of net profit, including the balance of £361. 19s. 9d, carried forward last year, is £3,850. 2s. 7d, ; out of this the Directors recommend the payment of a dividend of 3½ per cent., absorbing £2,056. 11s. 11d., placing £1,279. 9s. to the credit of depreciation-reserve fund, and a further sum of £250 towards a general reserve fund, and carrying forward the balance £264. 1s. 8d. to next year's account. The capital expenditure during the year amounts to £9,868. 3s. 2d., and includes the complete equipment of the present boiler house by the addition of three new boilers, the provision of two further engines and dynamos, and the extension of the Company's services.

The total number of 16-c.p. lamps, or their equivalent, on order on December 31, 1891, was 5,480, and on the same date in 1892 the number was 8,329. The demand for the light still continues to increase, and the additions since the close of the financial year bring the total number up to 9,142.

Your Directors are pleased to be able to report that since the last meeting the balance of shares alluded to in last report has been issued, the cost of such issue, £184. 12s., being added to preliminary expenses.

The frequent application for the light outside the Company's area induced the Board last year to look in what direction it might be advisable to extend the Company's system, and after careful consideration it was resolved to take the preliminary steps necessary to obtain Parliamentary powers over the district of Edgbaston, and what is known as the Jewellers' Quarter. Accordingly a deputation of the Board approached the Corporation in order to obtain their assent to these extensions. For reasons, however, with which your Board did not agree, the Corporation desired that the application should be postponed for a year ; but having regard to the uniformly courteous consideration extended by the Corporation and its officials to the Company, it was decided not then to press the matter. Your Board, however, feel that the claims of the public and interest of the shareholders alike demand that the question should not be further delayed, and at the proper time steps necessary to renew the application during the current year will be taken.

Two Directors, Mr. Geo. S. Albright and Mr. F. W. V. Mitchell, retire, and being eligible offer themselves for re-election. The auditors, Messrs. Sharp, Parsons, and Co., also retire, and being eligible offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

BIRMINGHAM STAMPING COMPANY (LIMITED).—This Company has been registered with a capital of £9,000 in £1 shares, to carry on the business of metal stampers, press tool makers, art metal workers, &c., at Pentonville-road, London, N.

COMMELIN ET CIE.—A Company with this title has been formed in France, with offices and works at Argenteuil, for the purpose of supplying electric light and power in that town, and for exploiting a new cadmium accumulator and a new electric meter. The capital of the Company is 450,000 francs.

COMPAGNIE FRANCAISE DU BI-METAL.—A Company with this title has been formed at Paris to take over from a Company in liquidation the patent rights granted to E. Martin for bi-metallic wires and the works for their manufacture. The capital is 1,300,000 francs.

DAFEN TIN-PLATE COMPANY (LIMITED).—This Company has been registered with a capital of £25,000 in £50 shares, to manufacture and deal in iron, steel, tin, terne and black plates, and to carry on the business of smelters, steel converters, suppliers of electricity, chemical manufacturers, &c.

LILLY AND LILLY (LIMITED).—This Company has been registered, with a capital of £10,000 in £20 shares, to carry on the business (*inter alia*) of electrical engineers and contractors.

LONDON AND LANCASHIRE ELECTRIC AND GENERAL ENGINEERING COMPANY (LIMITED).—This Company was registered on February 27th, with a capital of £20,000 in £5 shares, The objects are to take over the business of electrical engineers now carried on by William Robert Pryke and William Palmer, together with any patents, licenses, trade secrets, &c., to contract for public and private lighting by electricity, magnetism, or other agency, to supply electricity and magnetism, for the production or transmission of power for locomotive or other other purposes, and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, and of manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation, and utilisation of electricity. The subscribers, with one share each, are :—William R. Pryke, William Palmer, Frederick J. Hodgson, J. Cameron Walker, William E. C. Pinchbeck, Francis A. Franklyn, and John A. Hadley.

MAZARRON ELECTRIC LIGHT COMPANY (LIMITED).—This Company was registered on February 27th, with a capital of £15,000, in 10 000 ordinary shares of £1 each and 500 £8 per Cent. Cumulative Preference shares of £10 each. The objects are to establish electric lighting in the town of Mazarron in the Province of Murcia, Spain, or elsewhere ; to acquire a concession, dated September 6th last, granted to Mr. Santiago Olivera y Bazterrica, of Mazarron ; to produce electricity and electric power ; to store, distribute, and supply light or power generated by electricity ; and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, and manufacturers of, and dealers in, all apparatus and things required for, or capable of being used in connection with, the generation, distribution, supply, accumulation, or employment of electricity. The first Directors are Walter B. Kingsford and Stanley W. Richard.

G. T. TONKS AND CO. (LIMITED).—This Company was registered on February 22nd, 1893, with a capital of £2,000, in £1 shares, to acquire, take over as a going concern and carry on the business of a brass founder, gas

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and electric light fittings manufacturer and general metal works, carried on by George T. Tonks, Rea-street, Birmingham.

AUTOMATIC ELECTRIC RAILWAY SIGNAL COMPANY (LIMITED).—By recent agreements the above-named Company acquired from Reginald B. Annesley, George R. Leyland, Walter Emmott, and Robert W. Brown, certain patents for automatic electric railway signalling recently belonging to the Automatic Electric Railway Signalling Company (Limited) now in liquidation, the patents being granted for Great Britain and Ireland, Argentine Republic, New Zealand, Victoria, South Australia, India, and New South Wales, also certain signalling apparatus now on the premises of the Freshwater, Yarmouth and Newport Railway Company in the Isle of Wight, and other plant, for £3,400, payable £100 in cash and £3,300 by the allotment of 3,300 fully paid shares of £1 each.

BLAKEY, EMMOTT AND CO. (LIMITED).—At a meeting of this Company, held at Leeds on the 23rd ult., it was resolved that the Company be voluntarily wound up, and that Mr. James Lakeman, of 30, St. Swithin's-lane, London, E.C., and Bond-street, Leeds, was appointed liquidator.

COUNTY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to November 28th, has been filed; 200 shares out of a total of £100,000 in £5 shares have been taken up. £2 per share called, and all calls (£400) paid.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The annual return of the above-named Company, made up to February 10, 1893, has been filed. Out of a nominal capital of £1,300,000, divided into 65,000 shares of £20 each, 60,710 shares have been taken up; all fully paid.

ELECTRIC WELDING COMPANY (LIMITED).—The annual return of this Company, made up to January 3rd, has been filed. The Company was registered on May 1, 1890, with a capital of £460,000, divided into 45,000 ordinary and 1,000 founders' shares of £10 each. By agreements with the Thomson European Electric Welding Company of Boston, U.S.A., and the Thomson Electric Welding Company of Boston, U.S.A., this Company acquired the British patents and the machinery, designs, &c., of the Boston companies for £212,000, payable £128,670 in cash, and the remaining £83,330 by the allotment of 8,333 fully-paid ordinary shares. At the time of making up 25,000 ordinary and 947 founders' shares were taken up, of which 8,333 ordinary shares were issued as fully paid. Upon the remaining 16,667 ordinary shares a call of £6 per share has been made, while the full amount has been called on each of the founders' shares. The calls received amount to £114,934, and those unpaid are estimated at £61,206, which includes the amount on the ordinary shares as yet uncalled. 1,960 ordinary and 365 founders' shares are held by the City of London Contract Corporation (Limited).

EPSTEIN ELECTRIC ACCUMULATOR COMPANY (LIMITED). — The annual return of this Company made up to January 6th has been filed. Out of a nominal capital of £101,000 divided into 1,000 founders' and 100,000 ordinary shares of £1 each. All the founders' and 70,207 ordinary shares have been taken up. Of these shares the founders' and 70,009 ordinary shares have been issued as fully-paid, while 5s. per share has been called and paid on the remaining 200 ordinary shares.

EUROPEAN SIMS-EDISON ELECTRICAL TORPEDO COMPANY (LT'D.).—The annual return of this Company, made up to January 5th, has been filed. The nominal capital is £201,000, divided into 10,000 ordinary shares of £20 each, and 1,000 founders' shares of £1 each; 7,880 ordinary and 849 founders' shares have been taken up, and 7,350 ordinary shares have been issued as fully paid. Upon the remaining 530 ordinary shares and the founders' shares the full amounts have been called, resulting in the payment of £9,909, and leaving £1,542 in arrears.

GULCHER (NEW) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to January 5th, has been filed. The nominal capital is £70,000, divided into 20,000 ordinary and 50,000 preference shares of £1 each, and at the time of making up, all the shares were taken up, the ordinary shares being issued as fully paid. Upon 12,277 preference the full amount has been called, while upon the remaining 37,723 preference shares 15s. per share has been called. The calls paid amount to £43,344. 1s. 4d. (which includes certain sums paid in advance of calls), while £1,057. 10s. is, as yet, unpaid.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended February 26th were £943, as against £834 for the corresponding period of last year, being an increase of £109. The total receipts for half-year amount to £7,743, against £6,739 in the corresponding period of 1892, being an increase of £1,004.

COMPAGNIE HYDRO-ELECTRIQUE (ANTWERP).—M. Mourlon has been appointed manager of this Company in the place of the late M. Van Rysselberghe.

CROYDON TRAMWAYS COMPANY.—At the ordinary general meeting of this Company, which was held on the 23rd ult., Mr. W. J. Carruthers-Wain (the Chairman) said that the Directors continued to receive a variety of offers with regard to the putting upon the Company's line of various sorts of mechanical traction, electrical and otherwise. The line was very favourably situated for demonstrations of that kind, but the Board were not going to allow their lines to be experimented upon without making agreements which should, at any rate, be in their favour.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of February were £3,700, as compared with £3,643 in the corresponding month of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of February amounted to £55,281 and to £58,284 in the corresponding period of 1892.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of February, 1893, amounted to £39,533, and to £39,002 in the corresponding period of 1892, or an increase of £531.

ELMORE'S FRENCH COPPER DEPOSITING COMPANY (LIMITED).—Sir Thomas Farrer, Mr. W. Saunders, M.P., and Mr. Samuel Storey, M.P., have addressed a circular to the shareholders in this Company, in which they state that the pressing applications they, in common with other shareholders, have received for assistance point to the urgent necessity for an immediate, impartial, and independent examination into the financial position of the Company. To make the inquiry effective, expert assistance would be necessary, and they think if an accountant and an electrician were appointed to assist them they would, in a few days, probably obtain all the information required. If the proposal for this investigation is favourably received, a meeting of the shareholders will be held, at which all shareholders agreeing to the proposal must either personally or by representative attend. To defray the cost of the meeting and other expenses a contribution of one penny per share is to be levied, and the whole expense is limited to £100. Mr. J. A. Robertson, C.A., of the firm of Messrs. Good, Son, and Co., 57, Moorgate-street, E.C., and Mr. A. Le Neve Foster, electrical engineer, of 61, Cadogan-square, S.W., are the gentlemen whom it is suggested to appoint, and who will proceed to Dives to examine the Company's works and report upon their capacity and upon the cost of production of the Elmore specialities. The circular further states that Major Jones (the present Chairman of the Company) and Mr. F. L. Rawson have agreed, on behalf of the Board of Directors, to facilitate the inquiry. Mr. W. J. Burnside, of 171, Queen Victoria-street, E.C., acts as secretary in the matter.

GENERAL HYDRAULIC POWER COMPANY (LIMITED).—Speaking at the annual meeting of this Company, on Wednesday, Mr. Henry Chapman, C.E., said: I dare say many of you have considered a powerful competitor in the shape of electricity. It has not affected us much. We still find that, compared with steam, compressed air, and even electricity, we compete with the best and safest power yet known for lifting, pressing, elevators, cranes, and all intermittent power. We cannot say we have arrived at finality, but I believe we are within measurable distance of supplying electricity through our power—that is to say, of using hydraulic power for driving dynamos. It is all a question of finding an economical motor. A company in Antwerp has been formed, and has obtained a concession for supplying the electric light to that city, driving the dynamos by high pressure hydraulic power—the same as ours. We therefore, rather hope we shall be able to do the same here, and we are now giving the matter our most serious attention. We shall start on a small scale. We have had one machine working satisfactorily for some years, and we shall extend it now if we can see our way to do so profitably to the Company.

GREAT NORTHERN TELEGRAPH COMPANY.—A list is issued of the drawing of 100 debentures (1883 series "B") of £100 each, which will be paid off by Messrs. C. J. Hambro and Son, 70, Old Broad-street, E.C., on presentation. Interest on these bonds has ceased.

KESWICK ELECTRIC LIGHT COMPANY (LIMITED).—The annual report of the Directors of this Company has been issued, and the Directors recommend a dividend of 2 per cent. A new boiler and apparatus has been provided for the station, which accounts for an increase in working expenses amounting to £966. During the year an additional 150 lights have been added to the Company's supply.

LIBIOLA COPPER COMPANY.—At the meeting of this Company on Monday last Mr. K. H. James, the chairman, in the course of his remarks, alluded to the immense increase in the use of copper in the United States, and attributed this to the enormous development that has taken place in electric lighting in that country. In 1890 only 85,000 tons of copper had been consumed, whereas in 1892 118,500 tons had been used in the United States, which represented about two-fifths of the entire copper production of the world. Doubtless America had arrived at the turning point in her copper production, which had increased in the past ten years from 41,000 tons to 150,000 tons, whereas the supply of copper from all other countries was practically stationary. He anticipated that the price of copper during the current year was practically fixed, and that but trifling fluctuations would be witnessed.

SANITAS COMPANY (LIMITED).—The sixteenth ordinary general meeting of this Company was held on Tuesday last, under the presidency of Mr. F. N. L. R. Moll. The Chairman announced that the sales effected during the past year showed the very satisfactory increase of 28 per cent. over 1891, resulting a credit to revenue (after deducting income-tax and adding the amount brought forward) of £10,056. 7s. 6d. An addition was made to the reserve fund of 2½ per cent. on the paid-up capital, and a dividend making, with an interim, a total distribution of 15 per cent. for the year.

SOCIETE PIEMONTAISE D'ELECTRICITE.—This Company was formed in 1890 for the purpose of taking over from the Società Generale par l'Illuminazione di Roma the electric light central station at Turin. These works cost 2,700,000 lire to erect and equip, and were acquired by the Turin

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Company for 1,850,000 lire. That the change of ownership has been successful is shown by the results of the last four years' workings, the balance-sheet for 1889 showing a loss of 11,269 lire, whilst those for 1890, 1891, and 1892 show profits respectively of 52,985, 103,000, and 122,189 lire.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended February 24, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,232.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 22.	Price Wednesday, Mar. 1.	Rate per Cent. Yielded.	Dividend Due.	Business done during week ending Mar. 1. Highest	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	17/6	Anglo-American	53½ 54½	53½ 54½	4 11 9	Jan., Apr., July, Oct.	53¾	..
£2,876,140	Stock	35/0	Do. Preferred	94⅛ 95⅛	94⅛ 95⅛	5 9 11	" "	9[illegible]	94½
£2,876,140	Stock	5/0	Do. Deferred	13¼ 13¾	13½ 14	..	" "	13[illegible]	13⅛
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July ..	10[illegible]	..
130,000	£10	3/0	Brazilian Submarine	11½ 12	12 12½	5 4 0	Mar., June, Oct., Dec.	12[illegible]	12
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	104 108	105 109	4 11 9	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175 180	175 180	3 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine xd	12 13	11½ 12⅜	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10% xd	18 19	17½ 18½	5 8 1	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2½ 3½	4 11 5	April and October..	2[illegible]	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅜ 12	11⅜ 12	5 16 8	Jan., Apr., July, Oct.	12	11[illegible]
400,000	10	2/6	Eastern	14⅞ 15½	14⅞ 15⅛	4 5 11	" "	15[illegible]	14[illegible]
70,000	10	6%	Do. 6 per Cent. Preference	15¾ 16	15⅜ 15¾	3 13 10	" "	15[illegible]	15[illegible]
£1,394,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	112 115	113 116	3 9 0	May and November	114¾	114
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15½ 15⅝	15½ 15⅝	4 10 4	Jan., Apr., July, Oct.	15[illegible]	15[illegible]
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	110 113	110 113	3 10 10	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103 106	103 106	4 14 4	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102 105	102 105	4 15 3	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101 104	101 104	3 16 11	February & August	..	..
180,227	10	1/3	Globe Telegraph and Trust	9⅝ 9¾	9⅝ 9¾	5 1 4	Jan., Apr., July, Oct.	9[illegible]	9[illegible]
180,042	10	6%	Do. 6 per Cent. Preference	15¼ 15⅝	15¼ 15⅝	3 17 5	" "	15[illegible]	15[illegible]
150,000	10	5/0	Great Northern	19 19⅛	19 19⅛	4 7 8	Jan., April, and July	..	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883 xd	105 108	104 107	4 13 6	March & September	107½	..
17,000	25	12/6	Indo-European	43 45	43 45	5 11 1	May and November	..	..
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures xd	108 111	105 108	5 11 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7½ 8½	4 14 1	April and October..	7[illegible]	..
3,381	£100 Cert.	30 0	Submarine Cables Trust 6%	118 123	118 123	4 17 7	" "	120	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures xd	102 105	100 103	4 17 1	March & September	..	..
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	103 107	104 108	7 8 2	June and December	..	..
88,321	10	6d.	West India and Panama	1½ 1¾	1½ 1¾	..	" "	1[illegible]	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½ 11	10¾ 11½	5 6 8	May and November	11[illegible]	10[illegible]
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9 10	9 10	6 0 0	" "	..	..
£30,000	100	5%	Do. 5 per Cent. Debentures, 1917	106 109	107 110	4 10 11	June and December	109½	..
64,242	15	3/0	Western and Brazilian	7¾ 8¼	7¾ 8¼	5 9 1	" "	8	..
33,129	7½	3,0	Do 5 per Cent. Cumulative Preferred	5¾ 6¼	5¾ 6¼	6 0 1	" "	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾ 2¼	2 2¼	..	" "	..	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	105 108	5 11 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	105 108	5 11 1	" "	106	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds xd	103 106	101 104	5 15 5	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	..	..	..	..
22[illegible],000	14/0	1½d.	Consolidated Telephone Const. & Maintenance	[illegible]	[illegible]	7 16 5	May and November	..	..
220,000	£1	4⅝d.	Oriental (11s. paid)	[illegible]	[illegible]	7 18 2	Yearly	..	..
454,747	5	2/6	National	5¼ 5½	5¼ 5⅝	5 11 7	June and December	5⅜	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½ 15½	14½ 15½	3 17 6	" "	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13¾ 14½	13⅜ 14½	4 4 3	" "	14½	..
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	4⅜ 4⅝	4⅜ 4⅝	..	..	4[illegible]	4½
726 477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	113 116	1 3 116	3 17 7	January and July ..	114⅝	114
48,000	£10	..	New Telephone, Limited (£4 paid)	.. ..	.. ..	..	..	..	..
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	12½ 13	12¼ 13	..	..	13	12⅝
20,000	£10	..	Do. 6 per Cent. Preference	8¼ 8½	8¼ 8⅝	2 18 2	..	8⅝	8⅝
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	.. ..	.. ..	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	.. ..	.. ..	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	.. ..	.. ..	..	January and July ..	..	..
90,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	4¼ 4½	4¼ 4½	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5⅝ 6	5⅝ 6	..	March	..	..
111,000	5	..	London Electric Supply	1 1⅛	1 1⅛	..	..	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6 6⅛	5⅞ 6½	..	..	6⅞	6⅛
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	1 2 105	102 105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5½ 6⅛	5½ 6⅛	..	..	..	..
18,680	£5	9½%	St. James' and Pall Mall	8 8⅛	7⅞ 8¼	..	..	8¼	8⅛
7,900	£5	7%	Do. 7% Preference	8 8⅛	8 8⅛	4 2 4	..	8	..
12,853	5	2/0	Westminster Electric Supply (fully paid) xd	5½ 6	5½ 6	4 3 4	..	5⅞	5¾
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/6	Brush Electrical Engineering xd	3⅛ 3½	3¼ 3⅜	..	..	3[illegible]	3[illegible]
69,996	2	6%	Do. 6 per Cent. Preference xd	2¼ 2½	2⅜ 2⅝	5 1 1	..	2[illegible]	2[illegible]
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures xd	105 107	103 105	4 5 9	..	104½	103½
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July ..	5⅝	..
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	.. ..	.. ..	..	..	..	..
15,000	10	12/0	Electric Construction	3⅞ 4½	3⅞ 4½	..	..	3[illegible]	..
70,000	2	10/0	Elmore's Patent Copper Depositing	[illegible] [illegible]	[illegible] [illegible]	..	..	[illegible]	..
20,000	5	..	Fowler-Waring Cables (fully paid)	2 3	1½ 2½	..	..	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works xd	23 24	22 23	5 8 8	February & August	23¾	22[illegible]
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	103 105	104 106	4 4 11	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0 6/0	5/0 6/0	..	..	..	..
78,949	5	4/2[illegible]	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	3[illegible]	3[illegible]
37,350	12	12/0	Telegraph Construction and Maintenance	37 40	35 38	4 14 8	March and July....	38	36
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July ..	..	..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	..	..	..	..
..	£5	..	Do. Preference (fully paid)	.. ..	.. ..	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	.. ..	.. ..	..	..	..	..
600,000	Stock	[illegible]%	Do. Stock	35 37	35 37	3 0 9	May and November	37	36[illegible]

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Constant Current.
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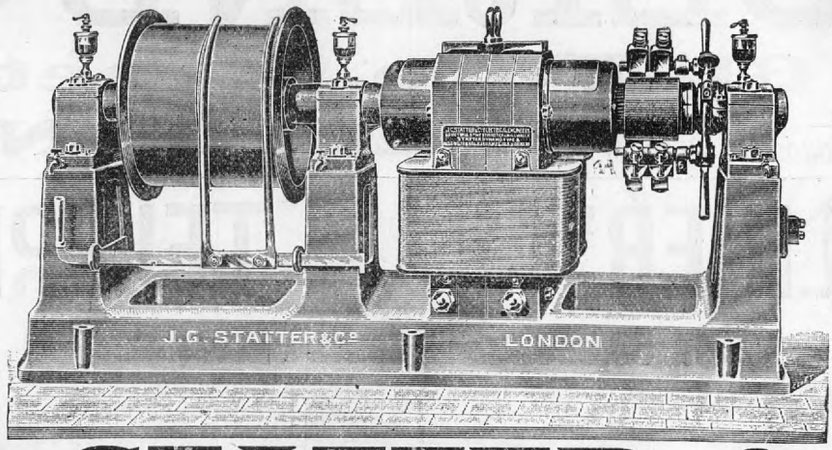

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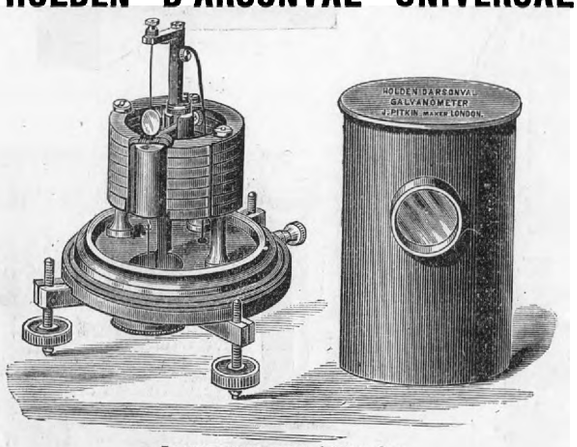

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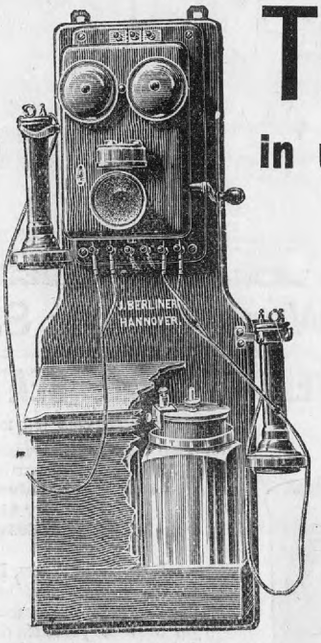

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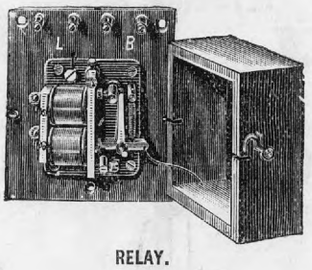

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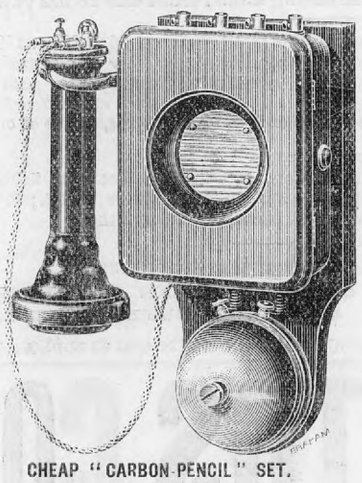

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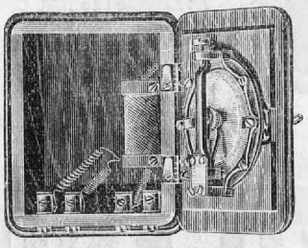

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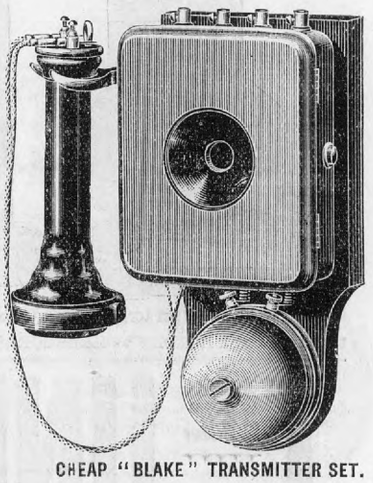

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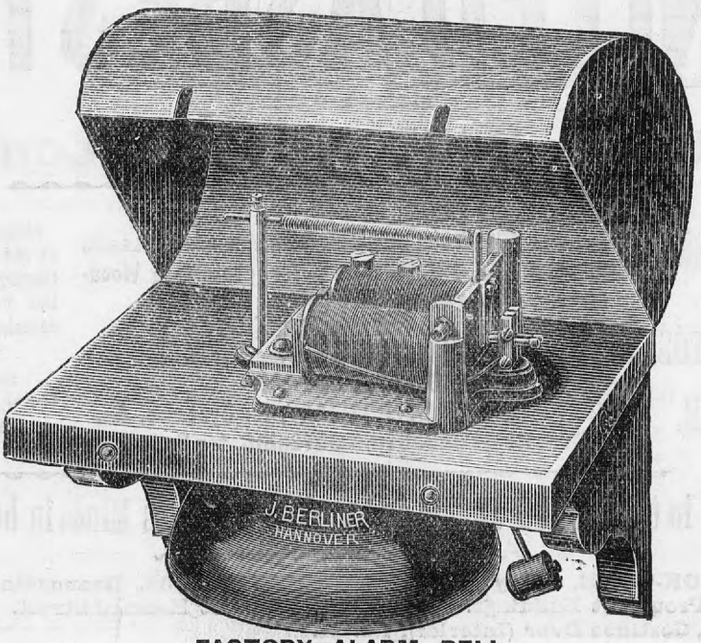

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LOCAL AUTHORITIES, ARCHITECTS, SURVEYORS, ENGINEERS, CONTRACTORS and others concerned in the introduction of Electric Light and Power Works will find in this valuable Directory and Handbook Advertisements from nearly every leading Electrical and Engineering firm in Great Britain.

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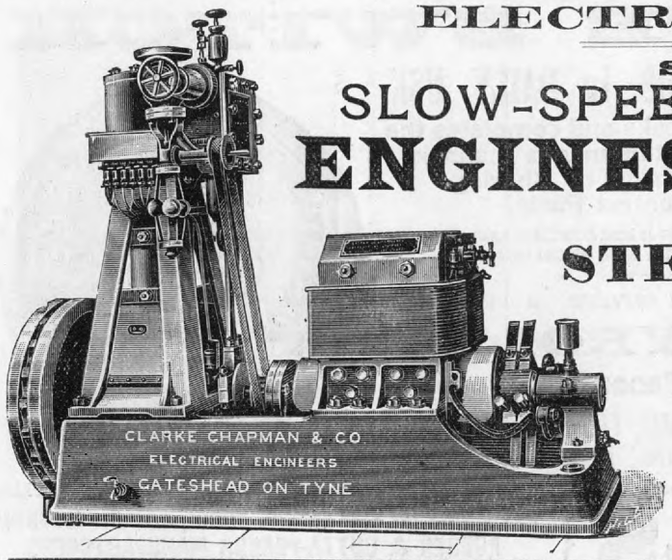

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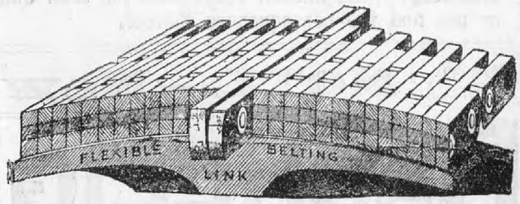
ORANGE TAN LEATHER offers the following ADVANTAGES:—

It possesses **more life** than any other Belt in the market.
It is **stretchless** and takes a **splendid grip** of the pulley.
It can carry with ease **one-third more load** than other leather.
It is **very thin** and **pliable**, and for **small diameters, fast speeds, and heavy work**, no other leather can compare with it.
Breaking strain (Lloyd's Proving House): **Orange Tan, 8,244lbs. Oak Tan, 5,746lbs.** per square inch.



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Where the one pulley is **flat** and the other **round**, this Belt will **easily accommodate itself** to either pulley, while at same time it will transmit the **maximum power.**

MOST TRUSTWORTHY BELT for ELECTRIC DRIVING.

We beg to call attention of belt users to a perusal of our Illustrated **GUIDE TO BELT-DRIVING,** *which we will send gratis on demand.*

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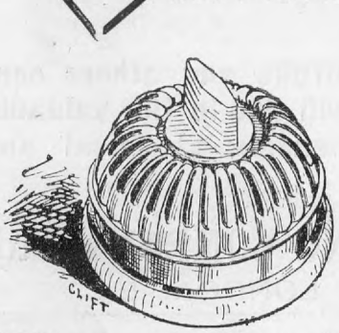

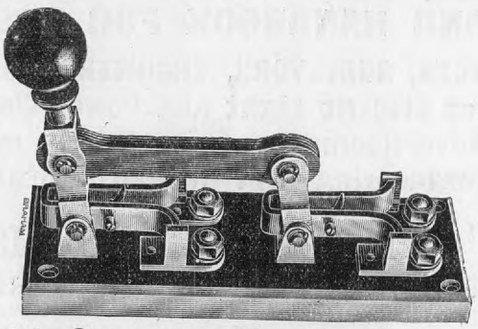

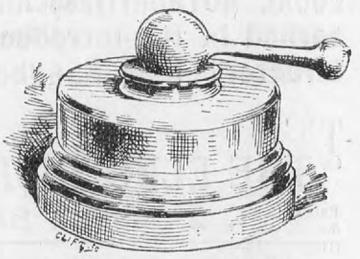

Offices: 5, Macclesfield Street, Shaftesbury Avenue, W. WORKS: BIRMINGHAM.

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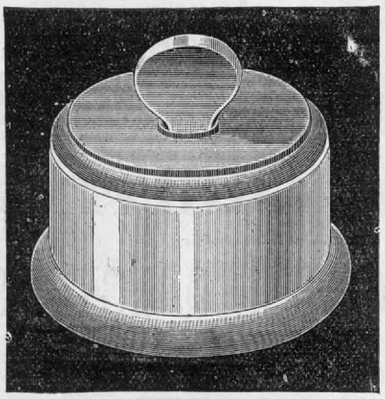

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The Movement breaks and completes the Circuit in an instantaneous manner, preventing Arcing or Charing of the Contact Parts.

Mounted on China, with Cover and Handle of same Material. Also on Porcelain, with Metal Cover.

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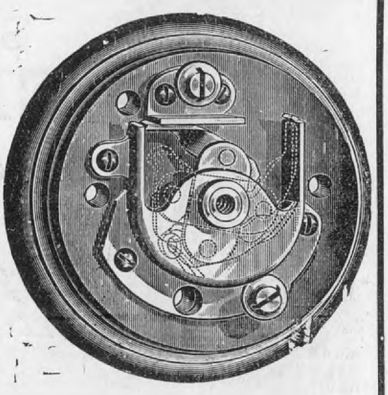

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NOTICE IS HEREBY GIVEN that every supplier and user of any joint for Concentric Wiring involving the use of Molten Metal, which is covered by J. D. F. Andrews' Patents, **WITHOUT LICENCE,** renders himself responsible for such unlawful supply or use and the consequences thereof.

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MESSRS. GEORGE HEAD and CO. will SELL BY AUCTION, on the Premises, as above, on WEDNESDAY, March 15th, 1893, at 2 o'clock, the HOUSEHOLD FURNITURE and Effects, comprising the usual bed room appointments, couches, easy chairs, mahogany and other tables, chimney and pier glasses, cheval glasses, fenders, carpets, china, and kitchen utensils; also copper and other baths, a number of specially made electric bath coils, electrodes, batteries, indicators, &c., a galvanometer and Wheatstone bridge coils by Latimer Clark, Muirhead and Co., a quantity of iron piping, fittings for shower, needle, and douche baths, insulated wiring, &c.

May be viewed the day prior to the Sale, and catalogues obtained on the premises, or at the Auctioneers' Offices, 7, Upper Baker-street, N.W.

MOODIE'S GOLD MINING AND EXPLORATION COMPANY (LIMITED).

TRANSMISSION OF ELECTRICAL POWER.

TO CONTRACTORS.

TENDERS are invited for the SUPPLY and ERECTION, upon the Company's Estate, near Barberton, South African Republic, of certain MACHINERY, PLANT, &c., for the purpose of

GENERATING and TRANSMITTING 250-H.P. by Electricity to various Sub-companies.

Specification and Conditions of Contract, &c., can be obtained from, and Plans seen, at the following places:—

OFFICES OF THE COMPANY:

Pietermaritzburg, Natal;
Moodie's near Barberton, South African Republic;
No. 8, Old Jewry, London, E.C.;

and at

Johannesburg (Messrs. Redwood and Watson), P.O. Box, 500;
Capetown (E. R. Syfret, Esq.), 39, St. George's-street;
America: Messrs. Corner Bros. and Co., New York, in conjunction with their Boston Agents.

Tenders, together with Specification and Conditions of Contract, &c., duly signed, attached thereto, must be sent in to the Head Office of the Company, Pietermaritzburg, Natal, by Noon on the 3rd day of MAY, 1893, and a Duplicate Copy must be lodged with the London Office, 8, Old Jewry, E.C., by the same time.

A Fee of Three Guineas will be charged for Copies of Specification, Conditions of Contract, &c., and inspection of Plans, which will be returned on receipt of a bona fide Tender.

The Lowest or any Tender not necessarily accepted.

By Order of the Board of Directors,
C. J. MACFARLANE, Secretary.
Moodie's Gold Mining and Exploration Co. (Limited).

Pietermaritzburg, Natal,
January, 1893.

BOROUGH OF DEWSBURY.

ELECTRICITY.

AMENDED ADVERTISEMENT EXTENDING TIME FOR SENDING IN TENDERS.

The CORPORATION invite TENDERS for the CONSTRUCTION, SUPPLY, and LAYING DOWN of the necessary PLANT and MAINS for the SUPPLY of ELECTRICITY in the Borough, in accordance with the specification, plan, and form of tender, which can be obtained from the undersigned on payment of £2. 2s., which will be returned on receipt of a bona fide tender.

The person or firm whose tender is accepted will be required to enter into a contract and a Bond with two approved sureties for the due performance of the contract. Sealed tenders, endorsed "Electricity," to be delivered at this office not later than SATURDAY, the 8th April, 1893.

Firms tendering may tender for the whole or any part of the Plant.

The Corporation do not bind themselves to accept the lowest or any tender.

By order,
E. MAWDESLEY, Town Clerk.

Town Clerk's Office, Town Hall,
Dewsbury, 9th March, 1893.

WHITEHAVEN ELECTRIC LIGHTING ORDER, 1891.

TO ELECTRIC LIGHTING CONTRACTORS.

The TRUSTEES of the TOWN and HARBOUR of WHITEHAVEN invite TENDERS for SUPPLYING and LAYING INSULATED CONDUCTORS required in connection with their Central Electric Lighting Station.

Plans can be seen, and a Copy of the Specification and Forms of Agreement and Tender obtained, at the Office of Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, S.W., and also at this Office, on payment of One Guinea, which will be returned if a bona fide Tender is sent in and not accepted.

Sealed Tenders, addressed to the undersigned, and endorsed "Tender for Electrical Conductors," must be delivered not later than 10 a.m. on WEDNESDAY, 22nd March instant.

The Trustees do not bind themselves to accept the lowest or any Tender.

By order,
JOHN COLLINS, Secretary.

Town Hall, Whitehaven, March 2nd, 1893.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (Limited).

NOTICE is Hereby Given that the TRANSFER BOOKS of this Company will be CLOSED from SATURDAY, 18th, to FRIDAY, 24th inst., both days inclusive, preparatory to paying an Interim Dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended December 31st, 1892, and payable on the 25th inst.

By order,
RICHARD COLLETT, Secretary.

Winchester House, Old Broad-street,
London, E.C., March 8th, 1893.

THE Telegrams: "CARWHEEL LONDON.

ELECTRIC & GENERAL CONTRACT CORPORATION, Limited.

Electric and other works for Local Authorities, Promoters, &c., undertaken and financed.

35, PARLIAMENT STREET, LONDON, S.W.

SITUATIONS VACANT AND WANTED, &c.

LONDON COUNTY ASYLUM, CLAYBURY, WOODFORD, ESSEX.

REQUIRED, a WORKING FOREMAN ENGINEER, to take charge under the Asylums Engineer of the whole of the Electric Light Installation, Heating and Ventilating System, Laundry Machinery and Cooking Apparatus.

He must be a thorough Mechanic and have had charge of an Electric Light Installation and be familiar with both its Mechanical and Electrical requirements. Salary £156 per annum, with house, coals and gas.

Persons desirous of applying must write, enclosing a stamped envelope, to the undersigned for an Application Form, upon which the conditions of service and other particulars will be stated.

All Applications are to be delivered here by or before 9 o'clock a.m. on Monday, 20th March, 1893.

R. W. PARTRIDGE,
Clerk to the Asylums Committee.

London Asylums Committee Office,
21, Whitehall-place, S.W., 6th March, 1893.

BATTERY PLATES for portable Electric Lamp.—WANTED a MAKER who can supply these to pattern, a large number likely to be required.—Address in first instance, by letter, to "S. R.," giving particulars, to *Electrician* Office, Salisbury-court, Fleet-street, E.C.

WANTED, an IMPROVER in a Central Station, must have some knowledge of accumulators.—Apply, letter only, stating experience and salary required, to "E. J. P.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

WANTED a first-class DRAUGHTSMAN and ESTIMATING CLERK for electrical work. Must be thoroughly used to switchboards and similar fittings.—Apply, stating age, experience, and salary required, to Box No. 9993, *Electrician* Office, Salisbury-court, Fleet-street, E.C.

WANTED, in a moderate size Engineering Works in London constructing high-class electrical machinery, where practical and theoretical knowledge is necessary, a thoroughly well-trained ENGINEER, not over 30 years' of age, with commercial knowledge, having natural energy and connection, and of gentlemanly address, as Assistant Manager.—A good salary would be paid to a competent man. Capital not necessary, but applicants should be willing to invest a few thousands if found satisfactory.—Apply, stating past experience, and salary expected to 9393, *Electrician* Office, Salisbury-court, Fleet-street, E.C.

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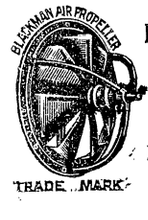

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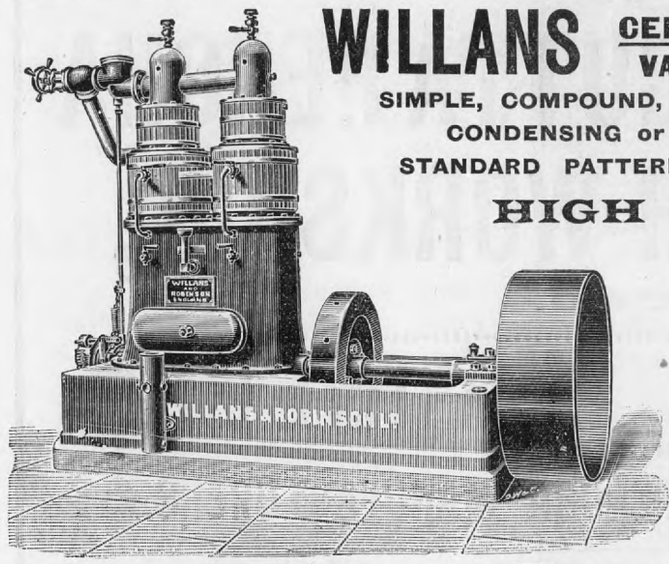

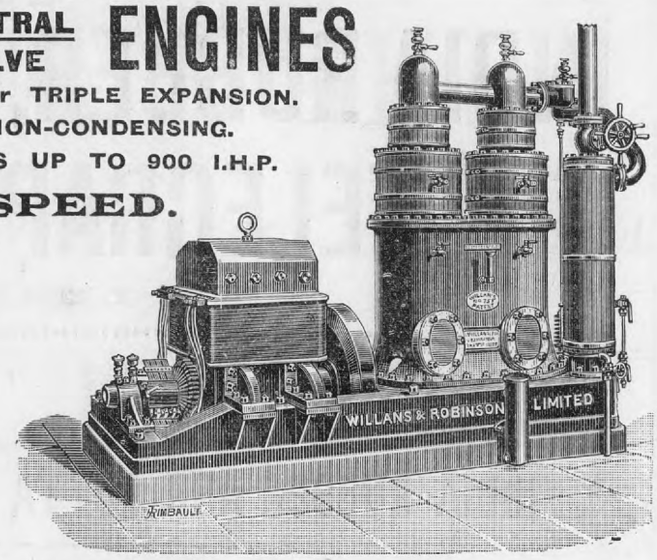

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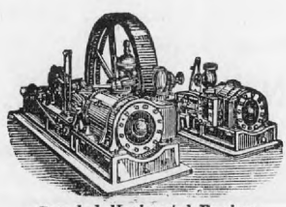

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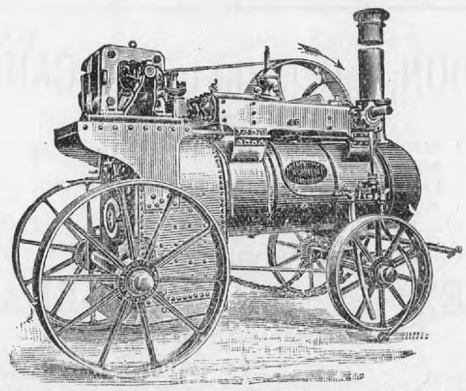

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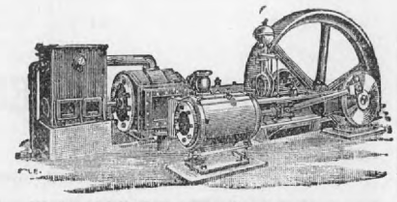

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ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 773 —Vol. XXX. FRIDAY, MARCH 10, 1893. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

The *Electrical Review* and *Science Siftings* Defence Fund has received a handsome contribution of £1,000 from Mr. C. B. Harness, not perhaps spontaneous, but due to the suggestion of a special jury and the approval of Lord Chief Justice Coleridge. While further congratulating our contemporary on having for the third time completely discomfited what Mr. Finlay called "an abominable system of imposture," we regret that Mr. Harness's plea that he was "not prepared to meet the case" should have stopped the mass of evidence which had been prepared, and which Lord Coleridge ruled to be relevant to the issue. We will believe in the other action which is said to be pending when it is brought into Court.

The discussion which took place last week at the Société Internationale des Électriciens on the American proposals with regard to electrical units was eminently satisfactory, in that there was no flood of new names or new units. We might well expect nice distinctions, and, where M. Hospitalier is to be found, accurate ones. We humbly note that M. Blondel thinks that "voltage" is slang, and accept his opinion. It might be argued that when a word is lifted bodily from the French language into the English, or *vice versâ*, it is rather difficult to determine whether it remains or becomes slang or *argot*, as the case may be. The modern French verb *five-o'cloquer*, for instance, is, we believe, *barbare* rather than *argot*, but, in the present instance, we have a guilty feeling that "voltage" was slang in its native country before it was imported into France. But what of it? True, we used the expressions "slovenly," "slang," and "far worse," in connection with "potential," "P.D.," and "E.M.F." a few weeks ago, tacitly approving of "voltage" in the same Note. We are inclined to agree with M. Blondel, Mr. Swinburne, and others who object to "voltage," but, all the same, we prefer it to most of its synonyms. We use C^2R without a scruple, but it is as bad as E.M.F. as far as its slanginess goes; as an adjective, *e.g.*, "C^2R losses," it has no synonym but the uncouth "joulian."

It is for scientific accuracy of terminology that we look to our French friends, rather than for verbal renderings of terms. We should not quarrel with them if they chose to speak of "*l'exploitation de l'installation d'une canalisation*," but regret to see these words imported with but little reason into ordinary English language. M. Guillaume's distinction between "resistance" and "resistibility" is rather too nice. Who would have time to remember which was which? There is, of course, a difference in the two uses which he proposes to make of them, but it seems hardly worth while to keep up the distinction at the expense of two names. The opinion of the society on the "henry" would have been interesting; this stands a better chance of adoption than the "gauss," "weber," "gilbert," and "œrsted," if only because of the numerous proposed denotations of the "gauss" and the "weber," and the comparative novelty of the "gilbert" and the "œrsted."

The radical abolition of the expression "bougie-metre" is only what one expects from M. Hospitalier, and as "lux" has been proposed, there is at all events no need to mangle any classically derived words, as is the custom of electrical logodædaly. The real objection to the "bougie-metre" or to the "candle-foot" arises when an illumination is expressed as a number of such units. The objectors say that 3 candle-feet implies the product of 3×1 candle $\times 1$ foot. The advocates say it simply means three times the unit of illumination, viz., 1 candle-foot; they imply nothing, and if anybody is so ignorant of optics as to suppose they mean 3×1 candle $\times 1$ foot, it is no business of theirs. Let the candle remain at 1 foot, or the bougie at 1 metre, and let the numeric in any given case simply denote a multiplier or divisor of that unit.

The closing of the Hanover Square School of Electrical Engineering and Submarine Telegraphy is not only in itself regrettable, but it is a significant sign of the times. Private enterprise seems destined in an ever-growing degree to be superseded by State or Municipal subsidised ventures, and this tendency, ever present in educational matters, is carrying all before it in this era of technical education. When the Hanover Square School first came into existence "sons of gentlemen" were possibly wanted to fill high appointments in the then restricted field of applied electricity, but it was a pity that such an invitation to increase the rush into the electrical profession should have been continued long after this state of things ceased to exist.

The tendency to ask for more is never more pronounced than when dividends are concerned. On this account, therefore, it is perhaps to be regretted that the companies who

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have the cream of the electricity supply business in their hands should have been the first to hold their annual meetings. A more artistic effect would have resulted had the dividends successively declared gradually risen from zero to a maximum instead of taking a sharp dip from 7¼ per cent. down to nothing.

On Thursday, last week, the Directors of the House-to-House Company met their shareholders at the West Brompton Central Station. The chief item of technical interest that transpired was the announcement that the House-to-House Company has fallen into line with the prevailing fashion, and has in contemplation the adoption of the transformer sub-station system of distribution. To the shareholders, however, the most comprehensible and, in their opinion, no doubt, the most reprehensible fact, was the absence of dividend.

At first glance if one is without any *a priori* convictions in regard to continuous and alternate currents, it is somewhat puzzling, lookely solely at the accounts, to understand why the Kensington and Knightsbridge Company should manage to scrape together the wherewithal to pay a modest dividend, whilst the House-to-House Company close by should be unable to perform a similar feat. The total capital expenditure up to December 31, 1892, amounted in the case of the Kensington Company to £153,000 in round figures, the lamps numbering 47,441 and the capital outlay per lamp connected being £3. 4s. For the House-to-House Company these figures are respectively £70,000, 23,700 and £2. 19s. The electricity revenue per lamp connected is in the case of the Kensington Company 7s. 1d., in that of the House-to-House Company 8s. 1d. So far what little difference there is, is in favour of the House-to-House Company. On turning to the "sheer cost" of production, however, the solution of the problem is writ very fine and large. The Kensington Company's expenses under that heading come to £3,746; in the case of the House-to-House Company they are £5,604.

The cable phenomena described by Herr Neustadt in another column are of interest in connection with high pressure systems of distribution by means of alternating currents. The combined action of condensers and inductive circuits produces the same effect as a transformer in changing the pressure of the circuits connected with them; and the resulting increase of voltage may in some cases become serious. An effect of this kind, as is well known, was noticed two years ago on the Deptford mains, but its importance was small, as it practically disappeared when the mains were conveying power, and in no case was the rise of voltage great enough to endanger the insulation of the cable. The result might, however, have been far more serious as the phenomenon was new and altogether unexpected. In some cases referred to by Herr Neustadt serious damage to the cables resulted from a cause of this nature, and it thus becomes of evident importance in such systems of distribution that proper precautions should be taken to guard against breakdowns. As Herr Neustadt points out, it is always easy to avoid any such danger.

The article will be read with more general interest owing to the omission of the mathematical theory, the result of the investigation being summarised in three formulæ. These expressions, it must be confessed, are somewhat lengthy, but their meaning is rendered easily intelligible by giving the numerical details of an actual case. Whether the example chosen is a practical one of course depends upon the data assumed, but for the most part these will be regarded as likely values for an actual system of mains. With regard, however, to capacity, it appears excessive to assume 50 microfarads for a cable only 80 kilometres long, and although a current-frequency of 43 periods per second is common enough in Germany, it does not at all represent English or American practice.

The result of the experiments which have been made as to the use of glow lamps with green side lights for ships, is unexpected, and it is not easy to account for them. Capt. Abney and others have found that the light of a glow lamp is practically the same as that of a good gas flame, and the only clue to the explanation seems to be that the oil flame of an ordinary ship's light differs materially in quality from a gas flame. It might have been expected that "electric light of very considerable candle-power" would have been, if anything, rather whiter than an oil lamp. If so, its spectrum, extending farther towards the blue, should be richer in green rays; but for some reason the colour was too pale. The brilliancy of the light, that is, the quantity apart from the quality, ought not to alter the colour.

Royal Society.—Amongst the Papers down for reading yesterday was one by Prof. J. J. Thomson, on "The Electrolysis of Steam."

The Commercial Cable Company.—The Directors of the Commercial Cable Company have decided to forthwith lay a third cable between Nova Scotia and Ireland.

The British Association, 1894.—*The Times* has reason to believe that Lord Salisbury has accepted the Presidency of the British Association for the year 1894, when the meeting will be held at Oxford.

Lang v. the House-to-House Electric Lighting Company.—It should have been stated in our report of this action last week that in the event of a verdict for the plaintiff the damages had been agreed at £195.

The Western Union Telegraph Co.—According to telegraphic advice received yesterday, General Eckert has been elected (in place of the late Dr. Norvin Green) President of the Company, retaining the position of General Manager.

Accrington.—A Local Government Board inquiry was held at Accrington on Wednesday last week relative to the application of the Town Council for sanction to borrow £22,000 for various purposes, including the erection of an electric lighting station.

A Chair of Electricity.—A decree has been issued by the Minister of Public Works creating a Chair of Electricity at the École Supérieure des Mines. M. Blondel, well known for his work in connection with alternate current working, is a candidate for the post.

Derby.—On Thursday last week Mr. F. H. Tullock, an inspector appointed by the Local Government Board, held an inquiry at Derby into the application made by the Corporation for sanction to borrow £50,600 for various purposes, of which £30,000 was for the inauguration of the electric light.

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Ealing.—At the meeting of the Local Board on Thursday last week, the Chairman moved that the Board request Messrs. Bramwell and Harris to prepare plans and specifications for the execution of the electric lighting scheme detailed and recommended in their report. The motion was carried unanimously.

Cable Repairs and Interruptions:—

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St. Thome-Loanda	February 17, 1893 ...	March 6, 1893.

Cables actually interrupted.

Cayenne-Vizeu	September 24, 1892.
Gibraltar-Tangier	February 18, 1893.

The Post Office and the Telephones.—Amongst the Select Committees of the House of Commons asked for, is one to consider the proposed arrangements between the Post Office and the telephone companies, and generally as to the future policy of the Post Office with reference to the extension of the telephone service.

Vienna.—An interesting station has been erected here by Ganz and Co., who utilise the water of the Iser to drive, by means of turbines, two 50-H.P. dynamos for lighting certain factories, and two 65-H.P. dynamos for supplying them with power. The former are alternate-current 1,800 volt, and the latter direct-current 550 volt machines. The distance of the transmission is about a mile.

Indian Telegraphs.—The Telegraph Department is, says the *Indian Engineer*, likely to show good results for the current financial year. There will also appear a very large increase in the number of new offices opened. We are, says our contemporary, probably within measurable distance of that four-anna telegram which only three or four years ago seemed like the dream of an imaginative Director-General.

Berlin.—Some interesting statistics of the lighting of Berlin during the past year are given in the *Journal für Gasbeleuchtung*. The total quantity of gas accounted for amounts to 4,062,568,000 cubic feet, against 3,945,185,000 cubic feet in the previous year, an increase of nearly 3 per cent. On the other hand, the use of the electric light has increased nearly 30 per cent. during the same period; and the importations of petroleum have advanced 6·5 per cent.

The German Electric Lighting Bill.—The German Electric Light and Power Bill, after slumbering on the table of a committee for a year and a-half, has been rushed through the Federal Council, and is, it seems, to be similarly treated in the Imperial Diet, before which it has just been laid. The Electric Light Bill is said to be neither necessary nor useful. It is, moreover, contended that the Bill, if it become law, will seriously hamper the electrical industries.

A Proposed Metropolitan Electric Railway for Vienna.—The Anglo-Austrian Bank, in conjunction with Messrs. Siemens and Halske and the General Austrian Electricity Company, has approached the Vienna Municipality with a detailed scheme for the construction of an electric railway to encircle the inner town and a branch line to pass through the inner part of the town. If a concession is granted for these lines, they would be laid down on the slotted conduit or Budapest system.

Tunbridge Wells.—At a meeting of the Town Council last week the proposal to adopt the electric light was discussed. Alderman Clifford moved the confirmation of Mr. Preece's report. Alderman Cronk moved an amendment in favour of deferring the matter for two years. An animated debate followed; and, on a show of hands being subsequently taken, 14 voted for the amendment and 14 for the original motion. By the casting vote of the Mayor the amendment was carried.

City and South London Railway.—A slight accident occurred at half-past nine on Monday morning on this railway between the Borough and the Monument Stations. Just after the 9:20 up train from Stockwell had left the Borough the brake got out of order, the train being immediately brought to a standstill. The driver and conductor examined the engine, but, finding it impossible to proceed, one of them informed the signalman at the station and another engine was procured, the passengers being carried back to the Borough.

Old Students' Association.—A very successful *soirée* was held in connection with this Association on March 3rd at the Central Institution, when Mr. Clinton T. Dent, the well-known Alpine climber, gave a most interesting lecture on "Mountain-craft," which was illustrated by very fine lantern slides from photographs by Mr. Dent, Prof. Donkin and others. A very large and brilliant audience attended the lecture. A hearty vote of thanks was passsed to Mr. Dent for his kindness in giving the lecture, which was much applauded. The dance in connection with the Association takes place on the 17th of March.

The Recent Telephone Case.—What's in a name? we are tempted to ask, on reading the following paragraph in *Electricity* of New York with regard to Transatlantic testimony in the recent telephone case:—"The English counsel had collected a mass of evidence showing that the tramway wires did not seriously injure those of the Telephone Company. Mr. Wise advised that all this testimony was irrelevant, and that the proper position to take was to admit the serious injury, but to claim equal rights to the earth with the Telephone Company." His advice was taken, and, of course, the Court sustained Mr. Wise's contention. How could it do otherwise?

A Proposed Postal and Telegraph Consultative Committee.—Mr. Henniker Heaton intends, upon the Post Office Vote, to press upon the Government the desirability of establishing a Postal and Telegraph Consultative Committee, similar to that existing in France called "La Commission Consultative des Postes et des Télégraphes," to consist, as in France, of 26 members, selected from the members of both Houses of Parliament, presidents of chambers of commerce, chairmen of railway companies, and representatives of the principal commercial, industrial, and social bodies. The Postmaster-General to be the President of such Committee.

Long Telegraph Lines in India.—The *Indian Engineer* of February 11th states that a few days previous to that date Calcutta was connected with Madras by way of Nagpur and Bombay, and messages were transmitted duplex direct. The distance was 2,100 miles, and the wire employed was of copper. The same journal states that a new and heavier copper wire is now being laid from Calcutta, through Dohnd and Manmad, to Madras. When it is ready the service along it will be unequalled among land telegraphs in the world. The necessity for this route arises from the fact that the line along the East Coast is subject to constant interruptions, and is most difficult to maintain in working order, especially during the monsoon seasons.

Telegraphists' Grievances.—In the House of Commons on Tuesday night Mr. Dalziel asked the Postmaster-General whether he would explain why the decision of his Department with regard to the petition received on April 12th last from the senior telegraphists employed at the Central Telegraph Office, setting forth certain alleged grievances, had not yet been made known. Mr. Arnold Morley said that the petition referred to repeated a number of points on which decisions had been previously conveyed to the petitioners, and he feared that, with the exception of an addition to the number of the class of assistant superintendents, which he was glad to say had now been sanctioned by the Treasury, he was not in a position to accede to the prayer of the petition. The answer had been delayed pending the decision of the Treasury on the point mentioned.

The Electric Railway Bills.—The provision in the South-Eastern Railway Bill for an electric tramway between St. Leonards and Hythe has been abandoned.—Mr. Mundella will move the rejection of the Brighton and Rottingdean Sea Shore Electric Railway Bill on the second reading.—Every endeavour will be made to get a clause inserted in the London electric railway Bills reserving to the London County Council power to purchase the undertakings after the expiration of a limited period, on terms similar to those provided in Section 43 of the Tramways Act, 1870.—The Committee appointed to consider the City and South London Railway Bill, the Extension of Time Bill for the continuation of the line to Clapham, the Clapham Junction and Paddington, and the Edgware-road and

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Victoria Railway Bills, will consist of Sir John Kennaway (Chairman), Mr. Gourley, the Marquess of Granby, and Mr. Grenfell. The Committee will hold its first sitting on Monday next.

The General Electric Company of America.—*Electricity*, of New York, is waging a vigorous campaign against the General Electric Company, which, according to it, threatens to monopolise the entire electrical business of the United States. The lamp case is, in its opinion, an important one, but not all important. Other patents are in reserve. The Electric Trust will, thinks *Electricity*, upset and demoralise the entire electric street-railway industry during the next two years. In the lighting field there will be patent suits almost without end. Suits are now being prepared claiming fundamental patents on sockets, fuses, the three-wire system and feeder distribution. The compound winding of machines is also claimed, and will be the first matter to be pushed to a finish. A truly gloomy presage, and, if correct, one which almost warrants the very strong language indulged in by *Electricity*, not only against the General Electric Company, but against its technical contemporaries who do not happen to see eye to eye with it in this matter.

A New Paris Central Station.—Our Paris correspondent writes that on Tuesday the central station supplying the Secteur des Champs-Elysées was formally "inaugurated." The station is situated at Levallois, on the borders of the Seine, a little over a mile from the fortifications. The station covers an area of 27,500 sq. ft. The feed water is taken direct from the Seine. The area of supply covers 4½ sq. miles. The plant comprises five Galloway boilers and six Corliss engines each driving direct on to a 400 kilowatt Hillairet-Huguet alternator. At 60 revolutions these alternators give 40 ∿. They have 80 coils of the Lontin type, and revolving field-magnets 19ft. in diameter, and they give 133 amperes at 3,000 volts. It is proposed to run the alternators in parallel. In the station all high-pressure wires are painted red, low-pressure wires black, whilst the conductors of the 150-volt exciting circuit are bare. Zipernowski transformers are employed. The station is fitted with a Green economiser and a Gaillet purifier.

Atmospheric Electricity.—On Wednesday next, at 7 p.m., Mr. Shelford Bidwell will deliver before the Royal Meteorological Society, at 25, Great George-street, Westminster, a lecture on "Some Meteorological Problems," which will be illustrated by experiments. The lecture will treat of the probable sources of atmospheric electricity, with experiments showing electrification produced by evaporation and by friction of dust, and the different forms assumed by the lighting flash. Photographs of flashes and electric sparks will be shown. The resemblance of a Leyden jar discharge to lightning will be demonstrated. The duration of flashes will be shown by means of a revolving disk. The efficiency of lightning conductors, Dr. Lodge's two forms of lightning discharge, the darkness of thunder clouds, the large rain drops of thunder showers, the electrification of steam jets and water jets, the influence of the dust in the air on condensation of water vapour, and the colour of the sky will be discussed.

Electric Traction at Coventry.—At the last meeting of the Coventry Town Council it was proposed that the portion of the minutes of the General Works Committee relating to the agreement with Mr. Graff Baker on the subject of the equipment of the electric tramways should be referred back. The mover said the Council on January 17th passed a resolution giving permission to Mr. Baker to introduce the Thomson-Houston system, provided that an equitable agreement could be arrived at between him and the Corporation, and the report of the General Works Committee was referred back with instructions to report as early as possible. Six weeks had now passed, and no report had been presented, but on the minutes it was stated that the Committee had considered the proposed agreement and agreed upon modifications thereof. It would be advisable to know whether the General Works Committee were carrying out the wish of the Council that electric traction should be introduced, whether the modifications were not of such a nature as to render the scheme impossible, and whether there was a danger that the scheme would actually fall through before the report was presented to the Council. A discussion ensued, in the course of which it transpired that there was no danger of the scheme falling through, and that the Committee were making every endeavour to hurry forward the completion of the negotiations. The motion was in consequence withdrawn.

American Experiences.—On Friday evening last a Paper was read at a students' meeting of the Institution of Electrical Engineers by Mr. J. M. Barr on "The American Experiences of an Embryonic Electrician." Prof. Ayrton occupied the chair. The Paper dealt in a humorous manner with many difficulties of young electricians in America, gave some useful practical information, and pointed out that students who entered the factory as ordinary workmen were often able to secure the most useful practical experience. Mr. Barr said that when he left college he found that there were three ways of acquiring practical knowledge; one was to enter the factory as a premium pupil, another was to gain admission by influence, and the third was to apply *incognito* and be taken on as an ordinary workman. On the whole he found that the last course was preferable, although it had the drawback of entailing long hours. He had without difficulty passed from department to department of the works and managed to acquire considerable information. He then proceeded to give some details of American practice, and gave an instance in his own experience where a lighting plant had to be laid down in an iron mine. The mine was a wet one, and being at a distance from any factory it was necessary to press domestic utensils into service. The wiring was carried out with bare conductors which had previously been drawn through a trough containing an insulating paint, the leads were attached to porcelain insulators fixed in the logs forming the roof of the mine. To protect these insulators from the running water, shades had to be improvised from several hundred bread pans. Mr. Barr then proceeded to explain the manufacture and testing of glow lamps and the methods of dry and wet "flashing." He also referred to the new Westinghouse lamps, the one with a glass stopper cemented in, and the other having a silicate plug with leading-in wires of iron, the composition of the plug being such that the co-efficient of expansion was the same for both the plug and the wires.

Brighton.—A Board of Trade Inquiry was held at the Brighton Town Hall, on Tuesday, by Mr. Ingram B. Walker and Major Cardew, with reference to the application of the Brighton Electric Light Company for a Provisional Order to supply electricity for public and private purposes within the Borough. Mr. Fletcher Moulton, Q.C., appeared for the Corporation; Mr. Castle, Q.C., appeared for the Company. Evidence was given on behalf of the Company at considerable length by Mr. Robert Hammond, and also by several customers, who declared themselves satisfied with its electric supply. Mr. Fletcher Moulton, passing over the history of the matter prior to 1889, stated that Parliament had from the very first taken up the position, that if the public preferred to supply themselves with such articles of consumption as gas and water, so as to relieve the burden of the ratepayer, they might decline to allow enterprises such as that of the Company to be made the subject of private property, private persons, or private companies. There was no shadow of a ground for accusing the Corporation of having failed in what they had undertaken. The Corporation had done all that a careful and responsible Municipality ought to have done. There would soon be £80,000 of the ratepayers' money invested in the Electric Light Works; nothing could more conclusively show the municipal *bona fides*. Mr. Castle said that when it had been stated that the Corporation had put forward a document containing false statements, it was strange that no attempt should have been made to justify them. He was debarred from going into the whole of the transactions before 1889, as he very much desired to do. But the real point to be kept in view was that the petitioning Company could not be turned out. If the Board of Trade refused this application, the Company must then go on with their present system, that was said not to be safe and to be prejudicial to the public. The Company had supplied a large public want, had done good work to the town, and had put £33,000 into the business. He asked the inspectors to favourably recommend this application to the Board of Trade.

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ELECTROMAGNETIC THEORY.—XLV.

BY OLIVER HEAVISIDE.

(*Continued from page 474.*)

§ 189. The properties of a perfect conductor are derived from those of common conductors by examining what would happen if the resistivity were continuously reduced, and ultimately became zero. In this way we find that a perfect conductor is a perfect obstructor, for one thing, which idea is singularly at variance with popular notions regarding conductors. But it is also a perfect conductor literally, though in a different sense to that commonly understood. Ohm's law has played so important a part in the development of electrical knowledge, especially on the practical side, that it is really not at all a matter of wonder that some practicians should have been so reluctant to take in the idea of a conductor as an obstructor. Scientific men who can follow the reasoning by which the functions of conductors follow from known facts have no difficulty in pursuing the consequences far beyond experimental observation. Again, younger men, with fewer prejudices to surmount, do not find much trouble with superficial conduction and internal obstruction. But the old established practitioner with prejudices, who could not see the reason, was put into a position of some difficulty—resembling chancery. If you have got anything new, in substance or in method, and want to propagate it rapidly, you need not expect anything but hindrance from the old practitioner—especially if he sat at the feet of Faraday. Beetles could do that. Besides, the old practitioner is apt to measure the value of science by the number of dollars he thinks it is likely to bring into his pocket, and if he does not see the dollars, he is very disinclined to disturb his ancient prejudices. But only give him plenty of rope, and when the new views have become fashionably current, he may find it worth his while to adopt them, though, perhaps, in a somewhat sneaking manner, not unmixed with bluster, and make believe he knew all about it when he was a little boy! He sees a prospect of dollars in the distance, that is the reason. The perfect obstruction having failed, try the perfect conduction.

You should make your converts out of the rising generation and the coming men. Thus, passing to another matter, Prof. Tait says he cannot understand my vectors, though he can understand much harder things. But men who have no quaternionic prejudices can understand them, and do. Younger men are born into the world with more advanced ideas, on the average. There cannot be a doubt about it. If you had taught the Calculus to the ancient Britons you would not have found a man to take it in amongst the whole lot, Druids and all. Consider too, what a trouble scientific men used to have with the principle of the persistence of energy. They could not see it. But everybody sees it now. The important thing is to begin early, and train up the young stick as you want it to grow. Now with Quaternions it is different. You may put off till to-morrow what you cannot do to-day, for fear you commence the study too soon. Of course, I refer to the Hamilton-Tait system, where you have to do violence to reason by making believe that a vector is a quaternion, and that its square is negative.

According to Ohm's law alone, a perfect conductor should be one which carried an infinite current under a finite voltage, and the current would flow all through it because it does so ordinarily. But what is left out of consideration here is the manner in which the assumed steady state is established. If we take this into account, we find that there is no steady state when the resistance is zero, for the variable period is infinitely prolonged, and Ohm's law is therefore out of it, so far as the usual application goes. In a circuit of no resistance containing a finite steady impressed voltage E, the current would mount up infinitely and never stop mounting up. On the other hand, if we insert a resistance R in the former circuit of no resistance, there will be a settling to a steady state, for the current in the circuit will tend to the value E/R, in full obedience to Ohm's law. The current is the same all round the circuit, although a part thereof has no resistance. We conclude that that portion has also no voltage.

But this is only a part of the story. Although we harmonise with Ohm's law, we overlook the most interesting part. The smaller the resistance the greater the time taken for the current to get into the conductor from its boundary, where it is initiated. In the limit, with no resistance, it never gets in at all. Where, then, is the current? For, as we have said, it mounts up to a finite value if there be a finite resistance inserted along with the perfect conductor, and mounts up infinitely if there be no resistance.

We recognise the existence of electric current in a wire by the magnetic force round it, and in fact measure the current by its magnetic force. Therefore, according to this, there is the same total current in the wire, if the magnetic force outside it remains the same. If, then, the magnetic force stops completely at the surface of the wire, whose interior is entirely free from magnetic force, the measure of the current is just the same. The uniformly distributed current of the steady state appropriate to finite conductivity becomes a mere surface current when the conductivity is infinite. In one case we have a finite volume-density of current, and in the other a finite surface-density. When the current inside the wire is zero so is the electric force, in accordance with Ohm's law again. The electric and magnetic phenomena are entirely in the dielectric outside the wire, the entrance of any similar manifestations into it being perfectly obstructed by the absence of resistance. For this purpose the thinnest skin would serve equally well. In the usual sense that an electric current is a phenomenon of matter, it has become quite an abstraction, for there is no matter concerned in it. It is shut out completely. In the circuit of finite resistance, a portion of which is a wire of no resistance, supporting a steady current, there is no difference whatever in the external magnetic force outside the resisting and non-resisting parts, though in one case there is entrance of the magnetic force and waste of energy, whilst in the other there is no entrance and no waste. These conclusions do not rest upon Maxwell's theory of dielectrics, but upon the second circuital law of electromagnetism applied to conductors. But it is only by means of Maxwell's theory that we can come to a proper understanding and explanation of the functions of conductors.

The sense in which a perfect conductor is a perfect conductor in reality as well as in name is that it allows electromagnetic waves to slip along its surface in a perfectly free manner, without waste of energy. Though perfectly obstructive internally, it is perfectly conductive superficially. It merely guides the waves, and in this less technical sense of conduction the idea of a perfect conductor acquires fresh life.

§ 190. The conditions at the interface of a perfect conductor and a dielectric are that the electric force in the dielectric has no tangential component and the magnetic induction no normal component. Or

$$V\mathbf{N}\mathbf{E} = 0, \qquad \mathbf{N}\mathbf{H} = 0,$$

if $\mathbf{N}$ be the unit normal from the conductor. Thus, when there is electric force at the boundary it is entirely normal, with electrification to match; and if there is magnetic force it is entirely tangential, with electric current to match. Both electrification and current are superficial. The displacement measures the surface density σ of the one, and the magnetic force that of the other, say $\mathbf{c}$, thus

$$\sigma = \mathbf{N}\mathbf{D}, \qquad \mathbf{c} = V\mathbf{N}\mathbf{H},$$

in rational units, without any useless and arbitrary 4π constant, such as is required in the B.A. system of units, of amazing irrationality. If, then, we have electromagnetic disturbances given in a dielectric containing a perfect conductor, the latter first of all is free from disturbance, and next causes such reflected waves as to annihilate the tangentiality of the electric force and the normality of the magnetic force.

As regards steady states, the influence of a perfect conductor on induction due to foreign sources is to exclude it in the same manner as if the inductivity were made zero; that is, the induction goes round it tangentially instead of entering it. This is usually ascribed to an electric current-sheet induced upon its surface, whose internal magnetic force is the negative of that due to the external field. This is right mathematically, but is deceptive and delusive physically. There is no internal force,

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neither that of the external field nor that of the superficial current. The current sheet itself merely means the abrupt stoppage of the magnetic field, and cannot really be supposed to be the source of magnetic force in a body which cannot permit its entrance. The previously mentioned case of a perfectly conducting wire inserted in a circuit of finite resistance supporting a steady current, will serve to bring out this point strongly. The supposed induced superficial current is now actually the main current in the circuit itself.

It is different with the steady state due to external electric sources. The displacement is just as much shut out from the perfect conductor (which may also be a dielectric) as was the magnetic induction, but in a strikingly different manner, terminating upon it perpendicularly, as if it entered it in the manner that would happen were the conductor nonconducting, but of exceedingly great permittivity, so that it drew in the tubes of displacement.

Although a perfect magnetic conductor is, in the absence of knowledge even of a finite degree of magnetic conductivity, a very far-fetched idea, yet it is useful in electromagnetic theory to contrast with the perfect electric conductor. A perfect magnetic conductor behaves towards displacement just as a perfect electric conductor does towards induction; that is, the displacement goes round it tangentially. It also behaves towards induction as a perfect electric conductor does towards displacement; that is, the induction meets it perpendicularly, as if it possessed exceedingly great inductivity, without magnetic conductivity. This magnetic conductor is also perfectly obstructive internally, and is a perfect reflector, though not quite in the same way as electric conductors. The tangential magnetic force and the normal electric force are zero.

As regards waves, there are two extreme ways in which a perfect conductor behaves—that is, extreme forms of the general behaviour. It may wholly conduct them, or it may wholly reflect them. In the latter case we may illustrate by imagining a thin plane electromagnetic sheet, consisting of crossed electric and magnetic forces in the ratio given by $\mathrm{E}=\mu v\mathrm{H}$, moving at the speed of light, to strike a perfect conductor flush—that is, all over at the same time, by reason of parallelism of the sheet and conducting surface. The incident sheet is at once turned into another plane sheet, which runs away from the conductor as fast as it came. If the conductivity be of the electric kind the reflected sheet differs from the incident in having its displacement reversed, but in no other respect. This is perfect reflection with reversal of **E**. During the act of reflection, whilst the incident and reflected sheets partly coincide, **E** is zero and **H** is doubled. Both are tangential; but there can be no tangential **E**, so the reflector destroys **E** and initiates the reflected sheet, in which **H** is the same as in the incident sheet, whilst **E** is reversed.

On the other hand, when the conductivity is of the magnetic kind, the reflected wave sheet differs from the incident only in having its induction reversed. The displacement persists, being doubled during the act of reflection, whilst the induction is then annulled.

The other extreme occurs when a plane electromagnetic sheet hangs on to a conductor perpendicularly. It then slips along the conductor at the speed of light, with perfect slip. This may occur with a plane reflector, but, of course, the most striking and useful and practical case is that of a straight cylinder—a wire, in fact, though it need not be round, but may have any form of section. The wave then runs along the wire at constant speed v, and without change of type, at least so long as the wire continues straight and of unchanged section. If the section vary regularly, so that the wire is a cone, then it is a spherical wave that is propagated along it without change of type. This case includes an infinitely fine wire, when we may have either spherical or plane waves. Other interesting cases may be made up by varying the angle of the cone, or using a double cone, or a cone and a plane, &c.

Now, in the first main case of perfect reflection (flush) the incident and reflected sheets are wholly separated from one another, except just at the reflecting surface, where there is a momentary coincidence. On the other hand, when a plane wave runs along a wire, or, say, more conveniently here, along a plane, we only see one wave. It is the case of reflection at grazing incidence, and may be considered the limiting case of permanent union of the incident and reflected waves. Between these two cases we have the general case of incidence and reflection at any angle. There are two plane waves (sheets, most conveniently for reasoning and description) one going to and the other coming from the plane reflector, where they join together, making equal angles with it. In the overlapping region, close to the plane, the displacement due to the union of the two waves is normal to the surface (that is, with an electric conductor) which is electrified, and the electrification runs along the surface at a speed depending upon the angle of incidence, being v at grazing incidence (of rays) and $v/\cos\theta$ at incidence angle θ, varying, therefore, between v and infinity. It may be, perhaps, rather a novel idea to some readers that electrification can run through space at any speed greater than that of light, but the matter is made simple enough by considering the rate of incidence upon the reflecting surface of different parts of the plane sheet. In the case of nearly flush incidence of a sheet, its different parts strike the surface nearly simultaneously, so that there is an immensely great speed of motion of the electrification along the surface. The electrification is the same in amount always, and is continuously existent, so we are somewhat justified in speaking of the electrification moving; but we may equally well regard it as a case of continuous generation of electrification at one end and of annihilation at the other end of the part of the conducting surface which is momentarily charged, the generation and annihilation being performed by the different parts of the incident sheet and the reflected sheet as they reach and leave the surface. Details of these simple cases, leading to a plainer understanding, will come later, when these general notions are got over. In the limiting case of normal incidence of rays, when the incident sheet strikes the surface flush, the electrification is non-existent. It goes out of existence just as its speed becomes infinite.

The above describes one extreme kind of reflection of a plane sheet at any angle, and is what occurs when **H** in the incident, and, therefore, also in the reflected wave, is tangential to the reflector, whilst **E** is in the plane of incidence. But when it is **H** in the incident wave that is in the plane of incidence, and **E** is tangential, we have quite another kind of composition in the overlapping part near the reflector. There is no **E** within it at all, and also no electrification; whilst the **H** within it is parallel to the reflector, and simply joins together the **H**'s in the parts of the waves which do not overlap, the **H** in one wave being directed towards the surface in the plane of incidence, and in the other away from the surface. In both waves, of course, **H** is in the plane of the wave. In other respects we have a similarity in propagation. It is now a surface current, instead of electrification, that runs along the surface at speed $v/\cos\theta$.

If the reflector be a magnetic conductor, we have two very similar main cases, in one of which magnetification (the analogue of electrification), and in the other a magnetic current runs, or appears to run, along the surface.

(To be continued.)

THE GERMAN ELMORE WORKS.

BY CLARENCE P. FELDMANN.

The newly-erected works of the Elmore's Metall Aktiengesellschaft are situated at Schladern, Rhenish Prussia, about 40 miles from Cologne, on the left bank of the Sieg, and not more than 300 yards from the railway station. The Sieg, which flows into the Rhine, winds its way in several large and nearly closed curves through the hills, and is able to furnish about 720 cubic feet of water per second. By negotiating one of these curves, and driving two 250ft. tunnels, it was possible to get a total fall of 18½ft., which, as the whole mass of water can be utilised, renders a total of 1,200 H.P. available.

The frontage of the factory (Figs. 1 and 2) measures 390ft., with a depth of 54ft., and at some parts 96ft. Most of the buildings have two floors. An embankment protects the whole building from the river, and, besides, it is situated so favourably that it cannot be injured by high-water or drifting ice. The main building is shown in plan in Fig. 1. The room A

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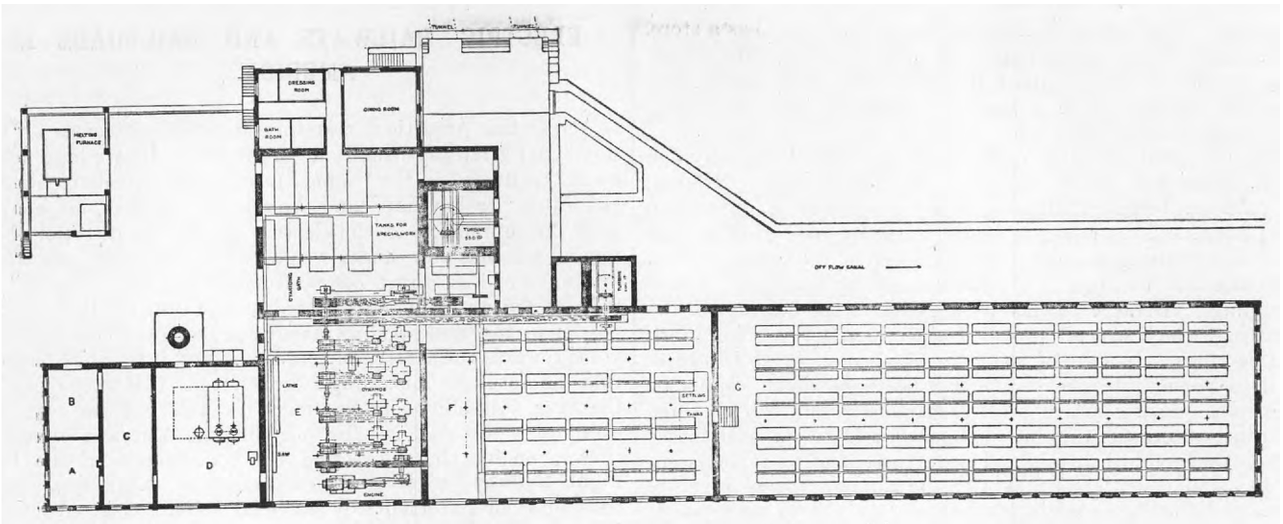

FIG. 1.—Ground Plan of the German Elmore Works near Cologne.

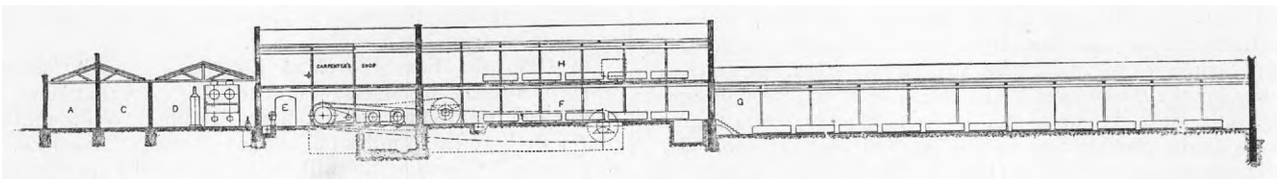

FIG. 2.—Sectional Elevation of the German Elmore Works near Cologne.

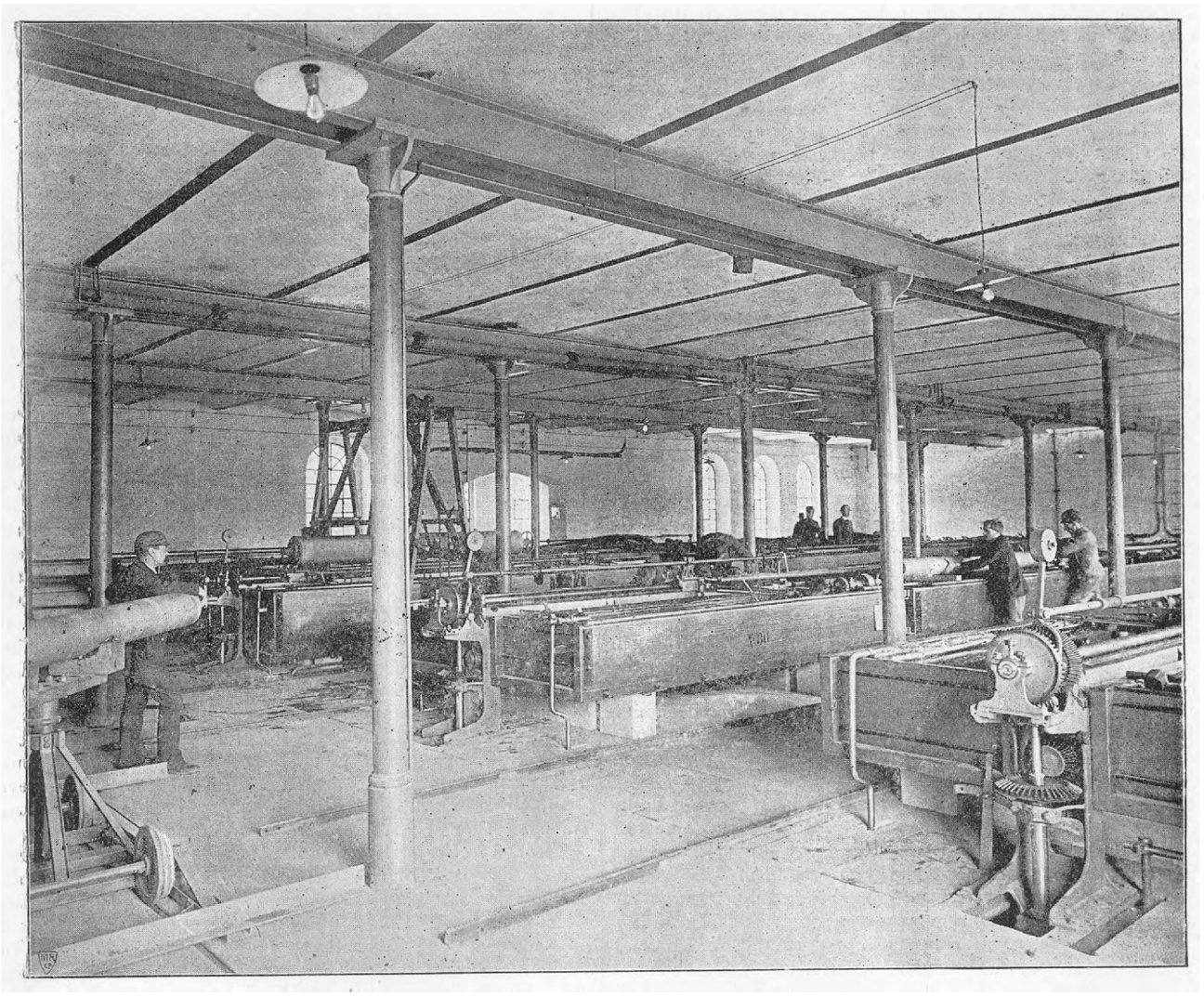

FIG. 3.—General View of Tank Room at the German Elmore Works near Cologne.

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serves as a smithy, room B as a laboratory, room C as a store. The boiler-house, D, contains one tubular boiler, with a heating surface of 1,270 square feet, and one small boiler with vertical tubes, having a heating surface of 90 square feet. The engine-room is at E.

Of the total available water-power of 1,200 H.P., only 550 H.P. have been made use of so far. Two Knap turbines, by Messrs. Briegleb, Hansen, and Co., of Gotha, have been laid down, and the power is transmitted by rope gearing to a common shafting in such a way that one or the other, or both turbines may be coupled or disconnected by means of suitable couplings. Great care has been given to the bearings of the shafting, which are all provided with loosely-revolving lubricating rings. In spite of the rather high number of 160 revolutions per minute one of the wall bearings, which cannot be controlled during active service, made a record run of three months' continuous running, and was found to be quite intact when it was refilled with oil. This feature, small as it may seem to be, is an essential one, as with the Elmore process interruptions or disturbances might prove disastrous. From the common shafting the dynamos are driven by belts. They are four-pole Helios Company dynamos, running at 230 revolutions per minute, and having an output of 1,200 amperes at 50 volts. The main shafting also drives a small dynamo, which lights the building, and provides, by means of other auxiliary shafting, the necessary power for the tank-rooms. The engine-room has been designed for eight large dynamos and for one or more steam engines, which might possibly become necessary in very dry summers.

The tank rooms, F, G, H (Figs. 1, 2, and 3), are intended for 200 tanks corresponding to a total output of 35 tons a week. At present only 40 tanks are at work, and a second set of 40 tanks is just being put down. The tanks, similar to those of the Leeds works, allow of the production of tubes of 10ft. 8in. in length and 22in. diameter. All 40 tanks are connected in series. A room near the turbine house contains very large tanks, the special tanks, in which tubes of 15ft. length and 5in. diameter can be made. This room also contains the cyaniding tank in which all the iron cylinders, hydraulic rams, &c., get the first thin layer of copper before they are passed into the tanks containing the sulphate of copper solution. Small electric motors drive rotating pumps, which produce the circulation of the liquor in the tanks; other electric motors are directly coupled to circular tube saws and polishing discs. A powerful testing machine, fitted up in a special room on the first floor, is in continuous use. Not a single tube is sent away, the qualities of which with regard to tensile strength, elongation, and contraction, have not been carefully tested and registered. These figures, together with a most complete system of daily reports, allow a very complete control of the whole output, and the origin of every tube, and all circumstances connected therewith, can be traced back at any time.

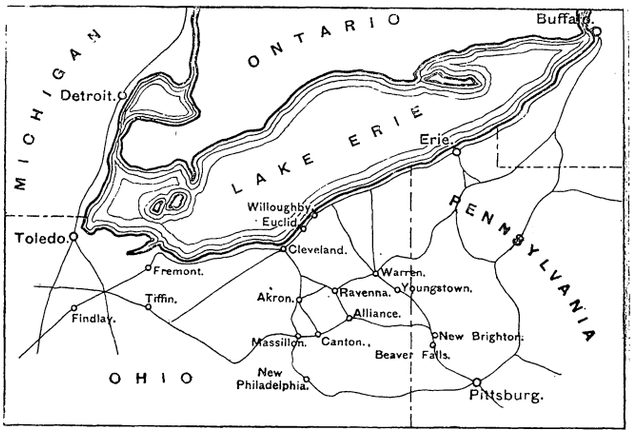
The greater proportion of the work done at Schladern is devoted to the production of tubes and the thickening up of calico rollers. Just lately another branch of the process has become of great importance, namely, the coating of seamless wrought-iron tubes. These tubes are first turned true on the lathe, and then covered with a firmly adhering copper deposit, varying in thickness from $\frac{1}{32}$in. to $\frac{1}{2}$in. The compound rollers obtained in this way are mostly employed in paper machines and in textile machines. They possess higher tensile strength than pure copper rollers without losing the advantages of the latter. It was also stated that large orders have come in lately for coating iron tubes for mining purposes inside and outside with a thin copper deposit, in order to protect them from oxidation. The adherence of the deposit to the rough iron surface is secured by a special process.

The situation of the works, which have been planned built, and are managed by Mr. Ernest Preschlin, in the midst of the most busy part of industrial Germany and close to the West Prussian Copper Mines, not only secures them skilled workmen and cheap raw material, but the selling facilities for their products are increased to a great extent, by the close vicinity of all the large German calico printers' establishments and paper mills. However, the splendid water-power is the main advantage which these works possess compared with their associated companies in other countries.

ELECTRIC RAILWAYS AND RAILROADS IN AMERICA.

Across the Atlantic a tramway invariably becomes a "railway," and a railway usually a "railroad." Before long nearly every "railway" in the United States appears likely to blossom out into a "trolley line," and American engineers, not content with the supremacy of the electric car in this direction, have several schemes now under weigh, which will bring electricity into more or less direct competition with steam "roads." A "Light Railway Bill" was passed by the Imperial Parliament a Session or two back, and as money has ever since been annually voted towards the construction of such lines, it may be presumed that the Act is not remaining a dead letter. It is to be regretted that the suitability of electricity for this purpose was not thoroughly threshed out by our obliging American friends in time to enable those directing the construction of the Irish Light Railways to profit by transatlantic experience, and to back up their statements by statistics of lines in actual successful operation. However, if the projects, said to be seriously contemplated in Ohio and Pennsylvania, are pushed forward with the rapidity customary in America valuable working data may yet be available in sufficient time.

In Ohio the East Cleveland Electric Railroad Company, which is already in possession of the streets of that town, has announced its intention of extending its line to Willoughby, a pretty little town 18 miles off, on the shore of Lake Erie. It is expected that the line will be largely used to carry grapes



and farm produce. A little further south it is proposed to connect Akron with Canton, 23 miles away, Canton with Alliance, 18 miles distant, and Alliance with Niles, by a road 25 miles long. A line is also contemplated between Warren and Youngstown, and another from Akron to Ravenna, 15 miles off. If the annexed sketch map be consulted it will be seen that in every case the proposed trolley lines will connect places already connected by steam "railroads." For some little time competition of this kind has already been successfully maintained in the case of the Canton-Massillon line, nine miles in length, the New Brighton—Beaver Falls line, and the New Philadelphia—Canal Dover line. The greater frequency of the cars and the lower fares are given as reasons for this state of things.

A project more ambitious than any of the preceding is one which is to be fathered by the Tiffin and Fostoria Electric Railway Company. It is proposed, first of all, to connect Tiffin with Fostoria, 13 miles away. This line will, however, only be one link in a system 100 miles in extent, connecting, amongst other places, Fremont, Fostoria, and Findlay.

Electric railways have up to the present a peculiar status in Ohio. They carry goods, passengers, mails, and are common carriers for an express company. In a word, they differ from other railways only in motive power used. Yet they are not amenable to the railway laws of the state. For this reason no official statistics are obtainable. No data are being collected for future use, although all such lines, being built along public highways and sometimes occupying part of the

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roadway, enjoy exceptional privileges, and will in time call for special regulation.

In Pennsylvania a charter has been granted to a company which proposes to lay down a network of electric lines 80 miles in extent, and connecting 39 towns and townships. The Reading Railroad Company is said to be alarmed at the prospect.

In connection with electric "railways," the last annual report of the Board of Railroad Commissioners for the State of Massachusetts may be read with interest. The Report is, as usual, redolent of all manner of statistics, those relating to street railways being particularly full. We do not know whether any serious attempt is made to check the accuracy of these American returns, but if not, we are afraid little good can come of them, unless, perchance, "the coefficient of involuntary mendacity" is abnormally low in New England, as, indeed, on all principles of heredity it should be.

For the year ended September 30, 1892, the total length of street railway track in Massachusetts—which, we may observe, is somewhat larger than Wales—was 814 miles, being an increase of about 21 per cent. on the mileage for 1891. Of this total 492 miles, or 65 per cent, are operated in whole or in part by electricity. The increase in electric mileage over that of 1891 is no less than 70 per cent. One company, the Milford and Hopedale, runs accumulator cars; all the others are trolley lines.

The report deals with sixty street railway companies, having an aggregate capital of not far short of four and three-quarter millions sterling. The average total cost per mile of the 814 miles of street railway existing in Massachusetts works out at £9,471. The gross income of the sixty companies which sent in returns amounted for the year ended Sept. 30, 1892, to nearly two millions sterling. The net income was £471,262, an increase of 32 per cent. upon 1891. About £316,540 was paid away in dividends, an average of 6·72 per cent. on the total amount of capital stock, as against 5·63 per cent. for the previous year. One company paid a 10 per cent. dividend, one 9 per cent. three 8 per cent., and 39 companies declared no dividend at all.

The total number of miles run was 29,617,975, an increase of 7 per cent. The total number of passengers carried during the year was 193,760,783, an increase of 10 per cent. over the preceding year. The average sum received for the conveyance of a passenger was a trifle over 2½d., and the average cost of carrying a passenger was nearly 2d., the average net profit to the companies on a passenger was 0·61d., as against 0·5d. in the previous year. On the sixty roads included in the report there were 610 accidents, of which 26 were fatal, 300 of the total being on the West End Company's system in Boston. Some 66 per cent. of the accidents were on electrical lines, against 40 per cent., during the preceding twelvemonth, the number of motor cars having doubled.

The report includes references to "fenders," or cowcatchers, and the noise made by the electric cars; the West End Company, of Boston, reporting that it has tested 43 "fenders," one of which, the Cleveland, has up to the present proved entirely successful.

THE AMERICAN PROPOSALS WITH REGARD TO ELECTRICAL UNITS.

Our Paris correspondent sends us the following *résumé* of the discussion on the recent proposals of the American Institute of Electrical Engineers with regard to electrical units, which took place last Wednesday week at the Société Internationale des Électriciens. A summary of these American proposals appeared in our issue of February 3rd :—

M. BLONDEL was of opinion that the definition of "impressed electromotive force" was a bad one, and tended to confusion. He demanded its withdrawal. He wished to keep the expression "difference of potential," and considered "voltage" slang. In his opinion there was no need to replace the word "permeability" by "inductivity," which did not appeal to the mind so much. The Committee of the American Institute of Electrical Engineers had defined "reluctivity" inaccurately, and the need for the term was by no means self-evident. He would suggest that the unit of illumination, the *lux*, should be equal to that of one bougie at one metre. He did not agree with the adoption of the Hefner-Alterneck amyl-acetate standard, which was difficult to use and of insufficient accuracy, whilst the carcel, or, better still, the Violle standard, were much more accurate. The speaker then exhibited a standard arc lamp based on the fact that the intrinsic brilliancy of the arc was constant. He (M. Blondel) had experimented, together with M. le Chatelier, upon carbons of various qualities, and had not observed any variation in their intrinsic brilliancy.

M. GUILLAUME suggested that the termination "ity" should be reserved for properties of matter—for example, "resistibility"; whilst the termination "ance" should denote a fraction—for instance, Resist*ance* = Resistibil*ity* × S/l. The term "inductance" was unnecessary. "Inductivity" was useless; moreover, there was an error of sign in its definition. The word "permeability" was handier. He would support the names of "gauss" and "weber," but not those of "gilbert" or "oersted." In any case, the size of the practical units should be such that the system was coherent.

M. HOSPITALIER voted for the radical abolition of the expression "bougie-metre"; the unit of illumination was the bougie at one metre. M. Hospitalier then read a letter which he had received from M. Potier with which he entirely agreed. M. Potier held that the units should not be called absolute but merely C.G.S. The "weber" was useless, since the C.G.S. unit of both total magnetic flux and of magnetomotive force sufficed. "Inductivity" had no *raison d'être* since we had "permeability." The expression *flux* was simpler and less ambiguous than "total induction." There was no need to give a special name to the ampere-hour or kilowatt-hour.

The discussion was then adjourned to the next meeting.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 10th.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "The Application of Lagrange's Equations of Motion with especial reference to a Perforated Solid in a Liquid," by Dr. C. V. Barton; (2) "On the Magnetic Field of a Circular Current," by Prof. G. M. Minchin, M.A.; (3) "On the Differential Equation of Electrical Flow," by T. H. Blakesley, M.A.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Methods adopted in constructing the Glasgow Central Railway Works—Bridgeton and Trongate Contracts," by Charles D. Barker, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Evening discourse: "Early Myth and Late Romance," by Sir Herbert Maxwell, M.P.

SATURDAY, March 11th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Sound and Vibrations," by Lord Rayleigh, F.R.S.

MONDAY, March 13th.

SOCIETY OF ARTS.

5 p.m. Cantor Lecture (2): "Alloys," by Prof. W. Chandler Roberts-Austen, F.R.S.

TUESDAY, March 14th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "On Plant for Harbour and Sea Works," by Walter Pitt, M.Inst C.E.

WEDNESDAY, March 15th.

INSTITUTION OF CIVIL ENGINEERS.

2 p.m. Students' Visit to the East London Water-works, Lea Bridge.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting at the Institution of Civil Engineers. Lecture: "Some Meteorological Problems," by Mr. Shelford Bidwell, F.R.S. (Illustrated by experiments).

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Technical Education: Its Progress and Prospects," by Sir Philip Magnus.

THURSDAY, March 16th.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting. Papers to be read.

FRIDAY, March 17th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Turbines," by C. V. Drysdale.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Ancient Egyptian Pigments,' by Dr. W. J. Russell, F.R.S.

SATURDAY, March 18th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Sound and Vibrations," by Lord Rayleigh, F.R.S.

*** **Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.**

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MODERN DYNAMO EFFICIENCY.

While electrical engineers may justly claim to have shown the world how efficiencies of machines may be measured to a hitherto undreamed of accuracy, and while they may indeed be said to have firmly established the true meaning of the word efficiency, as the ratio of work expended to work returned, and while they have crowned their teaching by the practical achievement of one of the most efficient machines that has ever been constructed, it is a question whether, intoxicated with the glories of 96 and 97 per cents., they are not in danger of being carried away with the enthusiasm for an ideal; an ideal which is not an end in itself, but only a factor of success. "Efficiency be hanged!" said a speaker at a recent meeting in Great George-street. It is hardly necessary to say that it was not a meeting of the Institution of Electrical Engineers. The denunciation raised only a laugh, but among electrical engineers would it not have been received with scorn? Not only is high efficiency merely a factor, but it is only one of several factors of success; for besides efficiency, sound mechanical construction, first cost, and in

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some cases weight, are of at least equal importance. Ingenious, and indeed startling, calculations may be made of the capitalised value of the saving effected by a high efficiency, and by proper handling of the figures it may be shown that a machine of this kind will pay for itself after a very few years. But, unfortunately, the cost of repairs cannot be estimated with any such facility. The racking of alternators and cutting of dynamo commutators, burned out armatures, worn brasses, and a score of items short of actual breakdowns, must all be set against this saving. More than this, almost every repair entails anxiety and additional supervision, besides possible annoyance to consumers, while a steady loss by a slight reduction of efficiency is to be detected only in the coal bill, and that only by calculation. We do not for a moment advocate any retrogression in a matter on which electrical engineers take such legitimate pride, but we do not hesitate to say that £20 a year spent in additional coal *and nothing else*, is better than £5 a year spent on additional repairs, and that the expenses consequent on a robust appetite are preferable to a succession of doctor's bills.

Among a class of young electrical engineers there appears to be a positive enthusiasm for high efficiencies in dynamos, and were reliable tests more commonly published, record-breaking would be watched with intense interest. But a central station with a dozen dynamos costing half-a-crown a piece per annum for repair, would pass unnoticed by these devotees of the high ninties. Not only does a slight increase of the coal bill fail to force itself unpleasantly on the notice of the engineers, but a diminution of repairs is necessarily accompanied by greater certainty of continuity in supply. The old Edison dynamos with all their faults, faults which the eager student can count off on his fingers with ease, ran for months and years without costing a penny. As a rule, they were run at what might be called about half-load, as far as their dimensions and weight were concerned, and many an enterprising owner has regretted changing them for the latest improvements, or has had very unfavourable comparisons forced upon him when his plant has been increased by the addition of modern machines. A most striking case of shocking efficiency combined with admirable running—perfection of running, in fact—is to be found in the De Meritens machines at St. Catherine's Point Lighthouse. Alternators with permanent magnets of the horseshoe shape seem archaic compared with our carefully selected forgings, our ampere-turns, our B, our cleverly-shaped pole-pieces, and our carefully-designed magnetic circuits; but we should like to hear an interchange of experience between their drivers and the staff of some modern supply station, on management and repairs. The builder of a machine with a marvellous efficiency is applauded for the cleverness of the design, and the figure remains as a permanent stamp of merit. The machine breaks down, and it is called an accident. Perhaps the mechanical construction might have been improved, and probably will be improved next time. The breakdown, it is said, was probably an accident, but the wonderful efficiency was no mere chance, but a highly scientific achievement. The secrets of the science of the high nineties may be taught, and are, we believe, commonly taught in lecture rooms. The true art of building a machine cannot so be taught, though praiseworthy attempts are sometimes made to do so. The elements may be discussed and the principles may be inculcated at colleges, but the art can only be learned in the shops. Electrical efficiency is easy enough to attain; so-called commercial efficiency is harder; but financial efficiency is as yet unrecognized, but should be the ambition of the dynamo builder.

AMBERLEY ROAD STATION.

The latest addition to the electric supply stations of London is that of the Metropolitan Company at Amberley Road, Paddington. The position of this station is marked on the coloured map which was issued as a supplement to *The Electrician* of January 13, 1893, and is at the extreme north-west corner of that part of the Metropolitan Company's district in which mains have been laid. The station is situated at St. Peter's Wharf, a site which has the advantage of both road and water access. The buildings consist of a boiler-house with coal store fronting the canal; engine-room and dynamo-room; and suitable offices and store rooms fronting the road, the upper floors over the offices being planned for the accommodation of the staff. After their experience of the practices of London building contractors, the Company decided to design and build their own station, the services of Mr. Mark Judge being retained chiefly for the purpose of smoothing off the difficulties which always arise in connection with the Metropolitan Building Act. The erection work proceeded without interruption through the period of the recent strikes in the building trade.

The engine-room is of ample proportions and is excellently lighted; it resembles a large country station, and is very different from most of the cramped and half-buried London stations. It contains five large horizontal engines by Hornsby, each driving a Kapp 100 kilowatt alternator by ropes. The driving centres are about 27ft.; and the speeds are 100 and 500 revolutions per minute. The contractors for the plant were Messrs. Johnson and Phillips, but owing to lack of time the alternators were made at the Oerlikon Works, Zürich. These machines reveal their continental origin in one or two minor points of construction, but seem to be excellently adapted for their work. They give 100 amperes at 1,000 volts, but will probably carry a heavier current. The design of the machines allow free access to all the parts, but without undue floor space or straggling proportions. In view of the necessity for avoiding all noise and vibration in a London station, Mr. Frank Bailey has made several experiments to obviate the hum which was set up by the rather open armature. Filling up the spokes of the wheel-like armature with wood did not produce any appreciable effect, while it rather spoilt the look of the machine, but wood filling between the armature coils effectually silenced the noise. The engines are provided with balanced governors controlling the eccentric by means of a link, and on the occasion of the visit of the Paddington Vestry on Friday last, one set was under steam on an artificial load, while two others were coupled together electrically, one alternator running as a motor and driving its engine, the cylinder and valve chest covers being removed. The steam piping is of interest, being constructed of electrically welded pipe by Messrs. Lloyd and Lloyd. A feed water-heater is provided, but no economiser. With such ample supply of water literally at their very doors, the Company is most unfortunately debarred from using it for condensing purposes, or rather, from returning it hot, to the canal. The contractors would no doubt have built the alternators at their Charlton works had time permitted, but we regret to find that not only have these come from Switzerland, but the measuring instruments on the switchboard were "made in Germany," and very much so. It is easy to understand that cheap German instruments are put on the English market by importers, but they are hardly to be expected in a first-class station equipped by such a firm of contractors as the present ones. Some of these instruments appeared to be trying to read volts, and others amperes, possibly they were German volts, certainly not Reichsanstalt volts, for these are almost the same as B.A. volts, "legal" volts, Board of Trade volts, or British Imperial volts. Like a country yokel struggling over a letter with his head on one side, the instruments were tilted

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at all sorts of angles to accommodate them to the climate or to the Kapp variety of current.

We understand that it is proposed to make no attempt to run the alternators in parallel, the switchboard is arranged for grouping the various circuits on any machines. The switchboard, placed in a gallery, is constructed of marble, and the mains, of Silvertown make, are brought into the engine-room through subways. Mr. Frank Bailey's system of ring mains, providing each customer with a duplicate supply, is carried out in the district served by this station.

One central station is very much like another, and on the occasion of the visit of the Paddington Vestry, the greatest novelty was a counter on which Messrs. Crompton and Co. exhibited electrical cooking appliances. Outside the buildings, however, we found something of considerably greater interest, but attracting no attention whatever from the visitors. This was the artificial load on which one of the alternators was running, and on which efficiency tests had been carried out. Nothing was visible but a gallows of three scaffold poles, one or two rope stays and a pair of cables disappearing into the water of the canal about 12ft. apart. The presence of half a-dozen dead or dying sticklebacks appeared to be accidental, and between the cables a board moored by cords carried a glowing 16-candle lamp. Some days ago before this little light-vessel was put down a barge load of iron pipes arrived at the wharf, and a bargee on landing was heard to indulge somewhat more freely than usual in the language of his tribe. Standing on the dry campshed, and holding a crowbar in the water, we received a slight shock, for beneath the surface two iron plates about 3ft. by 3ft. were suspended from the cables, and though not a bubble was to be seen, some 75 amperes at 1000 volts were expending themselves in the muddy fluid. The little lightship, a caution to bargees, owed its supply of energy to precisely those principles on which it has been proposed to signal to lightships from the shore. Two plates 18in. square were hung from the board, and when set between and parallel to the large plates, the lamp glowed; when swung round at right angles it was extinguished. We had no opportunity of studying the effect of the current on the little fish. On coming within two or three yards of the midway point between the plates, they appeared to be fascinated by the gratuitous electropathic treatment, and when well within the lines of flow turned over, and with a kick or two, became rigid.

SPARKING AT COMMUTATORS.

BY F. M. WEYMOUTH.

(*Continued from page 513.*)

Fig. 17 may now engage our attention. This represents in detail the brush in position C (Fig. 15), where it is shifted too far forward of the *N P* plane, which latter is indicated in both diagrams. It will first be noted that the coil *b* here carries the 500 s.-c. current instead of *f*, as in the last case, and it is a resultant 50 amperes of the *b* s.-c. that enters by lug *h*. There is thus a normal 450 assimilated s.-c. current entering through *i*, and a normal 500 s.-c. current flowing out through lug *g*. Now to consider the *c* main current, we find this attempting to enter through *g*. Being blocked, however, by the outflowing *b* s.-c. 500, it becomes assimilated with the latter in the coils *b* and *f* instead, in the same manner as the *d* current in the previous case. We then find the 450 entering by lug *i* to be composed of 200 assimilated *d* plus 250 s.-c. currents. To this latter is now added the 200 *d* main current, making a total *resultant* current of 650 amperes entering by this lug. Arriving at *o*, however, 400 amperes split off to ascend the brush, thus leaving only 250 to continue to *n*. At this latter point it is joined by the 50 *b* s.-c. current, making the 300 outflowing through *g*. Thus again is the cycle completed.

Now here there are various points to be noted. First, it is *not the main d and c* currents that are broken, for these have both a free entry into the brush through its *heel* instead of the point; and the heel continually *makes* contact with the segments, one after the other, instead of breaking contact, as compared with the case of the brush at A. It is thus the coils *behind* the brush that are reversed, and not those just leaving the point. The effect will then be that the momentary check due to the self-induction of the coil *f* will cause the reduction of the 650 in lug *i* to 50, as it arrives at position *h*, to be *gradual* instead of sudden. We shall return to this, however, in connection with the line *CnP*. The point to which we would now draw attention is thus, secondly, that it is only

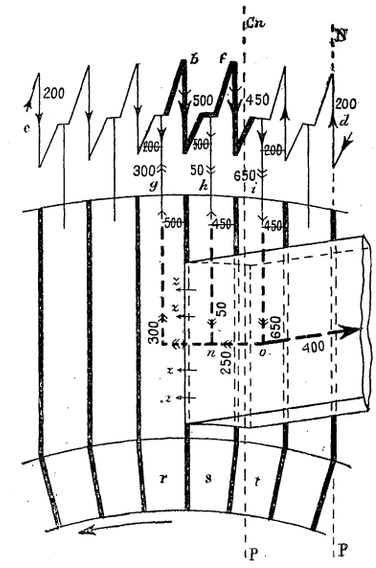

FIG. 17.—Positive Brush too far forward. Light Back Sparking. (Position C in Fig. 15.)

a *short circuit current* of 300 amperes that is broken at the recession; and further, that this is running in the *opposite direction to the main current* flowing up through the brush. We have here, hence, what has been termed "back-sparking," as indicated by the arrows *z z* in Figs. 15 and 17. Being due, moreover, to the self-induction of the coils *b* and *f* only, the

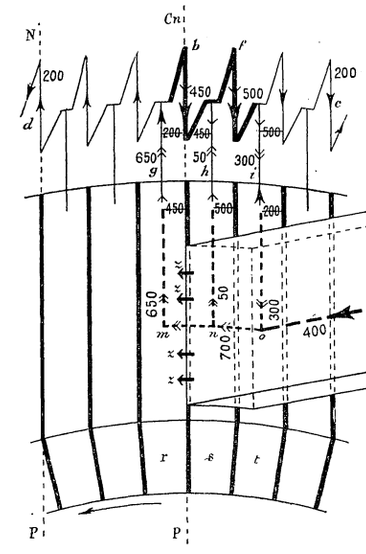

FIG. 18.—Negative Brush too far back. Heavy Forward Sparking. (Position B in Fig. 16.)

sparking is slight; while the current broken being but 300 instead of 400, or 650 as in the last case, the arcing is not so heavy. The brush, however, being positive, will incur most of the burning.

We now come to Fig. 18. This represents the lower brush in position B. As it would have been confusing to invert the diagram to make it accord with the actual position of the brush on the commutator, we do not do so, and merely indicate the

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main current *entering* by the brush instead of leaving. It will be seen here that the brush is too far back, like brush A; while of the two short-circuited coils, *f* carries the 500 amperes, being nearer the plane *y y*. The first point that may be noted is that the difference between the *b* and *f* s.-c. currents, that is, the resultant 50, instead of flowing inwards in the lug *h*, is here flowing outwards. A normal 450 s.-c. current outflows through lug *g*; and a normal 500 s.-c. current enters by *i*. But now the main current from the outer circuit arrives by the brush at *o*. Its natural course being to split and send 200 to the *c* coils and the other 200 to the *d* coils, the first-named 200 tries to obtain exit by the lug *i*. Here, however, it is baulked by the normal inflowing 500 *f* s.-c. current. This latter hence becomes reduced to a resultant 300 in *i o*, as indicated. Consequently, the first 200 becomes assimilated with the *f* current in *o n*; and being joined there by the other 200 entering by the brush, a total of 700 proceeds to *n*. Here the 50 pass up *n h*. The remaining 650 runs on to *g*, at the outer end of which 200 diverges into the *d* series of coils, while the 450 runs through *b*. This is joined by the resultant 50 up *h*, making 500 amperes in the coil *f*. At the outer end of *i* 200 separates into coils *c*, leaving the 300 to continue down *i*, as we found at the commencement.

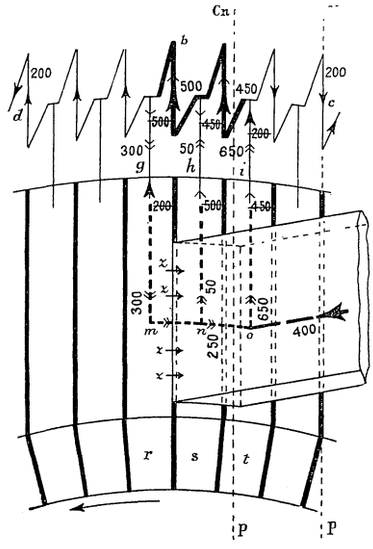

FIG. 19.—Negative Brush too far forward. Light Back Sparking. (Position D in Fig. 15.)

What we may here note is that the current broken at the recession is the *whole outer main current*, plus 250 amperes of the short circuit current. There is the whole self-induction of the outer circuit, together with the added effects of the short circuits, thus brought into play. As the outer circuit may include the field magnet coils, the sparking may here be very heavy; and with the large current, considerable burning will take place, principally, as it will be seen, at the expense of the brush.

The diagram (Fig. 19) may now engage our attention. The coil *b* here carries the 500 s.-c. current, and a resultant s.-c. 50 flows out through the lug *h*, as in the previous case. A normal 500 s.-c. current inflows through *g*, and a normal s.-c. 450 outflows through lug *i*. The 400 from the outer circuit now arrives at *o*. Of this, 200 would pass to the *d* series by lug *g*, but being met by the inflowing 500 *b* s.-c. current, reduces that to 300 instead. It becomes assimilated with the s.-c. current, and so forms part of the 450 s.-c. current outflowing through lug *i*. The remaining 200 of the outer current augments this 450, thus making a total of 650 finding exit by lug *i*. At the outer end of this lug, 200 splits off to enter the *c* series of coils, while the 450 continues through *f*. This latter amount is joined by the 50 s.-c. current from *h*, making 500 amperes in coil *b*. Of this, 200 diverges into the *d* series, leaving the 300 to continue down lug *g*. Arriving at *n*, the 50 pass up *n h*, leaving only 250 to proceed to *o*. So the cycle of operations is once more completed.

It will now be noted that we have back-sparking here, as in the case of the brush in position C; for it is the contrary direction to the main current. Moreover, as in the latter case, there are only 300 amperes broken, and that but short-circuit current. Thus, the sparking will be only that due to the self-induction of the short-circuited coils *b* and *f*. It will hence only be slight, and with the small current the arcing will not be great, though the segment will suffer the most. As with the brush C, the main current passes through the heel of the brush, and not the point, and so escapes being broken.

(To be concluded.)

CONCENTRIC CABLE PHENOMENA IN ALTERNATE CURRENT WORKING.

BY L. NEUSTADT.

It was noticed in a large network of concentric cables traversed by an alternating high-pressure current, that the insulation was often destroyed when a section of cable was switched in or cut out during the working, or if a cable-fuse went. In most cases the damage was done to the insulation between the outer conductor of the cable and the sheath, which is, of course, generally somewhat thinner than that between the two conductors. This phenomenon, which was frequently observed in

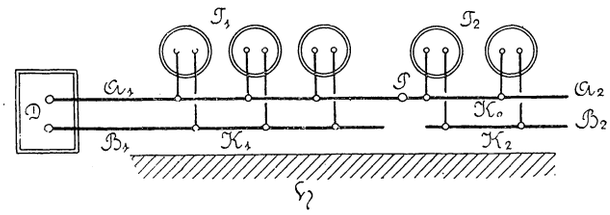

FIG. 1.

a large network embracing about 85 kilometers, occurred also in such cables as not only left nothing to be desired as far as insulation was concerned, but in which the insulation had been experimentally tested before laying with a pressure many times the normal working voltage, without sustaining injury of any kind whatever. The puncture only occurred when the inner conductor was coupled first (in the case of a joint being effected), or conversely if the outer conductor was first disconnected, and when the section in question contained transformers, which had either open or very lightly-loaded secondary circuits. The cause of this phenomenon, which may have very serious effect on working, is the subject of the following remarks.

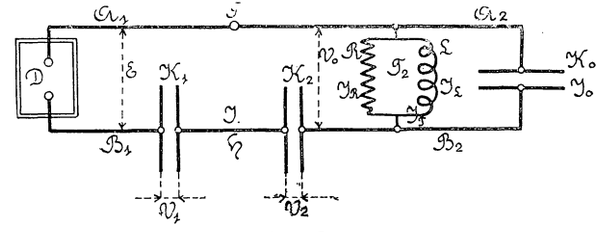

FIG. 2.

In Fig. 1 let D be the generator, delivering an alternating current into the cable, of which A is the inner and B the outer conductor, and let T represent transformers and K the condenser formed by the outer conductor B and the sheath H of the cable, which is of course earthed. Let K_0 be the condenser which is formed by the inner and outer conductors of the cable. The point of junction of the two parts of the inner conductor A is at P. Indices (1) indicate the parts of the system coupled to the dynamo, and indices (2) apply to the parts connected only by the inner conductor at P to the system. In this investigation I shall suppose that the insulation of the cable network is perfect, and that there are no concentric cables in the secondary network.

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One circuit is formed by the dynamo T, the conductor $A_1 B_1$, and the primary of the transformer T_1; another circuit, the one with which we are concerned, and which is diagramatically shown in Fig. 2, is formed by the dynamo T, the conductors $A_1 A_2$ and B_2, the transformers (with little or no load on) T_2, the condensers $K_0 K_1 K_2$, and the outer sheath H (earth). Call the voltage at the terminals of the dynamo E, and assume that E may be expressed by the simple formula,

$$E = \sqrt{\frac{r}{2} \int_0^{\frac{2}{p}} (E_0 \sin p\pi t)^2 \, dt}.$$

and neglect any drop of volts which takes place in the cable itself. Let I be the current in the circuit we are examining, L the coefficient of self-induction of the transformer system T_2; let R be a resistance which represents the equivalent of the losses by hysteresis eddy currents and load in the transformers, according to the formula

$$W = V_0^2/R.$$

and V_0 represent the pressure at the transformers.* The phenomena are easily explicable if we assume that K_1 is very great compared with K_2 and K_0 is very small compared with K_2, and that we are dealing with an ideally good unloaded transformer, so that

$$R = \alpha \qquad K_1 = \alpha \qquad K_0 = 0.$$

This assumption leads to the case shown in Fig. 3, under which circumstances it is well known that in certain cases the voltage at L and K_2 may be many times higher than that at the terminals of the machine.

Returning to Fig. 2, suppose for the sake of further investigation that V_0 represents the pressure at the group of transformers T_2—that is to say, the voltage between the conductors of the cable; and that V_2 represents the voltage at the condenser K_2—that is to say, the pressure between the outer conductor and the sheath or earth. For I_1, V_0, and V_2 values can

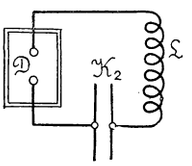

Fig. 3.

be found in terms of E under the foregoing assumptions, which I write down as the result of somewhat tedious though easy calculations, without trying the patience of readers with the full working of formulæ which rest on assumption which are not entirely justifiable.

$$I = E \times \frac{p \,.\, \pi \,.\, K_1 K_2}{K_1 + K_2} \sqrt{\frac{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{p\pi L} - p\pi K_0\right)^2}{\left(\frac{1}{R}\right)^2 + \left\{\frac{1}{p\pi L} - p\pi\left(\frac{K_1 K_2}{K_1 + K_2} + K_0\right)\right\}^2}}$$

$$V_0 = E \times \frac{K_1}{K_1 + K_2} \sqrt{\frac{(p \,.\, \pi \,.\, K_2)^2}{\left(\frac{1}{R}\right)^2 + \left\{\frac{1}{p\pi L} - p\pi\left(\frac{K_1 K_2}{K_1 + K_2} + K_0\right)\right\}^2}}$$

$$V_2 = E \times \frac{K_1}{K_1 + K_2} \sqrt{\frac{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{p\pi L} - p\pi K_0\right)^2}{\left(\frac{1}{R}\right)^2 + \left\{\frac{1}{p \,.\, \pi \,.\, L} - p\pi\left(\frac{K_1 K_2}{K_1 + K_2} + K_0\right)\right\}^2}}$$

I will not enter into a general discussion of these equations, but will consider a particular case numerically, taking values in practical use as a starting point which apply to the diagram constructed for this purpose. I observe further that the relation of L to R and of K_0 to K_2 is given by the general design to the transformer and cables used; while the relation of K_1 to K_2 depends on the lengths for the particular case and other dimensions of the network.

* R is really not a constant quantity, as the energy used for magnetising and demagnetising the transformers cannot be put proportional to the square of the volts V_0.

For example, let the frequency be 43 ∽, then $p\pi = 270$, and let E = 2,000 volts, R = 10,000 ohms, $L = 10 \times 10^9$ C.G.S. units, $K_1 = 50$ microfarads, $K_2 = 1{\cdot}0$ microfarad, $K_0 = 0{\cdot}4$ microfarad. These values represent a network of a total length of about 85 kilometres of between 25 and 250 square millimetres cross-section, to which network is coupled a section of cable 1-2 kilometres long containing transformers of about 20 kilowatts output, with no secondary load. Fig. 4 gives the diagram of the voltages and currents which can be constructed on the above assumptions, and which represents the formulæ given above.

The current circulating in the resistance R (I_R) is in the same phase as V_0, and the current (I_1) representing the self induction is 90deg. behind V_0: the current through the condenser K_0 (I_0) is 90deg. ahead of V_0. The total current I is the resultant of I_R I_L and I_0, displaced from V_0 by an angle ϕ. The voltages V_1 and V_2 are 90deg. behind the current I; and the resultant electromotive force E, resulting from the combination of V_0 V_1 V_2 is displaced by an angle ψ in phase from the resultant current I. Looking at Fig. 4 we see that $V_0 \cos \phi = E \cos \psi$, whence we note that the greater the angle ϕ (that is, the greater the displacement of phase in the system $T_2 K_0$, and the smaller the angle ψ, the greater can V_0 and $(V_1 + V_2)$ become relatively to E—that is to say, the greater can the pressure become on the insulating material of the cable for the same voltage on the dynamo. The pressure $V_1 + V_2$ divides itself in the inverse ratio of the capacities K_1 K_2 on the two condensers, that is to say, the higher and dangerous pressure comes on that piece of cable which has the smaller capacity;

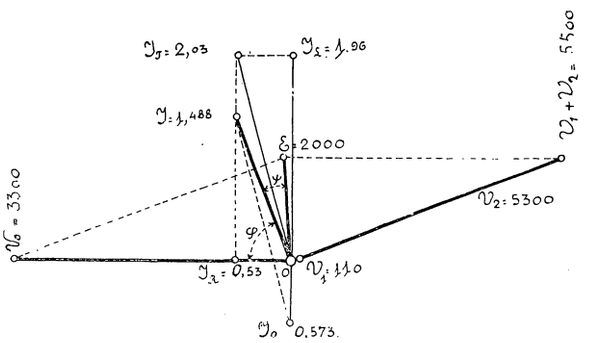

Fig. 4.

in most cases, therefore, on the part of the network which is being switched in or out. The greater K_1 becomes in relation to K_2 the greater becomes V_2 in relation to V_1, but when K_1 become much larger than K_2, the ratio V_2/V_1 rises very slowly, even if K_1 becomes very much larger. Thus when the section of the network already working is very extensive, the addition of another portion becomes of less importance and has less effect. For a certain length of the cable switched in (K_0 K_2) there is a certain number of transformers (R L), for which the ratios $V_0 : E$ and $V_1 + V_2 : E$ become maxima.

The calculations I have taken as an example under the above assumptions gave for V_0 and V_2 pressure of 5,300 and 5,390 volts, with a generator supplying current at 2,000 volts; and on the assumption that the dynamo furnished currents and volts which followed substantially a siné law. These cases are not very common in practical dynamos; on the other hand, there are cases in which the departure from a sine law is so great that a relatively much higher rise of volts can take place than in the case just considered. Further, a rise of volts can also take place for this reason, that the iron cores of the transformers become more saturated on account of the rise in volts. Apart from these latter considerations the "theoretical" values of V_0 and V_2 represent by themselves pressures which would be a source of danger to the cable network and the transformers coupled to it, and which as experience has shown are large enough to be a source of breakdown in cases in which the factors happen to have the right ratio to one another.

To avoid this undesirable rise of volts a rule must be made that the inner conductor must never remain coupled on alone in cases where the switching arrangements, are not so constructed as to make a mistake impossible.

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ELECTRIC SIDE-LIGHTS ON SHIPS.

In the Departmental Paper No. 176, recently issued by the Board of Trade, the use of powerful glow lamps in the red and green side-lights for ships is discussed. The following Memorandum by Sir Digby Murray relates to the green lights, and a further communication has been made by him on tests of the red lights. It is found that the electric light has the effect of somewhat paling the red light, but red slides of the darker of the two standard tints, or of a shade intermediate between the two standards, are found to give a very good colour.

In consequence of the representations of the Russian Naval Attaché as to the effect of the electric light on the green side-light of the Russian Imperial yacht, I promised to thoroughly investigate the subject. I requested Mr. Samson to make some initial inquiries and experiments, and as these latter appeared to show that the electric light did, to a certain extent, neutralise the colour of the green slide or lens (as the case may be), I determined to thoroughly experiment with a view to ascertaining definitely the effect of the electric light of different degrees of intensity on the green glass. Hearing that Sir Donald Currie and Co. applied electric light of very considerable candle-power to their side-lights, I wrote to that firm requesting that they would give Mr. Samson facilities for inspecting their lights, and it is owing to their kindness and courtesy and the able assistance rendered by their staff that it has been possible at once to arrive at a solution of this question. The Board of Trade sent their standard side-lights, together with the standard green slides as approved by the Admiralty and the Board of Trade, to Sir Donald Currie's office at Blackwall, and at 8 p.m. of Wednesday, November 2nd, the trials took place before Captain Rogestvensky, the Naval Attaché to the Imperial Russian Embassy, Mr. Samson, and myself, and were of the most conclusive character.

The lamps tried were three in number, viz. :—

1. An electric side-light manufactured by Messrs. Chance Brothers, of Birmingham, having a green slide of a different colour and deeper tint than the darkest shade of the two Board of Trade standard colours.
2. An electric side-light, having a green slide of the same tint as the darker of the two Board of Trade standard colours.
3. The Board of Trade standard oil lamp, having a green slide of the same tint as the lighter of the two Board of Trade standard colours. I was anxious to replace this slide with one of the darker tint; but our spare slides would not fit this particular lamp, and, as our experiments subsequently showed, this was not material.

It was raining during the time the experiments were being carried out, but this did not at all affect the comparisons between the three green lights, although it considerably affected the colour of the white mast-head light, giving it a reddish tinge. The electric side-light of Messrs. Chance showed a good colour throughout the whole of the experiments; though the green slide of this lamp was of a deeper colour than the darkest of the Board of Trade standard tints, there was only a very slight perceptible difference between its colour when lighted by electricity and the colour of the oil lamp which had a slide of the lightest of the Board of Trade tints.

The conclusions Mr. Samson and I have arrived at are as follows :— In the case of electric side-lights neither of the standard greens are dark enough, and the colour should either be determined by experiment, in which case the colour of the side-light at the particular candle-power it is intended to use should not show lighter than that of a full-sized oil lamp fitted with the lightest of the two standard tints of green, or the shade of colour which Messrs. Chance have in consultation with Sir Donald Currie and Co. manufactured for this particular lamp on board the "Roslin Castle" should be adopted. We think it desirable that a number of slips of glass of this colour should be obtained from Messrs. Chance for the information of the Board's officers, and through them of the shipowning public, and that a cautionary circular should be sent out to the surveyors to the following effect :—

> "It having come to the knowledge of the Board of Trade that the two standard green tints adopted by them for oil lamps are not applicable to electric side-lights, surveyors are informed as follows :—
>
> "In the case of electric side-lights neither of the standard tints of green are dark enough, and the colour should either be determined by experiment, in which case the side-light should not show of a lighter colour than that of a full-sized oil lamp fitted with the lightest of the two standard tints of green glass, or the shade of colour which Messrs. Chance have adopted in consultation with Sir Donald Currie and Co. in the starboard side-light of the 'Roslin Castle' should be adopted.
>
> "Samples of these glasses are forwarded herewith, and surveyors should make this information as public as possible."

We append a table showing the experiments :—

Description of Light.

Starboard electric side-light with a specially dark-tinted slide, by Messrs. Chance Brothers.	Starboard electric side-light with a slide of the darker tint of the two Board of Trade standards.	Board of Trade standard starboard side-light, burning mineral oil with a slide of the lighter tint of the two Board of Trade standards.
16 c.p.—Good colour	Pale in colour.	Very good colour.
32 c.p.— do.	Too pale in colour.	—
50 c.p.— do.	do.	—
100 c.p.— do.	Not tried.	—
200 c.p.— do.	do.	—

All the electric lights were incandescent lights. As compared with the oil lamp fitted with the light green slide, the electric light fitted with a slide corresponding to the darker standard green was too pale, and with 32 and 50 c.p. was nearly white. Messrs. Chance's light, though fitted with a specially dark slide, showed only just a shade darker colour than the oil lamp. The difference in candle-power did not seem to further affect its colour, *i.e.*, its colour with 200 c.p. was as good as with only 16 c.p.—(Signed) DIGBY MURRAY, PETER SAMSON.

ON TESTING AND WORKING ALTERNATORS.*

BY W. M. MORDEY.

(Concluded from page 516.)

Power Factor of Alternating Motors.

The "power factor," or "plant efficiency," of alternate-current motors, whether synchronous or not, is a subject of great importance, on account of its bearing on the economics of power transmission by alternate currents. Although at the moment the power factor of motors is not as pressing a matter as the power factor of transformers (which has received Dr. Fleming's recent attention), it is desirable to find whether for alternate-current motors we have to use cables and machinery capable of carrying a large idle current, or whether we can treat power-transmission projects, so far as these matters are concerned, in the simple manner that is possible with alternate-current transmission with good closed magnetic circuit transformers. I am able to say that, so far as my own observations go, working with one class of alternators, the power factor of these machines when used as motors under fair loads is very high, if they are used under conditions that are easily obtained.

Fig. 6 illustrates the way in which the load-factor varies with the excitation. The two V-shaped curves show the current that was taken respectively by an "A 7" 25-kilowatt alternator, and by an "A 10" 50-kilowatt alternator, running as motors, without

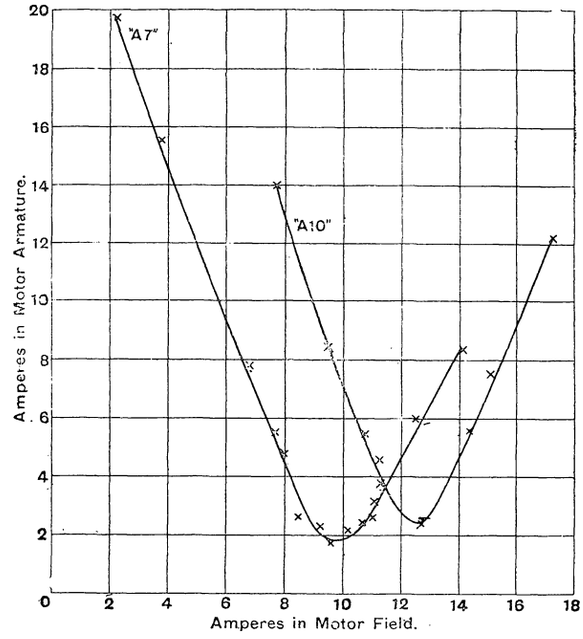

FIG. 6.

load, when the excitation was varied. They were driven by another alternator, and a potential difference of 2,000 volts was maintained across the terminals. Speed constant at 100 ∿. It will be observed that in each case there is an excitation that reduces the armature current to a minimum, and therefore gives a maximum power-factor and maximum efficiency. If the excitatiou is varied on either side of that value, the armature current rapidly increases. In order to find whether the same kind of effect takes place when the motor is loaded, one of the motors was made to drive another alternator the load on which was varied. It was found, as was to be expected, that with various loads, and of course at constant speed, there was for each load an excitation that corresponded with a minimum armature current; that the armature current rose on varying the excitation either up or down, and that the excita-

* Paper read before the Institution of Electrical Engineers, February 23, 1893.

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tion that gave the lowest armature current (or the highest efficiency and highest power-factor) was approximately the same for all loads, with the same impressed potential difference.

This is what one would expect. With a weak field a large armature current is required to give the necessary torque; while with a strong field the E.M.F. of the motor is higher than that of the generator; the driving current, therefore, is large for a given torque, as it cannot get in advantageously. It will be remembered that Dr. Hopkinson predicted years ago that an alternator would run as a motor under the condition of the motor having a higher E.M.F. than the generator.* From these curves we see that the power-factor may vary enormously, but there is no difficulty in making it a minimum and the efficiency a maximum by always working at the excitation that gives the lowest reading of current. It will be seen from the table of results given above that the power-factor is high. It appears to fall away at no load to a much lower value, as will be seen from an examination of the two curves. This, however, is of no practical moment, as the machines do not take much to drive them under light load conditions; and although I have not made determinations at intermediate points, it appears that, as was shown by Dr. Fleming to be the case with closed-circuit transformers, the power-factor approached unity as soon as load was put on. It is satisfactory to find that, in this respect, these two classes of alternate-current apparatus have similar qualities.

The present opportunity may be taken to allude to a device which I have used for some time in connection with the working of alternators, and which we apply to all the larger machines. In alternator armatures there are advantages in having the coils arranged in two or more parallel portions, instead of all in series. The insulation of the terminal portions of the winding is easier, and, except in small machines, the conductors are more manageable. But in practice we have found that the parallel arrangement has one drawback. Unless the coils are equally and simultaneously acted on all round, the voltage of the two portions will not be

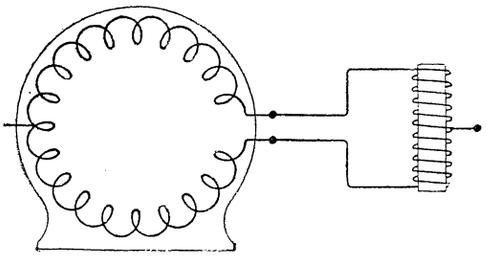

Fig. 7.

equal, and a circulation of current will take place within the armature. The machine will, in fact, act to some extent as in the dynamotor method described, and a loss of power will result. This has probably been overlooked in machines having revolving armatures, as with such armatures it is not easy to observe the effect. It is difficult to avoid this circular current by ordinary means. If the pole-faces are exactly alike in size and position, and the polar gap is the same all round, and the armature coils are identical in winding and in relative angular position, the inequality will not exist. But these are conditions that can only be certainly obtained at a considerable expense. With cast magnets the poles vary a little. The armature coils are adjusted radially, and it would be troublesome and expensive to place them so as to comply with the conditions mentioned. By a simple application of a known property of transformers this difficulty is avoided. This is shown in Fig. 7. A pair of similar coils is arranged in the manner of a transformer, one coil being placed in each half of the armature circuit. The connections are such that with equal currents from the two portions of the armature there is no magnetism induced, the two windings neutralising one another. But any tendency of one portion of the armature to give a larger current than the other portion is resisted by the "equaliser" (as I term this apparatus), which then acts as a transformer opposing an E.M.F. in the circuit which has an excess, and adding a corresponding E.M.F. to the circuit of lower voltage. Thus the two portions of the armature contribute equally to the external circuit, while the circular current is prevented, whether on open circuit or under load. The equaliser is quite a small affair. As an example of its efficacy, I may mention that in one case the two sides of a 250-kilowatt 2,000-volt alternator were made so unequal that a current of 16 amperes circulated. The addition of a small "equaliser" reduced this circular current to half an ampere.

I do not know whether this inequality has been noticed by others, but it is well known that it may exist in direct-current dynamos when different parts of the armature are acted upon unequally, and it has been cited as an objection to the paralle winding and connection of armatures in such machines with multipolar fields. Whatever force there may be in this objection, it will be granted that it is not as easily met as in alternators. Indeed, it may be said of alternate-current apparatus generally, that, although difficulties are met with, and often of an unexpected kind, their very nature provides us with new and simple means of avoiding or reducing them. In iron-cored armatures, whether of alternators or dynamos, the iron core may to some extent tend to counteract inequalities of this sort.

Parallel Working of Alternators.

This subject has received a great deal of attention during the last few years. I do not desire to add anything to the literature dealing with its theoretical aspects, but, as it may be of interest to some members of this Institution, I take the opportunity of giving a description of the principles on which my colleagues and I act in dealing practically with parallel working. Some years ago Mr. Raworth and I recognised that this was quite as much a question of prime motors as of electrical apparatus, and we then settled on the main points of the arrangements for parallel working, which have been acted on ever since, practically without change. 1. Each alternator is driven by a separate engine. 2. All the engines are in parallel on the steam-pipe, and are supplied with steam at the same pressure. 3. All the alternator fields are magnetised in parallel, and are supplied with current at the same pressure. 4. All the alternator armatures are in parallel, and supply into the mains at the same pressure. 5. Each alternator gives its proper proportion of load by regulation of the amount of steam admitted to its engine. 6. The regulation of potential difference is by the control of the common exciter.

Thus it will be seen that the individual regulation of current (that is, of load) of each alternator is entirely by control of the steam supplied to its engine. The regulation of the E.M.F. as a whole is by the control of the excitation simultaneously affecting all the alternators. Each engine must be capable of control when working, either by the stop-valve or by having a governor capable of adjustment when running.

In working alternators in parallel the precautions that should be observed will be best understood by a consideration of the following:—Consider the case of two alternators. Assume that one alternator, A, is running and doing work driven by its engine, E, and that it is required to start the second alternator, A_1, with its engine, E_1. Start the engine E_1 and excite the alternator A_1. If the fields of the alternators are excited in parallel from the same exciting source—as is preferred, and as we arrange whenever possible—there is no necessity for any adjustment of the individual excitation (except for differences of temperature). It is merely necessary to connect the field to the exciter. It will then receive the proper field current. Let the double-pole main switch of A_1 be open. The synchroniser is then to be switched on, and the speed of the engine E_1 adjusted till the synchroniser lamp is steady, showing that the alternators A and A_1 are running at the same speed. It will not be found difficult to so adjust the engine E_1 that the synchroniser lamp shall remain steady for several seconds at a time. For greater accuracy a voltmeter may be used instead of or in addition to the synchroniser lamp. When the synchroniser lamp (or voltmeter) is at its highest, the double-pole main switch of A_1 should be closed, so connecting the alternators in parallel. It will be perceived that at this time the engine E_1 is only supplied with steam sufficient to drive the alternator A_1 (without load) at the required speed. The alternators when put in parallel will therefore merely keep in step, A_1 doing no work on the external circuit and receiving no power from that circuit. This will be shown by its ammeter, which will show that no current, or only a very small current, passes between the machines. As the supply of steam is increased, the ammeter of A_1 will show an increased reading, while that of A will show a decreased reading, until (in the case of alternators of the same size) the two instruments show that the load is equally divided between the machines. When this condition is attained no further regulation of engines is required, any increase or decrease of load dividing equally between them. The control of E.M.F. is effected by regulating the exciter, and not by means of resistances in the field circuits of the alternators. As the fields are all wound to excite from the same mains, there is no need for an individual regulation of the fields, except, perhaps, a slight adjustment to compensate for difference of temperature between machines that are being started cold to work with others that have become warm by long running. The field ammeter should be observed in order to give each machine the same excitation.

To stop one alternator when two or more are running, the load should not be switched off suddenly, but steam should be gradually reduced by the governor or stop-valve of the engine until the alternator is doing no work, as shown by its ammeter. Then the switch between the alternator and mains should be opened and the engine stopped. If the steam is gradually reduced in this way, the load

* *Journal*, Vol. XIII., p. 505, November, 1884.

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will be transferred to the remaining engines and alternators before the machine is switched off, and no racing of the engine can occur. Steam should be turned off till the ammeter needle goes back to zero, showing that the alternator is not doing any work. If steam is continued to be turned off beyond this point, the alternator will then *take* current (to drive it as a motor and to enable it to drive its engine), and the ammeter needle will, after going back to zero, show a deflection representing this received current.

It may, perhaps, be pointed out that artificial loads need not be used in putting alternators in parallel. This is sometimes done, but it can only be necessary where the characteristics of the machines show great variations between no load and full load.

In conclusion, I have to thank the Brush Company for the preparation of the diagrams; and my hearty acknowledgments are due to Mr. Woof and Mr. Watson, two of the company's heads of works departments, and to Messrs. Stobart, Hansard, and Foyster, students and assistants, for much careful and willing assistance in carrying out trials by these methods.

[*An abstract of the complete discussion on this Paper will be given, probably next week.*]

THE LIGHTING OF BELFAST.

On Thursday last Prof. A. B. W. Kennedy's report on the proposed public lighting of Belfast was submitted to the Gas Committee of the Belfast Corporation. Prof. Kennedy states that, having had an opportunity of carefully examining the streets and buildings, and the several proposed sites for a central lighting station, he finds he cannot recommend any one of the ordinary systems in use without important modification, and he therefore, in his report, gives the Corporation separate figures connected with the proposed central and southern districts of lighting, as it is probable that the Corporation will proceed sooner with the lighting of the former than the latter district. It being impossible to obtain any definite data on which to base an estimate of the amount of current likely to be required, Prof. Kennedy has prepared his own estimate, based upon his examination of the City, and his experience in other districts. He thinks it probable that within two or three years of starting the works Belfast will require a current equivalent to 8,500 lamps of 8 c.p. in the central district, and in the southern district about 4,000 similar lamps, and he thought that provision would be ample if made for rather over 6,000 lamps in the first case, and for about 1,400 lamps in the second. Basing his estimate upon these calculations, and taking the charge per unit at 6d., the income per lamp in the central district would be 8s. 9d. per annum, and in the southern district 5s. 9d. per annum. On the assumption that about 17·5 units per annum would be used in the former district, and about 11·5 units in the latter, the total income would be £3,850 and £1,200 respectively, with a reasonable probability that in the former case the amount would be much larger. The central business part of the city is of small extent, comprising all the scheduled streets which contain first-class shops and business premises, clubs, banks, and other similar buildings. This is the sort of district in which the electric light is generally most popular, and where it has paid best, as there is no difficulty in supplying the light economically. For this district Prof. Kennedy recommends putting down a low-tension network of distributing mains; this is equally essential whether the current be originally generated at high or low tension pressure. Prof. Kennedy carefully reviews the special features observable in the case of Belfast, where one portion of the city is occupied by business premises, and another portion is entirely residential. He points out that for the latter it would be necessary to make a considerable expenditure, without any reasonable expectation of an early profitable return, and, in the result, suggests that the residential districts of Belfast should be omitted from the electric lighting scheme until such time as the demand for the light justifies its extension beyond the boundaries of the business portion of the city. The southern district could most cheaply be supplied with electric energy by a high-tension alternating current sub-transformer system, but that unfortunately there does not seem to exist (except on paper) any satisfactory way of cutting these transformers out of circuit when not in use, the result being that the loss is so considerable that he recommends the Corporation to spend an additional £1,500 in laying low-tension distributing mains in this district also, so that both the Central and Southern districts will be supplied in a similar manner. With regard to the site for a central station, two of those recommended have special advantages, and either of which would serve perfectly for generating high-pressure current; one is called the Ormeau-avenue site, the other the Albert Bridge site, and both belong to the Corporation. The riverside station would be out of the question for a low-pressure system, which would be considerably most costly than any other, the excess of cost being greater that Prof. Kennedy feels justified in recommending the Corporation to incur. In places like Belfast, where the day load is always very small, and where the difference between summer and winter lighting is much greater than the average, it is of special importance to economise both labour and fuel at times of low load, and the most practicable method of doing so in this case is by the use of batteries, and Prof. Kennedy has endeavoured to scheme out a system by which may be gained the advantage of the use of batteries at a cost very much less than that of a direct three-wire system worked from one central station in the usual way. This could no doubt be done on the Oxford system, but when worked out the expense appeared to be as great in the case of Belfast as that of an ordinary direct-current system. Prof. Kennedy therefore recommends the Corporation to adopt what he considers the most economical and advantageous form of sub-station, viz., one in which the dynamo or dynamos are driven by ordinary gas engines, using town gas (in Belfast 2s. 3d. per 1,000 cubic feet). This central sub-station should be used in a quite different fashion from the ordinary sub-station. It should be the head-quarters of the system of distribution, and would probably contain two gas-engines of about 50 I.H.P., with corresponding dynamos, and a battery installation of about 500 ampere hour capacity, so that the plant would be always at work when it was necessary for any machines to be running at all; it would be connected with the central station simply by a pair of trunk mains, and would not contain any special reserve plant, as in case of failure of any machine, the necessary additional current could be sent through the trunk mains from the central station without any disturbance of pressure in the distribution. By adopting this suggestion the whole of the plant of the central station would not always be at work; the gas engine would allow its machinery to be started at any moment if required, and even in the winter would only necessitate having one watch per day. The central station would contain plant for taking up three-fourths of the load, together with all reserves, as experience proves that the entire plant would only be required for a few hours, and always at times well known beforehand. From figures supplied of the gas demand it was probable that for three or four months in the year it would not be necessary to run the central station at all, as the small sub-station would be quite sufficient to generate all the current required. By this means the work could be carried on all the year round, in spite of the varying load, with the greatest economy in respect to wages and to wear and tear of plant. This system would necessitate the use of gas engines in both the cent al and sub-stations, as this would obviously be the most economical power under the circustances. One of the chief difficulties, and one which has put the use of gas engines out of the question in many cases, is the size of engine required. This difficulty does not exist in the case of Belfast, as no engine of more than 100 I.H.P. would, at any rate for the present, be necessary, and this fact has weighed very much with Prof. Kennedy in forming his decision. He is fully aware that great difficulties still exist in arranging that dynamos shall be driven direct by gas engines, but this has been done on the Continent, and may, consequently, be done at Belfast, but if unsuccessful it may be necessary to face the disadvantages of belt or rope driving. He does not feel himself able to recommend the Corporation to use generator gas, as this system is still only on its trial, more particularly in connection with work so irregular as electric light work; its first cost is great, while the cost of plant necessary in the gas-engine system which Prof. Kennedy recommends is small. The southern, or smaller district, would only require about 100 I.H.P. altogether, of which one-half might be placed in 25 H.P. units in, say, two sub-stations, and the remainder in the central station. The sub-stations would be connected with the central station, as in the case of the central district, and in such a way that the latter would serve as a reserve in all emergencies, and could also supply half the required power at the heaviest load.

The distributing mains would be connected through to the central district, so that the batteries would keep the mains always alive, and supply the small amount of current for 18 hours out of the 24 for the greater part of the year.

Summing up, Prof. Kennedy estimates the cost of the scheme which he recommends, exclusive of lands, buildings, and meters, but including the whole of the plant, mains, and road work, at about £19,000 for the central or larger district, and for the southern, or smaller district (including nearly double the amount of road work necessary for the larger district) about £11,000, including, as in the former estimate, all plant and machinery, mains and roadwork, but omitting buildings, lands, and meters. In the case of the central district the expenditure, to a certain extent, may be made dependent on the demand for light. The mains must be laid down at once, and represent about half the total outlay; but if the immediate demand for the light were smaller than estimated the plant at the central station could be reduced until the demand increased, which Prof. Kennedy does not think would be very long. In carrying out the lighting of the smaller district the Corporation would, of course, proceed step by step, commencing with the sub-station nearest the central, and where houses are closest together.

Prof. Kennedy estimates the actual station expenses, including salaries, wages, gas, stores, and repairs, at about one-half the price per unit, viz., 3d.—that is, when there are about 8,000 lamps wired. Other expenses, such as management, rent, rates and taxes, interest, sinking fund, and depreciation, would add a further 3d. It would seem, therefore, not unreasonable that the charge made at the start should be 7d. per unit, which would decrease as the number of units sold increased.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF COMMONS—TUESDAY, MARCH 7.

HAMPSTEAD, ST. PANCRAS AND CHARING CROSS RAILWAY.

A Committee of the House of Commons, presided over by Sir C. Dalrymple, sat on Tuesday to consider the Hampstead, St. Pancras and Charing Cross Railway Bill. Mr. Pembroke Stephens, Q.C., Mr. Hume Williams and Mr. Le Breton appeared as counsel for the promoters, and the opponents of the Bill were the Vestry of St. Pancras (represented by Mr. Castle, Q.C.), the British Medical Association (by Mr. Meysey Thompson, Q.C.) the St. Giles District Board of Works (by Mr. Courthope Monro), the London County Council (by Mr. Freeman, Q.C., and Mr. Cripps, Q.C.), and the Vestry of St. Martin's-in-the-Fields (by Mr. Claude Baggalley).

Mr. PEMBROKE STEPHENS opened the case for the Bill. The feature of the scheme was, he said, that the line would be made in two

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tunnels, which would ensure good ventilation and the avoidance of smoke and sulphur. The system under which they proposed to work was the cable system, with electricity in reserve, so that whichever was found to be the safest system would be adopted. The learned counsel referred to the report of the Joint Committee of both Houses of last year, which adopted conclusions in favour of the sufficiency and special adaptibility of electricity as a motive power for underground tubular railways, while they also regarded cable traction as of recognised utility, especially in the case of steep gradient lines. The proposed line would have a steep gradient nearly the whole way, and, therefore, the promoters proposed to test the cable system as a primary one; but they also included in the Bill power to use electricity in case it should hereafter be found to be the more desirable mode. He explained that the line had been somewhat altered from that which was projected last year, inasmuch as the St Pancras portion of it, which was originally intended to pass under St. Pancras Station and terminate at King's Cross, had been shortened to meet the wishes of the Midland Railway Company, who were naturally sensitive with regard to the effect which might be produced on the large pile of buildings which constituted their station and hotel. The capital of the company would be a million and a-half, with one-third that amount borrowing powers.

Mr. GREATHEAD, engineer to the Company, explained the plans to the Committee, and the method of construction, and said that communications could be easily made by means of subways with Euston Station and the South-Eastern Station, at Charing-cross. The line could be worked either by the cable system or by electricity, and he did not think there was much to choose between them. It was proposed to establish the motive power opposite the North London Station at Chalk Farm, which would be a very convenient and suitable site for a generating station.

Mr. HENRY CLARK, of the London County Council, a resident of Hampstead, and Mr. D. C. NICHOLS, an architect and surveyor, gave evidence in support of the Bill, and the main opposition arose with regard to the premises of the British Medical Association in the Strand, which the Chairman declared to be a matter of clauses. The preamble of the Bill was proved, and the Committee adjourned, but on the Wednesday spent a short time in adjusting the clauses for the protection of the British Medical Association, and the Committee then ordered the Bill to be reported to the House for third reading.

THURSDAY, MARCH 9.

THE BARRY ISLAND ELECTRIC RAILWAY BILL.

The Barry Railway Bill, one object of which is to construct a railway to be worked by electricity, came before a Select Committee of the House of Commons, presided over by Mr. Stephen Williamson. All appearances being withdrawn, and there being no opposition, the Bill was referred to an unopposed Committee.

LEGAL INTELLIGENCE.

Alabaster and Others v. Medical Battery Company (Limited).

This case came before Lord Coleridge and a special jury in the High Court of Justice on Tuesday last. It was an action by the proprietors of the *Electrical Review* for an injunction restraining the defendants from continuing to disseminate a circular alleging that the *Electrical Review* had published "malicious libels" concerning the Medical Battery Company and Electropathic and Zander Institute, and claiming damages. The defence was a plea of privilege.

Mr. Finlay, Q.C., Mr. Lawson Walton, Q.C., and Mr. Bankes were for the plaintiffs; and Sir Edward Clarke, Q.C., and Mr. R. A. Germaine for the defendants.

Mr. FINLAY, in opening, said the libel complained of was in respect of a circular sent out by a solicitor on behalf of the Medical Battery Company, which substantially belonged to Mr. C. B. Harness, to a large number of newsagents. That circular read as follows:—

"39, Hatton-garden, London, E.C., September 16, 1892.

"SIR: Having been consulted by my clients, the Medical Battery Company (Limited), the proprietors of Harness's Electropathic Belts, and also the Electropathic and Zander Institute, of 52, Oxford-street, W., with reference to some malicious libels published in the *Electrical Review* and a paper called *Science Siftings*, I beg to give you notice that if these or any further publications containing defamatory articles or paragraphs are sold or circulated by your firm, my clients will hold you responsible. In the same way you will be held responsible for the exhibition of any libellous bills or placards.—I am, Sir, yours obediently, AUGS. FLEET."

The answer of the defendants to the action now brought was that the circular was sent out to newsvendors in self-defence, and with the view of founding possible proceedings against those newsvendors. As a matter of law, he submitted, the plea of privilege in this case was an absolutely false one, and the jury would be able to form their own opinion as to the *bonâ fides* of that defence. The Medical Battery Company was a very extensively advertised firm, established for the purpose of selling what were known as electropathic belts. The patients had their choice of belts at different prices, and were recommended to wear them with the idea of being cured by currents of electricity, no matter what was the nature of the diseases from which they were suffering. This system of business carried on by the defendants was brought prominently to the attention of the plaintiffs by an action which was tried at the Bloomsbury County Court on July 19, 1892. A man named Jeffery had been suffering from hernia, and went to the Institute of the defendant, where he was persuaded to buy an electropathic belt for £5. 5s. He was only able to pay down the sum of £2, and the defendants had the assurance to sue him for the balance of £3. 5s. The case was fully investigated, Mr. Gatehouse, one of the plaintiffs, gave evidence on behalf of the defendant, and stated his opinion of the belt. Judgment was given for the defendant on the ground that the belt was absolutely useless, and the Medical Battery Company were directed to return the £2 which the poor fellow had been induced to pay on account. That was how Mr. Gatehouse first came to close quarters with the Medical Battery Company A report of the case, and also an article upon it, appeared in the *Electrical Review* for July 22nd. The article strongly condemned the practices carried on upon the premises of the Medical Battery Company, and said that if ever there was a matter demanding the immediate attention of the Public Prosecutor, the revelations made at the Bloomsbury County Court pointed to it. It was stated in the course of that case that the "hernia specialist" in the service of the Medical Battery Company had been at an earlier period in his career a furniture salesman. Subsequently the articles appeared in the *Electrical Review*, some of the most recent commenting upon descriptions which had appeared in other papers of Harness's Institute.

Mr. GERMAINE said Mr. Finlay had not accurately grasped the issue before the jury. On the pleadings there was an entire absence on the part of the defence of any justification whatever. Any question as to the efficiency, utility, or uselessness of the belts was not in issue in the case. If the defendants had intended to raise it they would have pleaded justification.

The LORD CHIEF JUSTICE: It all goes to the question of damage.

Mr. GERMAINE said there was an action pending in which the question of the efficacy of the belts would be gone into fully.

The LORD CHIEF JUSTICE: Possibly this case may save all that (laughter).

Mr. FINLAY said he would not waste time in dwelling upon the serious nature of the accusations against Mr. Alabaster, Mr. Gatehouse and the other managers of the *Electrical Review*, namely, that they had prostituted their position as editors of a scientific journal for the purpose of publishing malicious libels. If they had done this they would deserve to be exposed and condemned by every honest man But that was, in fact, the allegation the defendants thought fit to make with regard to these gentlemen. They sent round the circular to hundreds of newsvendors regardless of the fact whether they happened to sell the *Electrical Review* or not, and the result was that the plaintiffs were inundated with applications for indemnities relieving the newsvendors from responsibility. One large firm refused to sell the journal on any terms. Accordingly the writ for the present action was served on September 22nd, and the excuse set up by the defendants for the purpose of justifying so serious an attack upon the personal character and professional honour of the plantiffs was that they were acting in self defence. In order to show the shallowness of the defence counsel called the attention of the jury to the kind of proceedings that went on at the Institute and the character of the goods sold to an unwary public. A pamphlet had been issued by the defendants, containing the most formidable list of disorders counsel had ever seen. It was entitled "The Medical Uses of Electricity; a Treatise on the Electropathic Method of Curing Disease," by Mr. C. B. Harness, consulting medical electrician, President of the British Association of Medical Electricians, Member of the National Electric Medical Association, and Member of Honour (with Cross of Merit) of the Belgian Society of the Red Cross, &c., &c. The names of Sir Charles Locock, Sir Henry Holland, and Sir William Fergusson, Physicians to the Queen, were given in the pamphlet as advocating electrical treatment for the cure of disease. He (Mr. Finlay) was aware that there were diseases where electricity would prove beneficial. But as to the belts sold by the Medical Battery Company, could a person with the most elementary knowledge of electricity suppose they could generate electricity in the body at all? The belts contained discs of zinc and copper. An extremely minute quantity of electricity would be generated when the zinc and copper discs were worn upon the body, and the discs connected externally; but unless there was a connection there could be no current, and he would call evidence to show that belts had been sold at the Institute for such sums as five guineas, ten guineas and more, when it was absolutely impossible that there could be any current of electricity whatever. Even assuming there was an external connection—and Mr. Harness had recently been telling people there must be this connection—the current would be excessively feeble. By far the greater part of it would return, not through the body, but would pass through the webbing of the belt round the body. In dealing with the question of the *bonâ fides* of the attack made by the defendants upon the plaintiffs he would ask the jury to bear in mind these two facts—first, that the defendant Harness was in the habit of selling belts with the external connection, and secondly that even if an external connection were made the current of electricity generated would be so excessively feeble that for all curative purposes it would be absolutely worthless. He did not think he was exaggerating when he said they could get more electricity out of a pin and a needle dipped in ink than out of one of these electric belts even if properly connected. The jury would have materials laid before them which would satisfy them beyond all doubt that the defendants were seeking to stifle what they must have known or suspected to be well deserved criticism by endeavouring to stigmatise that criticism as a malicious libel.

Mr. W. Timbrell, Mr. Catlin, Mr. Vickers, Mr. Hughes, Mr. Allen, Miss Davis, and other newsagents, Mr. A. J. Godstall (from Messrs. W. H. Smith and Son), and Mr. H. Tourle (from Messrs. Simpkin, Marshall, and Co.), all gave evidence as to receipt of the circular, and of declining to continue the sale until given an undertaking to indemnify them by the plaintiffs.

Mr. FRANCIS REEVES, an electrician, carrying on business at Mansion House-buildings, said he knew Mr. Harness, the Managing Director of the Medical Battery Company. Mr. Harness told him that 500 circulars had been sent out to newsvendors.

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Cross-examined by Sir EDWARD CLARKE: At the time of these conversations they were either travelling by train or standing on the platform. They lived at the same place. He was not a friend of Mr. Harness's—only a railway acquaintance.

Mr. BANKES was about to call Mr. Jeffrey as a witness, when

Sir EDWARD CLARKE took exception to evidence being called as to the utility of the belts. Such evidence, he contended, was not admissible on the issues on the record. Having quoted cases bearing on what he averred was the real issue, the question of privilege, and the necessity of notifying newsvendors as to libels which they might disseminate. The only defence put upon the record was one of privilege. The defendants had an action pending against Messrs. Alabaster, Gatehouse, and Co., and in fairness they gave notice to the persons who might be selling the libel. The question as to the efficacy of the belts would be raised in the other trial, which would come on at an early date, and the proper course would be to leave that issue to be tried in that action, where it was the real issue.

The LORD CHIEF JUSTICE held the evidence to be admissible, and said the issue was clearly raised on the question of *bonâ fides*.

Sir EDWARD CLARKE then applied that this action might be allowed to stand over or be consolidated with the other action, in order that the whole question might be gone into, and have a final and effective determination. His clients would consent to any terms as to costs.

Mr. FINLAY opposed the application, and said the action of the Medical Battery Company was not brought until after the present action was instituted. They knew very well that the issue would be raised in this case, for it was quite impossible to suppose that the defendants did not appreciate that the question of their *bonâ fides* in sending out the circular would be at issue.

The LORD CHIEF JUSTICE said the issue was very narrow. In his opinion evidence was relevant which raised the issue as to the *bonâ fides* of the plaintiffs in writing the articles and publishing them. The plaintiffs said their object was to expose scientific humbug. On the other side it was said that was not so, but that the articles were printed with the object of injuring the Company. He could not say such things could not be introduced.

Sir E. CLARKE: Then your Lordship does not think it right to adjourn upon any terms?

The LORD CHIEF JUSTICE: I have no right to do so. The matter seems to be properly raised, and therefore you should have been prepared to meet it. I cannot—because you have another action pending, which may or may not be prosecuted—adjourn this action.

Sir E. CLARKE: Then I am instructed by my clients to say we are not prepared to deal with the points which have been indicated in the opening of Mr. Finlay, and which they were certainly under the impression would not be raised. Therefore I shall take no part in any controversy if these witnesses are called. We are prepared to admit the libel, and that damages must be paid. The jury will be left to fix the damages on the question relevant to that issue.

Mr. FINLAY said the course taken by his learned friend brought the case to an early termination. It was a termination which he should think very few of those behind the scenes had not expected. Up to the present moment the defendants had shown a bold front. They knew that the attack upon the personal character and honour of the plaintiff was not made *bonâ fide*. The suggestion was put forward that the circular was sent out to the 500 newsvendors precedent to possible actions being taken against them. The circular was written without any object of the kind. It was sent round because Mr. Harness resented the criticisms which appeared about his Institute, and the way business was carried on there. He resented the exposure of the system, and he had thought fit to characterise the articles as malicious libels. The defendant knew perfectly well what he had to meet. He could not fail to have known it. He knew the witnesses who were to be called. Why was the defendant not prepared? It was not for want of time nor knowledge. Mr. Harness had the assistance of learned counsel. He had the assistance of his solicitors. The jury were asked to suppose it never occurred to these gentlemen that questions as to the honesty and good faith in making the attack would come into issue? Of course they knew it. Then why was Mr. Harness not prepared? He was not prepared because he would never be prepared to face such an issue. After a strong denunciation of the methods pursued by the defendants Mr. FINLAY asked the jury to mark their sense of their conduct by giving exemplary damages.

Sir EDWARD CLARKE said his learned friend had assumed his case had been established by evidence. That was not so. There was another case pending in which the plaintiffs were the Medical Battery Company and the defendants the owners of the *Electrical Review*. At the hearing of that case would be the proper time to go into the question of the belts being effective or non-effective. The question raised in the present case was whether the circular which had been sent out by the solicitor to the defendants was privileged, whether the sale of the paper had diminished, and whether the reputation of the plaintiffs had been injured. As a matter of fact the plaintiffs had not suffered at all. The circulation of the *Electrical Review* they had heard had not diminished. But the plaintiffs claimed damages on other grounds. It was said they were entitled to damages because in the circular sent out it was said that malicious libels had been published. The articles were no doubt violent attacks upon the Medical Battery Company and all connected with the Company. The writer did not content himself with saying the appliances were not of real use, he did not content himself by saying there was exaggeration in the representations, but that there was actually fraud in the conducting of the business. It was natural the manager and those persons associated with the Medical Battery Company should say this was very strong language, and that the articles were malicious libels. The object of the defendants in sending out the circular was to remove the newsvendors from liability. He would venture to suggest that the damage, if any, caused by the issuing of the circular was of an absolutely unappreciable amount.

The Lord Chief Justice left his summing up till next morning.

On Wednesday LORD COLERIDGE summed up the case. The action, he said, was a good deal out of the common. The plaintiffs were the proprietors of the *Electrical Review*, a weekly periodical which appeared to have a large circulation. The editors appeared to be gentlemen of real knowledge of electrical science, and perfectly competent to deal with such subjects. It appeared that the Company of which Mr. Harness was a member was very much taken up with the sale of "electrical belts." The plaintiffs had denounced the "electrical belts" as impostures, and had done their best to expose what they deemed a gross system of imposture. As long as they did that honestly, and, as they believed, in the public interest, or the interest of science, they had a perfect right to do so. And the Company would have a right to vindicate their invention and to use strong language in so doing. But what they had done was to send round to 500 newsagents a circular denouncing the articles as "malicious libels." This, no doubt, was an effective, though unusual, way of preventing the circulation of the paper containing such articles. The view suggested by the counsel for the plaintiffs was that the object was to suppress the publication of criticisms upon the Company's remedies. And undoubtedly there was evidence to support that view. The jury had seen Sir E. Clarke virtually withdraw from any defence, and, of course, he would not have done so if he had felt that he had a case; but, of course, he could not "make bricks without straw." If the articles had been published with a malicious motive the Company would have a fair right to denounce them, but if they were honestly written and published it would be otherwise. The plaintiffs had a perfect right to argue that these electrical belts were quackery. The defendants must have known that such would be case for the plaintiffs. The use of the electrical belts in certain classes of cases, as hernia for instance, did seem preposterous nonsense. The plantiffs had a perfect right to say so, and to denounce a business in which sums of five or ten or 15 guineas were taken for such belts as remedies in cases in which they could not possibly be of any use, and especially were calculated to impose on persons subject to nervous disorders and who were ready to clutch at any apparent remedies. It was undoubtedly for the public interest that such pretences should be exposed and denounced. The defence set up for the publication of the circular was that notice was given to the newsagents, as necessary with a view to maintain actions against them. The jury must judge as to whether the excuse for the circular was sufficient and whether it was issued *bonâ fide*, or whether the articles had been published in the interests of truth and science and for the exposure of imposture. The latter was the case for the plaintiffs, and it had not been met by any evidence on the part of the defendants, who, on the contrary, had admitted by their counsel that their circular was libellous, and that it was a question of damages. That question was entirely for the jury. Probably there had not been much actual pecuniary damage, but the character of the paper had been aspersed, and for that the proprietors had a right to reasonable damages.

The jury, after a brief consultation, gave a verdict for the plaintiffs for £1,000. Lord Coleridge thereupon gave judgment for that amount. Counsel for the defendants asked for a stay of execution—the damages being excessive—to allow time for application to the Court of Appeal. Lord Coleridge said he saw no ground for interference.

In the Court of Appeal yesterday morning, Mr. A. G. Scott applied in the above case for leave to serve short notice of motion for to-day (Friday). It was, he said, a case in which the jury had awarded £1,000 damages for libel. The evidence was that the plaintiff's journal had increased in circulation since the libel. Within an hour of the verdict the managing clerk of the plaintiff's solicitor had called upon the defendants, demanded, and was paid £1,000.

The MASTER of the ROLLS: Then no harm can be done. You must give the ordinary notice.

CORRESPONDENCE.

BOVET MAGNETIC ADHESION APPARATUS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of this week M. R. V. Picou, in an article on "Bovet Magnetic Adhesion Apparatus" states:—"For large amounts of power friction must be given up and recourse had to claw clutches; but these have the great defect of not being operable during working." About three years ago I devised and patented a combined friction and claw clutch which overcomes the difficulty of engaging at any speed. Messrs. Arnold Goodwin and Son are now owners of the patent, and their enclosed circular contains an illustration which explains the construction of the clutch. It is adopted, as you can see, by electric light companies, flour mills, paper mills, &c.—Yours, &c.,

P. V. M. MAHON.

195, Clapham-road, London, S.W.,
March 8, 1893.

[The circular describes a combined clutch which is brought up to speed by friction cones, and afterwards locked by claws. The arrangement seems to be very effective.—ED. *E.*]

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"THAT BLESSED WORD, 'INSTALLATION'!"

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my attempt to be brief I have apparently been obscure, and have laid myself open to Mr. Massey's very neat "score." Of course, I do not mean to substitute the general term "installation," which, like all general terms, is in itself vague, for a detailed specification and schedule, nor do I mean to limit its meaning in all cases solely to the items I mentioned. But when the items and details, whatever they may be, have been properly specified, and it is necessary to refer to them frequently by some general term in a long agreement, what is the best term to use? I should be very much obliged to Mr. Massey if he would re-write some agreements which it has been my misfortune to draft without using the unspeakable word, and without materially increasing the length of the document or impairing its clearness. If he would add to it some of the epigrammatic point of which he is so evidently a master, I should be doubly grateful. I admire his purism, and dislike the sound and length of the word in question as much as he does, but it seems to me to possess certain useful qualities. First, it is, happily, not a word is general use, and so can be limited more or less arbitrarily according to circumstances without doing violence to established usage. Secondly, it is sufficiently general to cover anything or everything, and so its vice—when used alone—becomes its virtue when used in reference to the definitely specified items which it is desired to summarise. Thirdly, it covers equally well the process and the result, and applies to the operation as well as the product, according to the context. These seem to me the reasons why I have found the word practically useful, but I am most ready to adopt a synonym or substitute if Mr. Massey will provide one. I am quite ready to be ashamed of my limited vocabulary, of which I, in common with the "authorities" of my College, have long been painfully aware.—Yours, &c. L. A. SELBY-BIGGE.

University College, Oxford, Mar. 3, 1893.

[A correspondent writing to the *North British Mail* of March 4th, on the electric lighting of Glasgow, says: "SIR,—Installation; yes, that is the word. It is a big word and sounds grandly; but what does it mean?" He then proceeds to complain that "it has not installed an extra light into Union-street."—ED. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This useful book contains over 1,000 pages, and several new and handy features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

TENDERS INVITED.—*Extension of time.* - It will be seen by our advertisement columns that the time for sending in tenders for the plant and mains for the Dewsbury electrical installation has been extended to Saturday, April 8th.

——— The Manchester, Sheffield and Lincolnshire Railway Company invite tenders for various stores and materials.

——— The County Borough of Hanley invite tenders for the contracts in connection with their electricity works.

——— The Secretary of State for India invites tenders for boilers for locomotives. Tenders must be delivered at the India Office, Whitehall, S.W., by Tuesday, the 28th inst.

——— The Corporation of the Trinity House invite tenders for the supply of eleven iron mushroom anchors of 40cwt., 50cwt., and 60cwt. Tenders must be addressed to the Secretary, Trinity House, London, E.C., by Thursday, 16th inst.

TENDERS ACCEPTED.—The tender of Mr. W. Morton has been accepted by the Warrington Town Council for the erection of telephones and wires to connect the two intercepting depots at Howley and Hardy-street with the depot at Longford, the amount being £35, with an annual maintenance charge of £1.

TENDERS ACCEPTED.—The tender of Mr. James Procter has been accepted by the Burnley Town Council for the supply and fitting of patent mechanical stokers to the two boilers at the Council's electric lighting station, for the sum of £65 per boiler, less 7½ per cent. discount.

SALES BY AUCTION.—Included in a sale by Messrs. George Head and Co., at 55, Marylebone-road, London, N.W., on Wednesday next, at two o'clock, is a number of copper and other baths, some specially made electric bath coils, electrodes, batteries, indicators, &c., iron piping, insulated wires, a galvanometer, and Wheatstone Bridge coils by Latimer, Clark, Muirhead and Co. Further particulars are given in our advertisement columns, and catalogues can be obtained of the auctioneers, 7, Upper Baker-street, London, N W.

APPOINTMENT VACANT.—A working foreman engineer is required to take charge, under the Asylum's engineer, of the electric lighting installation, heating and ventilating system, laundry machinery, and cooking apparatus at the London County Asylum, Claybury, Woodford, Essex. Salary, £156 per annum, with house, coals and gas. Further particulars are given in our advertisement columns, and applications must be delivered before 9 o'clock on Monday morning, March 20th, to the London Asylums Office, 21, Whitehall-place, London, S.W.

APPOINTMENT.—Mr. W. J. Sowter, a former student of Messrs. S. Z. de Ferranti (Limited), has been appointed electrical engineer to the County Lunatic Asylum, Lancaster.

BANKRUPTCY,—Arthur Henry Wright Radcliffe, of Clare House, Claremont-road, Handsworth, Staffordshire, lately carrying on business at 10, Newton-street, Birmingham, as an electrical and telegraph engineer, has been adjudicated a bankrupt. Mr. Luke J. Sharp, of Birmingham, is the official receiver of the estate.

EDISON AND SWAN ELECTRIC LIGHT COMPANY.—This Company have recently been engaged in refitting their South Benwell Works, Newcastle, in order to compete with the heavy demand for electric light fittings, instruments, switch-boards, safety lamps, &c. The works, which will give employment to many hundreds of hands, will shortly be in full swing. New show-rooms are also being prepared over the Goldsmiths' Hall at Newcastle. These premises will be fitted up on a very elaborate scale, and an installation of over 200 lamps will be provided for. We understand that the works and show-rooms are to form a centre for supplying the Company's specialities to North of England trade buyers.

TYPEWRITERS.—Members of the electrical and engineering professions are amongst the largest users of the typewriter, and are much interested in the improvements introduced for the perfection of this useful labour-saving machine; they will, therefore, be glad to learn that the owners of the Bar-Lock Typewriter have, after several years' patient work, been successful in adding a number of material improvements to that popular machine. This is the only machine which gives perfectly visible writing, probably the most important feature of the typewriter, and one which accounts for its phenomenal success. The latest improvements include an automatic margin release key, by which margins can be regulated to any width, for the insertion of side notes, remarks, &c., without in any way interfering with the regularity of the text; six additional signs have been added; an automatic double alarm bell, by which parallel columns can be easily provided for; an automatic locking device, which prevents the key striking the paper after the full width of the line has been reached; a duplicate hard or soft roller pad for manifold copies; an automatic paper release; a backward and forward motion allowing an exact return to any spot on the paper; and a new method of forging the type bars, rendering each perfectly rigid. These, with several other smaller but still important improvements, go to make the new Bar-Lock machine the most perfect in the market. The new machine is only just completed, and readers interested in typewriters should inspect a fine specimen which has been specially made to Her Majesty's instructions for Windsor Castle, where, by the way, five Bar-Lock machines are the only typewriters in use.

MESSRS. WOODHOUSE AND RAWSON UNITED (LIMITED).—This firm send us a list of no less than thirty installations of the electric light, which they have recently completed, eight through their Dublin agency, fifteen through their Bradford branch, and seven through their London office, besides the electric apparatus for the pumping station at Crossness for the London County Council. The firm also report considerable activity in Manchester and Glasgow business.

MESSRS. JOHNSON AND PHILLIPS.—This firm send us a handsome catalogue of the specialities for which they are so well-known. The index to contents of this well-arranged book occupies three

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large quarto pages. Descriptions and prices are given of a variety of dynamos of various sizes, suitable for direct current lighting, or for use with secondary batteries, all being of Mr. Kapp's design and varying from the upright horseshoe field, with the yoke in the bedplate, which Mr. Kapp claims to have introduced, to the latest alternators as supplied to the Amberley-road Station of the Metropolitan Company. The slow-speed steam dynamo exhibited at the recent Crystal Palace Exhibition is excellently illustrated, together with an example of the Central Station dynamo and "Willans-Kapp" steam dynamos. Sections are devoted to particulars of alternating current apparatus, storage batteries and accessories, measuring instruments, cables and wires, insulators, arc lamps and arc lamp accessories, incandescent lamp fittings, switches and safety devices, &c., and particulars are also given of the Brooks' patent system of underground mains. The book consists of more than 90 clearly printed quarto pages, and a considerable number of useful tables are given, wire gauges, weights and resistances of wire, decimal equivalents of feet, inches, and yards. The arc lamp sections are of course prominent, and contain a list of users of Brockie-Pell lamps, of which the makers may be justly proud. These lamps will burn for 32 hours without re-carboning. A large variety of lamps, lanterns, pillars, jibs, and other accessories are given. Compilers of catalogues must be hard pressed in these days to find something original as well as interesting to offer their customers, besides high-class printing and engraving. Two novelties which enhance the value and the appearance of Messrs. Johnson and Phillips' catalogue are scales of millimetres and inches flanking their prices of carbons, and excellent photographs of Tottenham Court-road showing the Brockie-Pell lamps.

PRINTING BY ELECTRICITY.—The *Dundee Advertiser* and the *Dundee Evening Telegraph* "are now printed by electricity"—that is, the printing offices of these journals have been equipped with the electric motor. This is the first installation of the kind in Scotland, and has proved a decided success. A 22 H.P. motor is used, supplied by Messrs. Mather and Platt (Limited), who have also supplied the necessary apparatus, and the erection has been carried out by Messrs. Lowdon Brothers.

THE ELECTRICAL TRADES' UNION.—A contest is in progress for the election of a general secretary in place of Mr. A. J. Walker, who, it appears has incurred the displeasure of some of the members of the Union. Mr. W. T. Gooday, the general treasurer of the Union, in the course of a letter on the subject, expresses a hope that all members will do their best to support Mr. Walker, who has worked very hard to make the Union a success.

INTERNATIONAL EXHIBITION AT LYONS.—A universal, international and colonial exhibition is to be held at Lyons from April 26, 1894, to November 1st following, applications for space in which should be addressed to M. de Marçay, 46, Boulevard Haussmann, Paris, by October 31, 1893. Group VIII. comprises electricity and its applications (Class 34), and general machinery and apparatus (Class 35).

NEW CABLE FACTORY IN GERMANY.—The German press states that Messrs. Basse and Selve, of Altena, Westphalia, are, in conjunction with English capitalists, about to commence the erection of large works in Duisburg, Prussia, for the manufacture of electric cables and wires on a new and improved process.

ADDLESTONE (SURREY).—A public meeting was held last week called by the Lighting Committee of the Local Board, to discuss the question of the lighting of the district. The Committee had been in negotiation with several electric lighting companies, including those at Weybridge and Woking, the latter having their wires already laid as far as Woodham Hill, from whence they could easily be extended on to Addlestone, and on to Chertsey, where the electric light was said to be in much favour. Several speakers pointed out the great advantages of the electric light, which the Woking Company were prepared to supply for £3 per lamp per annum, with a minimum of 100 lamps. It was ultimately resolved to continue on the present voluntary system for another year, and then to give the matter reconsideration. It was subsequently decided that the Lighting Committee be re-appointed, and that the lighting area be mapped out and steps taken to obtain all necessary information on the subject of introducing the electric light.

BAGSHOT PARK.—The Duke and Duchess of Connaught are having extensive alterations made at Bagshot Park, which is being sumptuously re-decorated, and the electric light is, we understand, being installed throughout.

BELFAST.—Mr. J. H. Greenhill has received instructions from the Corporation for the lighting by electricity of the chief fire station in the city at an estimated cost of £400.

BLACKPOOL.—At Tuesday's meeting of the Town Council, the minutes of the Electric Lighting Committee, fixing the charges to be made for current and showing the discounts to be allowed, were referred back for reconsideration. The Committee proposes that small consumers shall be allowed no discount, but that 25 per cent. shall be allowed on accounts of £100. It was also stated by one of the members of the Committee that after twelve months electricity will be supplied in the Blackpool district at the same rate as gas.

BURGESS HILL, SUSSEX.—The Local Board have had under discussion the question of adopting the electric light for the district, and have resolved to make inquiries as to the best steps to adopt in furtherance of this object.

CAMBERWELL.—The General Purposes Committee of the Camberwell Vestry have appointed Mr. E. Manville, of Messrs. Kincaid, Waller and Manville, to advise them "as to how best to introduce electric power into Camberwell."

CEFN, SOUTH WALES.—At the last meeting of the Rural Sanitary Authority the Parochial Committee recommended that the question of lighting by gas be deferred, and that the surveyor be instructed to obtain an estimate for the lighting of the district by electricity.

CHATHAM.—The *Chatham News* of the 25th ult. contains an account of a visit to the Chatham, Rochester and District Electric Lighting Company's central station, and an interview with the Managing Director of that Company. The account is interesting, as showing the development of electric lighting in the Chatham district of Kent.

CHISWICK.—At the last meeting of the Local Board the Clerk announced that he was about to wait upon the Board of Trade in reference to the dispute between the Board and Messrs. Bourne and Grant regarding the electric lighting of Chiswick.

COLCHESTER.—The Town Council have received an intimation that the Board of Trade are prepared to grant them a Provisional Order in the form applied for, subject to certain minor amendments. A copy of the Provisional Order has been received.

CRAIG-Y-NOS.—A supplementary electric lighting installation is being put down at Craig-y-Nos, the residence of Madame Adelina Patti, at an estimated cost of £250.

DERRY.—The tender of Mr. Matthew McClellan, builder and contractor, has been provisionally accepted for the work required in the erection of the central station for the Derry Corporation electric lighting scheme.

DUNDEE.—The Dundee Gas Commissioners have before them a large number of applications for the supply of the electric light, and altogether the Corporation's enterprise seems to be receiving public support. It was mentioned at the last meeting of the Commissioners that the consumption of gas for the past nine months exceeded by 5,000,000 cubic feet that of the previous nine months.

GLASGOW.—Sevenpence has been fixed as the charge per Board of Trade unit for electricity in Glasgow, and the charge is to be based upon the actual amount of electricity supplied.

HAMPSTEAD, LONDON, N.W.—Mr. W. H. Preece last week presented the plans and specifications for the erection of an electric lighting station in the Finchley-road, and for the lighting of the compulsory area fixed by the Provisional Order obtained by the Vestry. The plans, &c., were referred to a sub-committee for their consideration and report.

HERTFORD.—The Electric Lighting Committee have prepared a report in favour of a scheme for electric lighting, and this has been considered by the Committee of the Corporation, the majority of which are in favour of the report of the Lighting Committee, and at their meeting yesterday recommended the Council to employ an electrical engineer to advise them in the matter.

ILFORD.—A report has been received by the Local Board from the Brush Company, upon the subject of the lighting of Ilford by electricity, which, with a tender also received from the same Company, has been referred to the Lighting Committee for consideration.

JERSEY.—At the last meeting of the States the President announced that official correspondence had been sent to the Lieut.-Governor by the Postmaster-General concerning the proposed electric lighting works in Jersey, and asking that care should be taken for the due protection of the telegraphs. The States had received a petition from a manufacturing company asking for a concession. The correspondence on the subject is to be printed and circulated among the members.

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KENSINGTON.—The Vestry have agreed, by a small majority, to withdraw their petition against the arrangement proposed to be entered into between the Kensington and Knightsbridge and the Chelsea Electric Lighting Companies for the transfer to the Kensington Company of a portion of the Chelsea Company's area. A discussion followed as to the advisability of the Vestry undertaking the supply of the electric light, and ultimately the matter was referred to a committee to report on the subject.

KINGSTON.—An important meeting of the Town Council was held last week, at which the minutes of the Electric Lighting Committee were presented. The minutes included a report upon the tenders received for the generating and distributing plants for the Central Station, the site for which adjoins the Sewage Works. Twenty-four firms had tendered for the whole or various portions of the work. The following tenders for the complete plant had been received :—

	Generating Plant. £ s. d.		Distributing Plant. £ s. d.
Siemens Bros. and Co. (Limited)	10,019 0 0		7,597 0 0
,, ditto	11,112 0 0		— —
Brush Electrical Engineering Co. (Ltd.)	10,247 12 0		6,896 0 0
,, ditto	—		6,236 0 0
Electric Construction Corporation (Ltd.)	8,703 0 0		9,924 0 0
,, ditto	11,718 0 0		6,561 0 0
Latimer Clark, Muirhead and Co. (Ltd.)	11,256 16 0		9,698 0 0
Sharp and Kent	12,200 0 0		6,271 0 0
New and Mayne	13,019 0 0		6,687 0 0

These tenders were investigated by Mr. W. H. Preece, who recommended the acceptance of Messrs. Siemens Bros. and Co.'s tender, which was the lowest for the station plant, and it was found that for the distributing plant Messrs. Siemens Bros. and Co. had included heavier copper mains than had been arranged for by other firms, while their schedule prices were lower. Slight modifications will reduce the total first cost to about £11,800, including the mains, this being the amount of the modified tender now recommended. Reviewing the general situation, the Committee are satisfied that their authorised capital expenditure of £16,000 will be sufficient to meet the expenses in connection with the lighting scheme, including the buildings, foundations, &c. A proposal by the ex-Mayor of Kingston that Messrs. Siemens Bros. and Co.'s tender, as modified, be accepted was, after some discussion, carried.

LECTURES.—Amongst lectures delivered during the past few days on "Electricity," we notice addresses by Mr. Alex. Siemens at Birmingham, Prof. Silvanus Thompson at the Carpenters' Hall (London), Mr. Haldane Gee at Manchester, Mr. D. O. S. Davies at Oakamoor, Prof. W. E. Robinson at Nottingham, and Mr. W. M'Whirter at the Broomloan Hall, Govan, Glasgow. In most cases the above were illustrated by experiments.

LEICESTER.—The Laing, Wharton, and Down Construction Syndicate (Limited) have written to the *Leicester Post* a letter complaining of the way in which their tender for lighting the borough has been treated by the Gas Committee of the Corporation. The letter states that, whereas the tender proposed to be accepted amounts to £27,000, exclusive of the buildings, the Syndicate's original tender for rapid-driven dynamos and vertical engines amounted to £20,310, and for slow-speed direct-coupled dynamos and horizontal engines to £23,620, or nearly £3,500 lower than the tender it is proposed to accept. The Syndicate point to the fact that the Commissioners of Sewers for the City of London awarded an important contract to them as proof of their fitness and responsibility in such matters.

NEWCASTLE.—The lighting of certain isolated sections of this city has been attended with marked success, and is continually being added to. At the last meeting of the Town Council a proposal was made that that body should take into their own hands the lighting of the whole of the city by electricity, and it was further proposed that a sub-committee be appointed to obtain the necessary information and present a report. The suggestions were carried unanimously. It is expected that a recommendation will be made to the Council at its next meeting with respect to the lighting of Gray-street, and several other propositions on the subject of electric lighting are now under consideration.

PONSONBY HALL, CALDERBRIDGE.—Mr. W. B. Turner, the owner and occupier of Ponsonby Hall, has just completed an extensive installation of the electric light, the motive power being a turbine supplied from the flow of the river Calder. We understand that several of the gentry resident in the neighbourhood have under consideration the adoption of the electric light.

RATING OF MACHINERY BILL.—In the House of Commons on Wednesday the second reading of this Bill was agreed to by a majority of 153.

READING.—At the last meeting of the Town Council the report of the Electric Lighting Committee came up for confirmation. The Committee reported that a meeting had taken place between Mr. McMullen, the electrical adviser of the Corporation, and the representatives of the Reading Electric Light Company (Limited), and it has been arranged that a clause should be inserted in the draft agreement between the parties, making provision for the working in parallel of the alternating system, and for determining beforehand the type of dynamo to be used, which clause had been duly inserted in the agreement, as proposed. The Town Clerk, in the course of the discussion which followed, stated that before the Board of Trade they had proposed an amendment that if the Corporation purchase the Company's undertaking it should not only be free from mortgages but also from any debenture or similar charges. This was a novelty and had never previously formed part of any Provisional Order, and while the Board of Trade could not admit the amendment in the form in which it had been prepared they were willing to give effect to it by altering the form of wording. The Corporation had also added to the purchase clause powers, for the Local Authority to raise money by mortgage or otherwise, in the event of their determining to purchase the undertaking. This was also a novelty and the Board of Trade did not altogether appreciate it but a suggestion which he (the Town Clerk) had made had been admitted by the Board of Trade to get over the difficulty. He was more than satisfied with the result of the interview with the Board and doubtless within a few days their decision would be received. The Committee's recommendations were approved.

ROTHERHAM.—As stated in our last issue a resolution was proposed at the last meeting of the Town Council that a Sub-Committee be appointed to inquire into and report upon the cost of electric lighting, the most suitable site, the probable revenue likely to be received, and any further information likely to assist the Council in deciding upon the question of supplying the electric light to the Borough. Mr. Hurst, who moved the resolution, submitted that the present was a favourable time for the introduction of the electric light. He gave details of the installation suitable for the Borough at an estimated cost of about £5,700, with a total possible outlay of £15,000. An addition to the resolution was moved that a canvass be made in order to enable the Council to ascertain the amount of public support likely to be accorded the scheme, with which addition the motion was carried.

RUNCORN.—A recommendation on the part of the Electric Lighting Committee of the Improvement Commissioners to have an experimental installation of the electric light at a cost not exceeding 25 guineas has been rejected, several members suggesting that further information should be provided before anything definite was attempted.

SALFORD.—At the meeting of the Town Council last week the Chairman of the Gas Committee was asked if sufficient support had been promised to the proposed electric lighting scheme to warrant the contemplated expense of £50,000, to which a reply was given that support had already been promised sufficient for an installation costing £30,000, and that further support would, no doubt, be forthcoming to warrant their incurring the maximum expenditure. In answer to a further question the Chairman of the Committee was unable to say with any certainty that the light would be ready by next winter, but efforts were being made to complete the work. In reply to another question, the Town Clerk said that no opposition was offered by the National Telephone Company to the Corporation's Lighting Bill.

SHOREDITCH.—The Parliamentary Committee of the Vestry having recommended that body to borrow £63,000 for laying down the necessary plant for their electric lighting scheme, Mr. Manville, the Vestry's electrical expert, advises them to adopt the high-tension continuous-current transformer system for private purposes, and arc lamps for the public lighting. Three sub-stations are recommended—one in the basement of the Town Hall, one at the corner of Curtain-road and Holywell-lane, and the third in Old-street. Very great economy could be effected by utilising the dust of the parish to generate the steam. Mr. Manville concludes by stating that experiments showed that the ashbin refuse of the district would prove a valuable field for the production of electricity.

SOUTHPORT.—Mr. A. J. Crompton, of the Scarisbrick Hotel, Southport, has decided upon a complete telephone, bell, and speaking tube installation at his hotel, and Messrs. Maunsell, Mercier, and Co. are carrying out the work to the plans and specifications of Mr. Walter Leake, of Victoria-buildings, Manchester.

SPENCER HOUSE.—At a dinner recently given by Lord and Lady Spencer to the Duke of York and a select party, the electric light was introduced into Spencer House for the first time. The new illuminant was unanimously voted a great success.

THE TRANSVAAL.—During last year machinery to the value of £314,200 was imported into the Transvaal.

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TOXTETH PARK.—Major Cardew (on behalf of the Board of Trade) held a private inquiry last week into the dispute between the Toxteth Park Local Board and the Liverpool Electric Supply Company upon the question of the specifications and conditions upon which the Company should lay mains, &c., for supplying the Local Board's district with the electric light.

WOOLWICH.—At the last meeting of the Local Board notice was received from the Local Electric Light Company of their intention to open up the principal streets for laying mains. A central station is to be situated in Globe-lane.

WORCESTER.—Proposals made by the Watch Committee to materially modify the plans for their electric lighting scheme by the substitution of low-pressure mains for high-pressure mains in certain districts were adopted at the last meeting of the Town Council.

WREXHAM.—At the last meeting of the Town Council the report of the Lighting Committee was presented. The Committee had received a notification from the Wrexham and District Electric Supply Company (Limited) that they were now prepared to enter into negotiations for the sale of the Company's undertaking. In response to this notification an appointment was made for a meeting with the representatives of the Company at an early date. The Committee's action in this matter was approved.

WOODHOUSE AND RAWSON UNITED (LIMITED).

REPORT OF THE SHAREHOLDERS' COMMITTEE OF INVESTIGATION.

The Committee appointed by the shareholders at the annual general meeting held on the December 22nd last to enquire into the affairs of the Company, convened a meeting at the Cannon Street Hotel on Tuesday for the purpose of presenting the report of its investigations. Mr. W. S. Squire presided, and there was a large attendance.

The CHAIRMAN read the report of the Committee, which was as follows:—

"The Company was formed in 1889 by the purchase of several companies from Woodhouse and Rawson (Limited), who were the vendors, for £269,000. The vendors stated in the original prospectus that they had been carrying on business very profitably, and, as an inducement for the public to subscribe, they undertook to guarantee the new Company a dividend of 15 per cent. on the ordinary shares for three years, and to deposit £75,000 with them as a guarantee. The way in which this was done was simply to leave £75,000 of the purchase money unpaid. This, no doubt, was legitimate. At the end of the first financial year (1890) the Directors presented their first annual report, showing a gross profit of £99,399. 7s. 8d., reduced by certain charges to a net profit of £61,085. 1s. 9d. Out of this, dividends of 15 per cent. were paid on the ordinary shares and 8 per cent. on the preference shares, £25,000 was carried to reserve, and £16,335. 15s. 3d. was carried forward. There was no explanation of how these profits were arrived at, or any statement of the amount of commission paid to the Managing Director. Your committee have to report that a considerable portion of these profits consisted of very doubtful items, which, in their opinion, should not have been carried to profit and loss at all, and were certainly not legitimate trading profits. The first of these items was £25,000, an amount received from the Kensington Stores for leasing to them the front portion of the Cadby Hall property. This item the auditors of the Company at first refused to pass, and only consented to do so when informed that the Directors had taken counsel's opinion. The second item relates to Jensen's Bell. This property was purchased in September, 1889, for £2,050. It was straightway entered in the books at £3,920, and the difference between the two amounts—viz., £1,870—was considered as profit. The Directors also took credit as a business profit for £4,050 premiums received on their issue of shares. The fourth item was £37,240, being the balance for promoting the International Okonite Company. This was entered in the books on the last day of the financial year—viz., June 30, 1890—but the prospectus was only issued on the first day of the next financial year, and it must have been some considerable time before it could be seen whether it would be successful, or whether there would have been any profit at all. Not one penny of this profit accrued in cash; it was all in bonds and shares. The result was that at the end of the next financial year, to which the operations really belonged—viz., July 31, 1891—Woodhouse and Rawson were left with 1,462 ordinary shares, valued at £8 each; 539 preference shares, valued at £9. 15s. each; 255 debentures of £100 each—of a total somewhat depreciated value of £42,951. These securities were in the following year (1892) valued at £4, £6. 10s., and £100 each respectively, having originally cost par price. They are still in the hands of the Company, and are to a large extent unsaleable. Your committee are of opinion that these securities should have been carried to a suspense account, and not considered as divisible profit until realised; and, further, that the profit, such as it was, properly belonged to the second year's trading. These four items come to £68,160. Assuming that the Directors were technically justified in carrying the £25,000 for the Kensington lease and the share premiums to profit and loss, there remains a sum of £39,110, which, if rejected as not being legitimate profits, would reduce the net profit from £61,085 to £21,975, in which case the Managing Director would not have been entitled to commission. One result of the profits of the first year being swelled in this way was to entitle the Managing Director to a large commission. Most of the shareholders are probably unaware that at the formation of the Company a contract was made with the Managing Director which provided that if in any one year the profits were more than sufficient to pay 15 per cent. on the ordinary shares, he was to receive 25 per cent. of the excess as commission. He did, as a matter of fact, receive in respect of this year's trading a commission of £13,775, of which more than £10,000 was in cash. Secondly, he was the liquidator of Woodhouse and Rawson (Limited), the vendor company, in which he was largely interested. It would benefit those interested in that Company to get the guarantee fund of £75,000 (which had served its purpose in attracting the public) out of jeopardy as soon as possible. Accordingly, two months after the issue of this balance-sheet the shareholders were asked by the Directors to consent to the repayment, as the Directors 'had a confident assurance that the rate of dividend would be maintained.' Your committee have a confident assurance that if the shareholders had been told, or been allowed to know, in what way the profits of the first year had been arrived at, no sane shareholder would have consented to part with his guarantee. For, whatever opinion may be entertained of the technical right of the Directors to carry the £25,000 for Kensington and the premium on shares to profit and loss, these items can be, at best, looked upon as windfalls peculiar to that year, and impossible of repetition. They could not, therefore, justify the confident assurance they expressed that this rate of profit would be maintained. The £75,000, while it remained a guarantee fund bore no interest. By the way in which it was repaid it was made to come before both the ordinary and preference shares; it at once began to bear 5½ per cent. interest, and has nearly doubled the debenture debt of the Company. It is just the large amount of this debenture debt which makes it so difficult to reconstruct and save the Company. The terms of repayment were a rebate of £12,000, £12,000 in cash, and £51,000 in debenture stock. Your committee now turn to the year ended July 31, 1891. The £12,000 rebate on the £75,000 was placed to credit of profit and loss; so that a transaction which was really a source of heavy loss, and has done more than anything else to ruin the Company and prevent its reconstruction, was actually claimed to have resulted in a net profit of £12,000. The next item of profit is £14,975 appreciation of founders' shares in the Phœnix Trust Company. Twenty-five founders' shares in this Company are stated to have been purchased for £25, and were then entered in the books of Woodhouse and Rawson United (Limited), as being worth £15,000, the difference, viz., £14,975, being considered as profit. The Phœnix Trust Company appears to have been practically a *nom de guerre* of the well-known Baron Grant. The books show numerous transactions in which the Phœnix Trust Company have been jointly interested with Woodhouse and Rawson, Limited, and, in one case, at least, the Phœnix Company took three-fourths of the profits. The paid-up capital of the Phœnix Trust Company being almost nominal, it was able to pay on its shares held by Woodhouse and Rawson United, Limited, a large dividend which consisted almost entirely of paper. The Directors of Woodhouse and Rawson United, Limited, then capitalised this dividend, and called their 25 shares worth £15,000. Woodhouse and Rawson United, Limited, being in difficulties, the Phœnix Trust Company has gone into liquidation, and its shares are worthless. Woodhouse and Rawson United, Limited, having acquired the control of the Epstein patents for accumulators, formed a company called the Epstein Accumulator Company, with a nominal capital of £100,000. Of this, shares worth nominally £70,000 were allotted: 55 per cent. (£38,500) to Woodhouse and Rawson United, Limited, and 45 per cent. (£31,600) to Mr. Epstein. Woodhouse and Rawson and Epstein both gave 10 per cent. of their shares—say, £7,000 altogether—to the Phœnix Trust Company. The whole of this transaction was absolutely on paper, not one penny of capital being subscribed; yet after deducting the 10 per cent. to the Phœnix Trust Company, and certain expenses, Woodhouse and Rawson United, Limited, take credit for £31,630 net profit, which is brought into the profit and loss account as divisible profits. The Epstein Accumulator Company's shares may be worth much or nothing; it is a thing to be tested in future by actual practice. Your committee may here refer to the relations between the Epstein Company and Woodhouse and Rawson. By an agreement dated July 31 (again the last day of the financial year) the expenditure and liabilities of the Epstein Company up to that date—amounting to £3,780 12s 6d., together with a further agreed advance of £7,500—were to be borne by Woodhouse and Rawson United, Limited. This sum—amounting to £11,280 12s. 6d.—was to be repaid to Woodhouse and Rawson United, Limited, only in the event of shares to double this amount being issued and paid for by the public; so that, in the event of no such issue being successful, the advance will not be repayable. Yet the whole of this advance is put down as a good asset, and the shares taken as profit as well. Another item of profit is £15,188, being the profit on the Issue of French and Austrian Elmore Companies; but these are all in paper, and practically unsaleable. Other items are £1,000 shares held against the Phœnix Trust Company, and 1,000 £1 shares of the National Financial Company, which appears to be mixed up with the Phœnix Trust Company. These the Directors have put down as being worth £2,000, the difference being called profit. Then again, the value of the Kidsgrove works is again raised to the extent of £2,640, though these works, in one way or another have been a source of loss to the extent of £40,000 or £45,000, and the Kensington works are appreciated £1,000. These various items, added together, come to £81,233, while the net profits claimed for the year amount (including these items) to no more than £51,439 4s. 5d. Your committee are of opinion that in these two years the profits have been apparent rather than real, and that the dividends ought to have been paid out of the guarantee fund. In the third year the inevitable Nemesis began to overtake the Company. The losses at Kidsgrove and elsewhere, and the disastrous effects of the attempts to infringe other persons' patents, had to be confessed. The unsaleable

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securities had to be written down, and the opportunities for showing apparent profits were exhausted. The result was a heavy loss. Great as the loss appears to be, it is understated. To take one instance. The Directors met the shareholders on December 22nd last with accounts in which the 25 founders' shares of the Phœnix Trust Company still figured for £9,156. On the following day this Company went into voluntary liquidation. That this would be so must have been known to your Managing Director when he faced the shareholders, as he held one-fourth interest in that Company. The total paid-up capital of the Phœnix Trust Company was £1,124 up to December, 1892, and it is remarkable that in the list of shareholders at Somerset House the name of Woodhouse and Rawson United (Limited) does not anywhere occur. Your committee think it their duty to report to the shareholders that in the very month in which the Directors induced the shareholders to assent to the repayment of the £75,000 they were borrowing money at 10 and 12 per cent. to pay the dividends, and at this very time the account of the Managing Director with the Company was overdrawn more than £20,000, In another instance, the interest works out at 22 per cent. On January 15th £9,500 was borrowed from Mr. Wood at 10 per cent. interest; if not repaid by April 15th a fine of £500 was to be paid. It was not repaid, so that this for the three months amounts to an interest at the rate of 30 per cent. per annum. At this time the Managing Director's debt to the Company was £20,833, for which he was charged 6 per cent. per annum. Your Committee find that on December 12 last, a few days before the general meeting, the Directors agreed by deed, under the seal of the Company, to cancel the debt of the Managing Director on his giving £18,480, the balance then due, in Second Debenture Stock. The deed is attested by Sir Rawson Rawson (the father of the Managing Director) and Mr. S. Pope, Q.C. These debentures were to be accepted at par price, though their market value was not half that, and not saleable at this price. The amount was due in cash, and not in depreciated paper. The Company was put forth to the public as an electrical manufacturing company. Your Committee find that the manufacturing department has been utterly neglected and shamefully mismanaged, while the Managing Director has devoted his energy to hunting financial will-o'-the-wisps. As a consequence, the manufacturing carried on by the Company has not been profitable, and, probably from the same cause, none of the branches or agencies of the Company have shown any profit. Your committee have visited the Manchester, the Kidsgrove, and the Kensington works. The Kidsgrove purchase they regard as particularly unfortunate. The purchase was decided on hastily, without proper professional advice, and the price paid was enormously in excess of its value. The plant is for the most part antiquated, the situation unsuitable; the assets taken over turned out bad, and the contracts then on hand have resulted in a heavy loss. Your Committee have endeavoured to arrive at the present financial position of the Company, computed on a rational basis. In order to do this, they insisted on the stocks as at December 31st being properly taken, and they would have been in an position to have reported earlier to the shareholders if greater diligence had been exercised in taking these stocks. As the stocks evidently contain a good deal of antiquated apparatus, they have taken this at two-thirds of its nominal value. The securities, which stood at July 31 last at the nominal value of £101,827.5s., being for the most part unsaleable, as matters stand at present, they have cut these down to £25,000. The goodwill was at that time put down as worth £99,263. 3s. 7d., and the patents at £73,450. 18s. 1d. The Managing Director and other persons interested have failed to convince your Committee that their real intrinsic value is anything like this amount. The goodwill of a business losing money is, obviously, worth very little. They have, therefore, taken patents and goodwill together at £20,000. They have endeavoured to value the assets and ascertain the liabilities, and have come to the conclusion that the Company is just solvent; that is to say, that under an intelligent realisation, there would be just enough to pay off the liabilities, including the debentures and debenture stock. With regard to any proposal for carrying on the Company, the main difficulty consists in the heavy debenture interest, £9,350, to which must now be added £2,000 interest on the secured debenture stock, authorised at the last general meeting. This is an intolerable weight for the Company, with its diminished resources, to bear. Your Committee visited the Cornbrook and Kidsgrove works, and were favourably impressed by the managers there. Neither were sanguine. The former thought that if £500 were spent in new plant, he might be able to make £1,000 or £2,000 a year; the latter thought that if £7,000 additional capital were given to him, he might be able to make a profit of about £2,500 a year. Mr. Stutchbury, at Cannon-street, thought that the merchants' business might possibly produce £4,000 a year. In what is called the financial business the only chance seems to lie in the Epstein business, which Mr. Epstein estimates might produce £5,000 a year, one-half of which would come to this Company, and there is also a rent of £500 paid by his Company. All the profit thus visible to your Committee is £11,000 a year. Unless the vendor company can be made, or is willing, to revert to the original arrangement, this profit would be only just sufficient to meet the debenture interest, and there would be no inducement for the shareholders to subscribe fresh capital. It seems clear that it is no use attempting to raise capital which would be subject to the existing debentures. A more hopeful proposal would be that a new and perfectly independent company, under fresh management, should be formed, which should lease from the old Company their existing works and plant; that this Company should carry on the existing manufacturing and merchant business, which is of considerable volume, buying from and selling at a commission for the old Company the existing stock; and, as the assets are realised, the debentures might be paid off. A company with a small and reasonable capital, unburdened by a heavy debenture interest, might be able, under these circumstances, to make a living profit. It is only within the last few days that your Committee have been able to ascertain the position of the Company, and they are not prepared to propose any more definite scheme for the future. This requires more mature consideration than they have been able to give to the subject in the short time at their disposal. Your Committee would draw attention to the extremely small holdings of some of your Directors, who have had, consequently, a very small stake in the prosperity of the concern. The Chairman (Sir W. R. Rawson) holds 70 shares; Sir John Stokes, 51 shares; Sir Edward Thornton, 50 shares; Mr. Samuel Pope, Q.C., 222 shares; Mr. Philip Rawson, 374 shares. Your Committee cannot close this report without saying that the accounts and everything connected with the Company are in the greatest confusion, and they are indebted to the able assistance of the auditor of the Company (Mr. Pixley) and Mr. Thomas Pilling, of Manchester, one of the Committee."

Mr. PILLING, of Manchester, an accountant who had been engaged by the Committee to examine the books of the Company, submitted a communication which, if anything, was even more condemnatory of the management than the report of the Committee.

The CHAIRMAN then went on to say that the foregoing statement represented what was practically the position of the Company. He did not think that it need have made any losses at all. It was quite impossible —and the public could not realise this too soon—for £15,000, or £20,000 working capital to earn a dividend on £100,000 nominal. But if this Company could in some way be freed from its enormous liabilities, and particularly its debenture stock, there was in his opinion—and he believed that in stating it he was giving utterance to the belief of most members of the Committee—no reason why this should not be made a fair working property in proportion to its resources. If they desired to carry on the Company it could only be done by a scheme of reconstruction, which put any new money subscribed in a position of safety, and not liable to be swallowed up by the debenture holders. Subject to that he thought that the industrial part of the business might be carried on at a moderate profit; but it would require a great deal of consideration before anything like a definite scheme could be propounded. He concluded by stating that the Committee were much indebted to Messrs. Pilling and Bacon for the trouble these gentlemen had taken in investigating the affairs of the Company.

After a few remarks from General FYFE, more or less of a personal nature, and from Mr. SWAIN,

Mr. F. L. RAWSON (the Managing Director) made a statement in vindication of his own action and that of the Directors. He admitted that they had made the mistake that all the Directors of other companies had made, namely, that of putting down the assets at too high a figure. What they did was to go on the market quotations, and possibly they had made errors in the valuation. They had tried to enlarge the industrial business, and they thought that they had efficient management, but found too late that that was not the case. His whole time in connection with the Company had been thoroughly devoted to the interests of the shareholders, and those friends whom he had brought into the concern for whom he held himself morally responsible. He had never had a penny out of the concern in any way.

Mr. SAMUEL POPE, Q.C., also addressed the meeting at some length. He said that he did not feel surprised that there should be anger among the shareholders. He himself felt angry because, whatever happened, he must be a very considerable loser. He had done everything he could to avert disaster. He had found thousands of pounds, and had become liable for thousands more to keep the Company on its legs that they might go there to discuss what was the best thing to be done in the interests of all parties. He occupied the position of being not only a director, responsible, no doubt, for the acts of the Directors morally, it might be even legally, but, unfortunately, he held the position of being a trustee for the 5½ per cent. debenture stock, so that he stood in two relations, while he had to do the best for the shareholders to see that the assets should not be squandered to their detriment. He did not feel that he ought to desert the ship because it had got into shallow water. He wished that he could run away and hide his head from that report. He believed that most of the facts stated in it were true. He did not quite agree with all the deductions that the Committee drew. What he wished to impress on the shareholders was this, that they must not blame the Directors for not being wise before their time. He ventured to say that not one of the shareholders would dare to rise and say that he believed that any Director was a party to a fraudulent valuation. The report said that they were founded as an industrial Company. This was so, but an important part of their business was to assist in the introduction through public companies of electrical inventions. He remembered well when he became a Director of the Company that Lord Aberdare said that they looked upon their industrial business as their backbone. He wished that they had kept it as their backbone. Instead of looking after the industrial part of the business, the Manager was looking after financial schemes from which large profits had been previously made. It seemed to him, however, that nothing could be worse in the interests of all parties than a hostile winding up, and he would tell them why. It would mean the realisation of the assets—if they liked of questionable assets—but it would mean the realisation of the assets under the worst possible conditions. It would be a sacrifice, contrary to the interests of anybody, of any possible value that these assets might have. Therefore, however they might blame the Directors, they must stand or fall by what they had done; but at least let them be reasonable, and face the position. Everyone ought to put his shoulder to the wheel as far as possible to prevent the disaster of a hostile winding up. This must be done, or the the whole concern would go to the wall. The only way he could suggest was to call an adjourned meeting of the shareholders and discuss some scheme of reconstruction which would commend itself to the general body of shareholders and debenture holders.

The CHAIRMAN said that this was not, properly speaking, a meeting of the Company at all. The proper course was to call an adjourned meeting and follow the course suggested by Mr. Pope. He did not doubt that their Manager's efforts to make a profit for the Company had been honest, but he had made the mistake of going into financial affairs right and left.

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Mr. ABRAHAM paid a warm tribute to the conduct of Mr. Pope in all his relations with the Company, and reminded them that this was not a meeting at which any decided action could be resolved upon. They must wait till the adjourned meeting, when the Board would have been put in possession of the Committee's report, and would be able to state their case in reply.

After some remarks, from Mr. GRIFFITHS, mainly on the lines of the report of the Committee,

The CHAIRMAN, in reply to Mr. Bond, said that the Committee having discharged the duties for which it was appointed ceased to take any further action as such.

Mr. BACON proposed, and Mr. PEAT seconded, a resolution to the effect that the report of the Committee and the subsequent discussion should be printed and circulated among the shareholders. The former said that the report would have been stronger than it was in some parts, but out of deference to some of their members certain excisions had been made.

Mr. F. L. RAWSON added that the Directors had been taking the advice of some practical business men upon the question of reconstruction, and a large debenture-holder had made a suggestion, in which he was bound to say neither the Committee nor the Directors had found any flaw. If adopted, this would protect the interests of the debenture and debenture-stockholders, and would, at the same time, save some of the shareholders' money, and enable those now interested in it to get a return in the future. The Directors saw no reason why that scheme should not be laid before the shareholders at an early date—certainly before the end of the month. (Hear, hear.)

Mr. MADDISON said he represented some debenture and debenture-stock holders, who felt that every opportunity should be given to the shareholders to save the assets of the Company as a going concern (hear, hear).

Mr. POPE remarked that a special general meeting could be convened by the Directors to follow the adjourned annual general meeting, and a scheme of reconstruction could then be considered.

The proceedings terminated with a vote of thanks to the Chairman.

COMPANIES' MEETINGS & REPORTS.

Consolidated Telephone Construction and Maintenance Company (Limited).

An extraordinary general meeting of this Company was held yesterday at Winchester House, Old Broad-street, Mr. C. L. W. Fitzgerald presiding,

The SECRETARY (Mr. Charles Curtoys) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the resolution I have to propose, condensed, means that your Directors suggest to the shareholders that the £1 Preference shares be paid off at par, that 2s. be returned on the Ordinary shares, and that the share of 14s. nominal value be written down a further 2s., making each share 10s. nominal value. I must, to make matters clear to you, go back somewhat into the past history of the Company. In the year 1881 your Company bought certain concessions in Austria, and then formed a subsidiary Company, called the Telephone Company of Austria, to work those concessions. Unfortunately, the Directors of that period were unable to obtain capital for this Austrian Company, and the whole burden of providing money fell on the Consolidated Telephone Company. This proved such a drain that it very nearly ruined your Company. When myself and colleagues in 1884 took the management of your affairs things had come to the pass of certain persons agitating for the cancelling of the concessions, on the ground that the business was not being worked properly. We found a book debt owing by the Telephone Company of Austria to your Company of many thousands, and eventually we received £34,500 Austrian Debentures for that book debt. Some £15,500 has been also advanced by your Company against Austrian Preference Shares, and we hold £28,355 Austrian Ordinary Shares—the shares received for the concessions. The concessions purchased were for the short period of only 10 years, of which three had elapsed. The subscription to the Telephone Exchanges were only at the low rate of £6 per subscriber. When we examined the concessions in 1884 I think we should have decided not to go on with the installation, although we had already at stake the sum of £34,500, because the clause relating to the termination of the concession was somewhat obscure—but for the fact that the then Minister of Commerce in Austria had written a letter to the effect that in the event of the Austrian Government purchasing our telephone business it was to be bought at the commercial value—that is, on the basis of net profits also. It was verbally stated that if the Company's installation were not so purchased we should have a prolonged concession. We were satisfied, and worked the business energetically, doing everything that was asked us, and fully satisfying the Austrian public as well as the Government. Time went on, and at last we approached the Austrian Government with a view to finding out their ideas as to purchasing or renewing the concession. The Government decided on purchase, but to our astonishment entirely repudiated the letter of the Minister of Commerce, and said their view was to purchase us at cost of material. Anything more unfair cannot be conceived; we had made a splendid business, and were simply to get no profit. To show how much the Austrian Government benefited, I will mention that, during the concessions, the Company paid as interest on its debentures and shares some £20,000, while the Austrian Government, in taxes and royalties, received no less than £13,000 in the same period. Myself and two colleagues went twice to Vienna to plead your cause, but, in spite of our getting the assistance of our Ambassador, and very powerful assistance from influential personages in Austria, we could not move the Government from their point, and at last, only one day before the end of the concession, we had to take the terms offered. The bulk of the purchase money having been paid and sent over here has led to our calling you together to-day. We have received the £34,500, and most of the £15,500 Preference, which will enable us to pay off our 6 per cent. Preference shares and return 2s. on the Ordinary shares. Owing, however, to the Austrian Government not having fulfilled their bargain, which bargain if carried out would have made valuable the £28,355 Austrian Ordinary which you hold, we are under the necessity of asking you to write down the nominal value of your shares by a further 2s., making them 10s. instead of 14s. If the resolution I have now to move is carried to-day, we shall take the earliest steps to obtain the sanction of the Court and return the money to the shareholders without delay. He concluded by moving:—

"*That the capital of the Company be reduced from £307,545, divided into 75,000 Preference shares of £1 each, 75,150 Ordinary shares of £1 each, and 224,850 Ordinary shares of 14s. each, to £234,988, divided into 47,362 Preference shares of £1 each, and 75,150 Ordinary shares of £1 each, and 224,850 Ordinary shares of 10s. each; and that such reduction be effected by returning the amount of £1 per share credited as paid upon each of the 27,637 issued Preference shares of the Company to the holders thereof, and thereupon cancelling such shares, and by returning 2s. per share to each of the holders of the 224,850 issued Ordinary shares of the Company, and by writing off each of the said 224,850 Ordinary shares the sum of 2s. per share as being capital unrepresented by available assets.*"

Sir ALEXANDER ARMSTRONG seconded the motion.

A shareholder asked whether, if they realised the 28,355 Austrian Ordinary shares, it was necessary to write down the 2s. a share.

The CHAIRMAN said that it was impossible to say how much they would pay back until the Austrian Company was liquidated.

The motion was then carried, and the proceedings terminated.

House to House Electric Light Supply Company (Limited).

We learn that the fifth ordinary general meeting of this Company was held at the Central Station, Richmond-road, S.W., on Thursday, last week under the presidency of Mr. H. R. Beeton. We were not, for some reason, favoured with a copy of the Directors' report, and are indebted to an outside source for the following account of the proceedings at the meeting:—

The SECRETARY read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN, in the course of his remarks, stated that the whole of the capital expended had been laid out with the strictest economy, and by the Company's own staff without having occasion to have recourse to the more or less costly services of consulting professional engineers. This expenditure amounted to £11,391. 12s. 3d, and represented the construction of a large portion of the second smoke stack, which would suffice for the completed station, giving three times the power at present possessed, and an addition to the plant equal to the supply of 28,000 35-watt lamps, so that the capital expenditure was larger than was necessarily represented by the revenue which appeared on the face of the accounts. With regard to revenue, for the first time in the history of the Company continuous day and night running had been undertaken. In these circumstances it was matter for congratulation that with the heavy extra consumption of coal and labour which they had to face, the cost of working should amount to no more than that for 1891. For this reason, and for others revealed by a more detailed analysis of the accounts, he thought he could promise the shareholders, by a limited capital expenditure on the sub-stations for securing more economical distribution, more satisfactory results in the future. They would agree with him that the Debenture and Preference shares constituted as good an investment as the market for this class of property afforded, and it was matter of regret to him that the hopes of the ordinary shareholders remained still to be fulfilled. The fact was that in this, as in other similar enterprises, they had drawbacks to contend with, but, unfortunately, their drawbacks were in the present, and their compensations in the future. The situation of their central station was such that it could never create a nuisance to the neighbourhood, and secured them from all possibility of difficulty and disturbance with the growth of their business in the future, but it imposed upon them a system of distribution which probably—he said probably, only—involved a more expensive method of distribution in earlier stages of their business. Moreover, laying mains as they had done in all the thoroughfares scheduled in the area, had resulted in only a sparse distribution of lights, as the statistics of other companies showed, so that there remained nothing for them but to wait patiently for the success which he believed would ultimately result. He then moved the adoption of the report and accounts.

The MANAGING DIRECTOR seconded the motion, and stated that they had made certain alterations in the arrangements of their steam pipes. Their old system was found to be very wasteful. These improvements were completed towards the end of last year, and the accounts for the ensuing year ought to show a great saving of coal, &c. Another point he wished to mention was the laying down of sub-stations, as under the old plan of putting in a converter in every house for reducing the electricity from high to low tension a great loss of current was apparent when the demand became extended. To avoid this the Directors had decided to adopt the system of grouping the converters in convenient places by which any portion of the mains could readily be got at and switched off when not in actual use. This, when completed, should show a marked improvement in their revenue.

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Mr. ARTHUR KIMBER asked what was the number of lights which had been connected since January 1st.

Mr. FROST asked if the Directors could not pay an interim dividend, as most companies were accustomed to do.

The CHAIRMAN replied that the number of lights connected since the 1st of January this year was about 1,500, and that the subject of paying half-yearly dividends upon the Preference shares would receive consideration.

The report was then adopted.

The dividend on the Seven per Cent. Preference shares was declared; Messrs. William Page and R. A. Germaine were re-elected to their seats on the Board. Messrs. Theobald Bros. and Miall were re-elected auditors, and the usual vote of thanks terminated the proceedings.

The following is the report of the Directors:—

The revenue account for the year ended December 31st, 1892, shows a credit balance of £2,836. 19s., which, with the sum of £525 referred to below, and the balance of £291. 0s. 8d. brought forward from the previous year, makes a total of £3,652. 19s. 8d. The Directors propose to deal with this amount as follows:—Interest paid on £30,000 debentures, £1,800; in reduction of preliminary expenses, £500; in reduction of suspense renewals account, £100; depreciation fund, £250; dividend of 7 per cent. on amounts paid up on £21,155 Preference shares, £962. 5s. 5d.; leaving a balance to be carried forward of £40. 14s. 3d.

The Directors have the pleasure to report that during the past year the business of the Company has continued to increase; the number of lamps attached to the Company's circuits on the 1st January being the equivalent of 19,383 8c.p. lamps, and on the 31st December 23,700. At the beginning of the year there were 373 houses connected, and at the end of the year 471. During the year another unit of plant has been laid down. This addition admits of the number of connected lamps being increased to 23,000 8-c.p.

A further issue of Seven per Cent. Preference shares was made during the autumn, bringing the total preference capital issued up to £21,155.

In addition to the profits at Kensington, the sum of £525 is guaranteed to the Company for the year 1892 in connection with the business of Central Station Construction, which the Leeds and London Electrical Engineering Company, Limited, took over from the Company, a similar amount being guaranteed for the current year.

The Directors have drawn no fees during the year, but £200 has been paid to Mr. William Page for special services.

Cambridge Electric Supply Company (Limited).

The annual general meeting of this Company was held at the offices, Sidney-street, Cambridge, on Friday, under the presidency of the Rev. G. B. Finch.

The Directors' report, which was taken as read, contained the following:—

"The Deed of Transfer of the Cambridge Electric Lighting Order, 1890, by the Corporation to the Company, was completed on December 13, 1892. The number of shares issued up to the present time is 1,836. A site in Thompson's-lane was adopted for the generating station, and the works were commenced at the end of July, 1892. The supply of electric energy to consumers was begun on November 19, 1892, at which time the number of lamps in electric connection with the station was equivalent to 230 10 c.-p. lamps. The number of lamps connected at the present time is equivalent to 4,700, and the number actually applied for to 6,200 similar lamps. Two steam boilers, one steam superheater, one economiser, and three turbine-alternator dynamos, each capable of supplying current for 3,500 10-c.p. lamps at the same time, and all other requisites for a complete central station have been set up. A length of five miles of double cable has been laid down in iron pipes in the streets, and seven colleges have the mains in their courts and are consumers of the current. The engine-room, boiler-house, and chimney shaft at the station have been built in a good substantial manner. The engine-room and shaft are large enough for the supply of 30,000 lamps. A strong river wall, consisting of iron piles, 30ft. long and 4ft. apart, with timbering between, is in course of construction, and will be completed in a few days. The Directors deemed it expedient that the Company should themselves undertake the wiring of houses and buildings and the supply of fittings—at all events, for a time—and a considerable amount of this work has been executed by the Company. The prices charged have been made as low as possible, consistent with securing a moderate profit, which has been realised. The total expenditure incurred up to the present time amounts to about £22,000, and a considerable further expenditure will be required for some time to come. The demand for current from the outset of the Company's operations has been much greater than the Directors anticipated, and a considerable extension of the Company's mains and works is, and will be, necessary to fulfil the present and future requirements of consumers. The Directors propose for these reasons to make a further issue of £10 shares, on which it is intended to call up not more than £8 per share. The amounts paid for these shares will rank for dividend on an equal footing with the other shares of the Company, but from the respective time only when the several amounts are paid, and in proportion to such amounts. The Directors are gratified with the success which the enterprise has met with in Cambridge, and they regard the position of the Company as most satisfactory and encouraging."

The CHAIRMAN, in moving the adoption of the report, said that of course they had not much progress to report in regard to the conduct of the business as a profit-earning concern. Their main business had been in regard to the construction of the works, and he was very glad to be able to report that the works were substantially completed. They were making provision for more lamps than would have been provided under the extension scheme contemplated by the Corporation, and, whereas the Corporation were providing for an outlay of £40,000, the Company's outlay, including the land of the Abbey estate, which they were not using, and the £1,000 they paid to the Corporation, was £25,000. That was due to two causes. One was the greater simplicity of the machinery under Mr. Parsons' system, by which a very great saving was effected in the size of the building and cost of machinery, and the other was they had not let the work out to contract, but had been doing it themselves. He explained that the Directors had no anxiety whatever in the matter of capital, and said that they might look forward to paying before long a reasonable dividend.

Sir B. C. BROWNE seconded, and stated that the Company had been formed on lines similar to that of the Company which was successfully carried on at Newcastle, and which was now paying 5½ per cent. interest. His impression was that the Company was working well and satisfactorily.

The motion was unanimously agreed to.

Sir B. C. Browne and Mr. Munsey were re elected Directors, and Mr. Arthur Rutter was appointed auditor.

The question of the remuneration of the Directors was postponed until the next meeting, and the meeting concluded with a vote of thanks to the Chairman.

Northampton Electric Light and Power Company (Limited).

The annual meeting of the shareholders of this Company was held recently in the Old Council Chamber, Town Hall, Mr. R. Cleaver, J.P., occupying the chair.

The fourth annual report stated that the business of the Company continued to increase, and that the electric light is steadily making its way. At the present time there are more than 4,000 8-c.p. lamps, or their equivalents, connected with the Company's mains, and not a few of the original customers have shown their appreciation of the light by extending its use. The debentures referred to in the last report, amounting to £5,000, have all been taken up, and the interest upon them has been punctually paid. After providing for debenture interest there is a balance of profit, £87. 15s. 1d., which will go in reduction of the deficiency necessarily occasioned last year by working expenses having been incurred for some months before the accession of customers. The third engine-set will be shortly in working order, and will be an invaluable addition to the Company's resources. To meet the additional cost it was resolved to issue Six per Cent. Cumulative Preference Shares to the extent of £5,000, and these have been allotted to the amount of £3,180. The Directors have secured, after protracted negotiations, some property adjoining the Company's works in Angel-lane, for the erection of coal sheds, which will result in a substantial saving in the way of cartage and there will be abundant room for any future extension of the works. The chief engineer, Mr. B. R. Beale, has given up his position, but most kindly continues to devote a considerable amount of time and energy to the promotion of the Company's interests. He is succeeded by the second engineer, Mr. W. E. Heenan. The statement of accounts showed that the sale of current for the year realised £1,182. 19s. 5d., and that, as stated previously, there is a profit of £87. 15s. 1d. on the year's working.

The adoption of the report and accounts was moved by the CHAIRMAN and carried unanimously, great satisfaction being expressed at the position and prospects of the Company.

The retiring Directors, Messrs. Seekham and Manfield, having been re-elected, votes of thanks to the Chairman and the auditor closed the proceedings.

South Staffordshire Tramways Company.

The annual meeting of this Company took place at the Depôt, Darlaston, on Wednesday in last week, Mr. W. J. Carruthers Wain being in the chair.

The SECRETARY read the notice convening the meeting, and also a circular which had been issued by the Chairman to the shareholders, stating that he intended to move the adjournment of the meeting, as a libellous circular, full of misleading statements, had been secretly and at the last moment issued to certain selected shareholders, but not to the Directors or officers of the Company.

A short and stormy discussion was held, and the meeting resolved by an overwhelming majority to adjourn.

The following is the report of the Directors to be submitted to the adjourned annual meeting:—

"The receipts for the year ended December 31, 1892, have increased by £656. 13s. 7d. over those for the twelve months to December 31, 1891, and were 13·47d. per mile run, as compared with 14·03d. for the previous year, and the average fare per passenger carried was 1·50d., in comparison with 1·52d. for 1891. The total expenditure has decreased by £311. 8s. 11d., and is at the rate of 11·90d. per mile run, as compared with 12·86d. in the previous year. The profit on the working amounts to £3,172. 19s. 8d., to which must be added the amount of £1,064. 12s. 9d. brought forward from last year, less the amount of £600 placed to reserve and renewal account, and after providing £1,781. 11s. 8d., the amount due for interest on Debenture Bonds, and £57. 12s. 8d. for income tax, a balance remains of £1,798. 8s., of which, following the auditors' recommendation, it is proposed to carry £1,200 to the reserve and renewal fund, and the balance of £598. 8s. 1d. carried forward to the next year's account.

"Your Directors are glad to be able to announce the completion of the conversion of the steam worked tramway, between Wednesbury, Darlast

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Walsall and Bloxwich, into a system of tramways worked electrically by the overhead system of wires, and these lines (7½ miles) were opened for traffic on the 1st ult. The work appears to be satisfactorily executed upon sound principles, but your Directors must emphasise the long and what appears to be the unreasonable delay on the part of the contractors in completing the work. The prescribed penalties for the six months delay, although amounting to a considerable sum, do not in the opinion of your Directors more than represent the loss sustained by the Company, and as at present advised such penalties can be rigidly enforced.

"Your Directors have during the past year again approached the Birmingham Central Tramways Company in the hope that a through service into Birmingham might be arranged, but the Directors of that Company declined on any terms to grant running powers over their lines to this Company, but are, however, willing to continue their service of cable cars from the terminus of their line at Handsworth to Carter's Green, West Bromwich, a distance of nearly 2¾ miles of route, in the event of the conversion of this Company's lines between these points as a cable line, and your Directors having satisfied themselves that such an arrangement would be productive of mutual profit are now arranging for an agreement. It is hoped that a definite statement on this subject may be made at the meeting. The Directors will do all in their power to effect an arrangement which will not only be immediately profitable to this Company, but will also remove the present acute difficulties with the Corporation of West Bromwich and the Handsworth Local Board respecting the use of steam, the power to use which ceases at an early date."

W. T. Henley's Telegraph Works Company (Limited).

The following is the report of the Directors, to be presented at the ordinary general meeting of the Company, to be held at the Cannon-street Hotel, London, E.C., on Friday next, the 17th inst., at noon :—

The accounts for the year 1892 show a net profit of £15,456. 2s. 10d., after charging interest on the Mortgage and Debentures, and writing off £3,500 for depreciation of machinery and ship gear. Adding £21,731 0s. 3d. brought forward from last year, and deducting £808. 14s., the half-year's dividend to June 30, 1892, paid in October, on the Preference shares, there remains a disposable balance of £36,378. 9s. 1d. The Directors have added £18,545. 1s. to the reserve fund, and they propose the payment of a further half-year's dividend on the Preference shares at the rate of 7 per cent. per annum, and a dividend for the year at the rate of 5 per cent. free of income-tax, on the ordinary shares, leaving a balance of £13,425. 9s. 4d. to be carried forward.

Of the £30,000 "B" Debentures created in 1891, £14,000 were paid off during the past year, and the Directors purpose to pay off immediately a further £4,000, which will reduce the amount of these debentures to £12,000.

The general business of the Company in the manufacture of electric light cables, telephone cables, &c., has been satisfactory, and a considerable quantity of submarine telegraph and mining cables has been constructed for the British and foreign Governments. A cable has been manufactured and laid between the Bahamas and the coast of Florida (U.S.A.), and a repair of one of the Western Union Telegraph Company's cables, in the vicinity of New York has been effected. It is interesting to note that no fault has been reported in any of the submarine telegraph cables laid by the Company since 1888.

Numerous and important improvements have been made, and are still in progress in the machinery and buildings of the North Woolwich works, including the erection of new buildings for insulating the cores of submarine cables with gutta percha. The machinery in these buildings will be driven by electric motors, and the Company will then possess the most perfect workshop of its kind in the world. A branch establishment has been opened during the current year at Melbourne (Australia).

The Directors who retire on this occasion are Mr. Sydney Gedge and Mr. R. J. Jenkins, C.E., and being eligible, they offer themselves for re-election. The meeting will appoint auditors for the ensuing year.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRITISH ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to January 3, 1893, has been filed. The Company was registered on October 4, 1878, with a capital of £100,000, in £10 shares, and at the time of making up 8,640 of these shares were taken up, 1,144 shares have been issued as fully paid, while upon the remaining 7,496 shares the full amounts have been called and all calls (£74,960) paid.

EASTERN TELEGRAPH COMPANY (LIMITED).—The annual return of this Company, made up to February 9th, 1893, has been filed. The nominal capital is £4,700,000, divided into 400,000 ordinary and 70,000 preference shares of £10 each. 469,988 shares have been taken up, the full amount called, and all calls (£4,699,880) paid.

FOWLER, LANCASTER, AND CO. (LIMITED).—At meetings held on January 17th and February 13th a resolution was passed and confirmed that the Company be voluntarily wound-up. Mr. James Rhodes, chartered accountant, Waterloo-street, Birmingham, has been appointed liquidator.

BIRMINGHAM TELEGRAPH FACTORY (LIMITED).—At a meeting held on February 13th it was resolved to voluntarily wind up the Company, and Mr. James Rhodes, chartered accountant, Waterloo-street, Birmingham, was appointed liquidator.——In the Chancery Division on Friday last, Mr. Jenkins applied to Mr. Justice Kekewich on behalf of Messrs. Fowler, Lancaster and Co. (Limited) for the appointment of a receiver in Birmingham Telegraph Factory (Limited) now in liquidation. His clients were debenture holders for £3,000. The Company went into voluntary liquidation on February 13th last. His Lordship allowed the person appointed by the plaintiffs to act as receiver until Tuesday next.

W. T. HENLEY'S ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The final winding-up meeting of this Company was held on January 16th, when an account, showing the manner in which the winding-up had been conducted and the property disposed of, was laid before the meeting.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum (free of income-tax), for the quarter ended December 31, 1892, and payable on the 25th inst. The books of this Company will be closed from the 18th to the 24th inst., both days inclusive.

CALLS DUE.—*March 15th*, City of London Electric Lighting Company (Limited), £2 on 20,000 £10 Cumulative Six per Cent. Preference Shares. *March 15th*, Electric Construction Corporation (Limited), £3 on 10,000 £10 Second Mortgage Debentures. *March 15th*, National Telephone Company (Limited), final £1 on 90,950 £5 per Cent. Non-Cumulative Third Preference Shares. *March 31st*, Scottish House-to-House Electricity Company (Limited), final £1. 10s. on 6,000 £5 Ordinary shares.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended March 5th were £929, as against £893 for the corresponding period of last year, being an increase of £36. The total receipts for half-year amount to £8,672 against £7,632 in the corresponding period of 1892, being an increase of £1,040.

COMMERCIAL CABLE COMPANY.—The report of this Company states that the gross earnings for the year 1892 amounted to $1,890,377, and the net revenue to $1,099,587, the latter showing an increase of $14,263 as compared with 1891. Quarterly dividends of 1¾ per cent. each have been paid, absorbing $540,120, and debenture bonds to the amount of $500,000 were redeemed on January 15th last, thereby reducing the total amount of bonds outstanding to £80,000. In order to provide for the laying down of a third cable it has been decided to offer to the shareholders, for subscription at par, 19,290 shares out of 22,840 shares now unissued.—A quarterly dividend of 1¾ per cent. has just been declared, payable on April 1st.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The Board have decided to recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares and a dividend at the rate of 4 per cent. per annum (free of income-tax) upon the ordinary shares, both for the half-year ended December 31st last.—The traffic receipts for the month of February were £1,808, against £1,865 for the corresponding period of last year.

DIVIDENDS.—Bell's Asbestos Company (Limited) have declared a dividend of 5s. per share for half-year to December 31st last, payable on the 18th instant, and making 7½ per cent. for the year.——Bolckow, Vaughan and Co. (Limited) have declared a dividend of 2½ per cent. for the year ended December 31st last.——Brown and Bayley's Steel Works (Limited) have declared a dividend of £1. 5s. per share, making 20 per cent. for the year ended December 31st last.——Muntz's Metal Company (Limited) have declared a dividend of 5s. per share, making 10 per cent. for the year ended December 31st last.——Scottish Boiler Insurance and Engine Inspection Company (Limited) have declared a dividend of 2s. per share for the year 1892.——A. and J Stewart and Clydesdale (Limited) have declared a dividend of 9 per cent. for the half-year to December 31st last, making 7½ per cent. for the year 1892.——United Alkali Company (Limited) have declared a dividend of 6 per cent. for the year 1892.——United Asbestos Company (Limited) declare a dividend of 5s. per share for the year ended December 31st last, payable on the 15th inst.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for February amounted to £20,400, and from January 1st to February 28th to £41,200. In the corresponding months of 1892 and 1891 the amounts were £40,800 and £41,600 respectively.

PHOSPHOR BRONZE COMPANY (LIMITED).—At the annual general meeting recently held at the Bridge House Hotel, London, S.E. (Mr. James Rock in the chair), the report of the Directors and the accounts were adopted and dividends of 5 per cent. on the preference shares, and 1¼ per cent. on the ordinary shares were declared, to be paid on or before March 31st next. £1,000 was added to the contingency fund, and £134. 1s. 2d. was carried to new account. Mr. Richard Gamble was re-elected a Director, and Mr. Robert Payne, F.C.A., was re-elected auditor.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Tuesday next, the 14th inst., as a settling day in the City and South London Railway Company's Perpetual Five per Cent. Preference Shares, Nos. 1 to 7,000, and have ordered these securities, and £30,000 additional stock, to be quoted in the Official List. Application has been made to the committee to allow the further issue of 4,120 ordinary shares of £5 each, Nos. 454,748 to 458,867, of the National Telephone Company (Limited), to be quoted in the Official List.

WESTERN UNION TELEGRAPH COMPANY.—The Directors' statement for the March quarter shows an estimated surplus, after the payment of

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the customary dividend of 1¼ per cent., of $247,127. General T. T. Eckert is to be appointed president, in place of the late Dr. Norvin Green.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended March 3, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,816.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended February 28th were £2,443, as compared with £2,635 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Mar. 1.	Price Wednesday, Mar. 8.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 8. Highest.	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	17/6	Anglo-American	53⅜ 54½	52 53	5 3 9	Jan., Apr., July, Oct.	54⅛	52
£2,876,140	Stock	3⅚0	Do. Preferred	94½ 95½	91½ 92½	5 18 11	" "	95½	91½
£2,876,140	Stock	5/0	Do. Deferred	13⅜ 14	13¼ 13¾	.. ..	" "	13¾	12⅛
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100 103	100 103	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	12 12½	12 12½	5 4 0	Mar., June, Oct., Dec.	12¼	12
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	105 109	105 109	4 11 9	June and December	..	..
$7,716,000	$100	7/1	Commercial Cable Capital Stock	175 180	175 180	3 17 9	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine xd	11½ 12½	11½ 12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10% xd	17½ 18½	17½ 18½	5 8 1	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2½ 3½	4 11 5	April and October..	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅜ 12	11⅝ 11⅞	5 17 8	Jan., Apr., July, Oct.	11⅜	11 1/16
400,000	10	2/6	Eastern	14⅜ 15½	14⅞ 16⅛	4 5 11	" "	15 1/16	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	15⅜ 16½	15½ 16	3 15 0	" "	16	15 9/16
£1,294,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113 116	113 116	3 9 0	May and November	114½	113
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15½ 15½	15¼ 15⅜	4 10 4	Jan., Apr., July, Oct.	15½	15¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	110 113	110 113	3 10 10	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103 106	103 106	4 14 4	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102 105	102 105	4 15 3	" "	103½	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101 104	101 104	3 16 11	February & August	102½	..
180,227	10	1/3	Globe Telegraph and Trust	9⅝ 9⅞	9⅝ 9⅞	5 1 4	Jan., Apr., July, Oct.	9⅝	9 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15¼ 15½	15¼ 15⅜	3 17 5	" "	15½	15¼
150,000	10	5/0	Great Northern	19 19⅜	19 19⅜	4 7 8	Jan., April, and July	19 7/16	19¼
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883 xd	104 107	104 107	4 13 6	March & September	106¼	..
17,000	25	12/6	Indo-European	43 45	44 46	5 8 8	May and November	44½	..
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures xd	105 108	105 108	5 11 1	March & September	..	..
10,802	8	4/0	Reuter's	7½ 8½	7⅜ 8⅛	4 14 1	April and October..	..	..
3,381	£100 Cert.	30/0	Submarine Cables Trust 6%	118 123	118 123	4 17 7	" "	121	120
15,609	10	5/0	West African Telegraph	6½ 7½	6⅜ 7½	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures xd	100 103	100 103	4 17 1	March & September	..	..
30,000	10	2/0	West Coast of America	2¼ 3¼	2⅜ 3⅜	.. ..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	104 108	105 109	7 6 10	June and December	..	..
88,321	10	6d.	West India and Panama	1⅛ 1⅜	1⅛ 1⅜	.. ..	" "	1 6/8	1 4/8
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾ 11¼	10⅝ 11¼	5 6 8	May and November	11⅛	11
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9 10	9 10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	107 110	107 110	4 10 11	June and December	..	..
64,242	15	3/0	Western and Brazilian	7⅜ 8¼	7⅜ 8⅜	5 9 1	May and November	..	..
33,129	7½	3,0	Do 5 per Cent. Cumulative Preferred	5¾ 6¾	5¾ 6¼	6 0 1	" "	6	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2 2½	2 2⅛	.. ..	" "	2⅜	2 1/16
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	105 108	5 11 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	105 108	5 11 1	" "	107½	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds xd	101 104	101 104	5 15 5	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone	3 4	3 4	.. ..	..	..	..
22,500	15/0	1½d.	Consolidated Telephone Const. & Maintenance	1/16 1/16	¼ ⅜	1 13 4	May and November	..	..
20,000	£1	4½d.	Oriental (11s. paid)	⅛ ¼	⅛ ¼	7 18 2	Yearly	..	..
454,747	5	2/6	National	5⅛ 5⅜	5¼ 5⅜	5 11 7	June and December	5 5/8	5 1/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½ 15½	14½ 15½	3 17 6	" "	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13¾ 14½	13¾ 14½	4 4 3	" "	14½	14
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	4⅜ 4⅝	4⅜ 4⅝	.. ..	..	4 9/16	..
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	1 3 116	113 116	3 17 7	January and July ..	114⅜	114
48,000	£10	..	New Telephone, Limited (£4 paid)	.. ..	.. ..	.. ..	..	..	..
58,000	5	1/0	United River Plate	2½ 3	2⅜ 3	.. ..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	12⅞ 13	12⅞ 13	..	..	12 15/16	12⅝
20,000	£10	..	Do. 6 per Cent. Preference	8¼ 8¾	8¼ 8¾	2 18 2	..	8 9/16	8 7/16
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	..	..	..
8,332	£5	..	House to House Electric	.. ..	.. ..	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge Elec. Light (fully pd.)	.. ..	.. ..	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	.. ..	.. ..	..	January and July ..	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	4⅛ 4⅛	4⅛ 4⅛	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5⅞ 6	5⅞ 6	..	March	..	..
111,000	5	..	London Electric Supply	1 1⅛	1 1⅛	..	..	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	5⅞ 6⅛	5⅛ 5⅞	..	..	5 1/16	5
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	..	..
16,318	10	..	Notting Hill Electric Lighting (fully paid)	5½ 6½	5⅜ 6⅛	..	..	..	..
18,680	£5	9½%	St. James' and Pall Mall	7⅞ 8⅛	8 8⅛	..	..	8⅜	8⅛
7,900	£5	7%	Do. 7% Preference	8 8½	8 8⅜	4 2 4	..	..	..
12,853	5	2/0	Westminster Electric Supply (fully paid) xd	5½ 6	5½ 6	4 3 4	..	5⅞	5⅝
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/6	Brush Electrical Engineering xd	3⅛ 3⅜	3⅛ 3⅜	..	..	3 5/8	3⅛
69,996	2	6%	Do. 6 per Cent. Preference xd	2⅜ 2⅝	2⅛ 2⅜	5 1 1	..	2 3/8	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures xd	103 105	103 105	4 5 9	..	104⅛	104
20,000	5	5/0	Crompton and Co., 7 per Cent. Pref. Shares	5 5½	5 5½	6 7 3	January and July ..	5 7/16	5½
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	.. ..	.. ..	..	..	..	..
45,000	10	12/0	Electric Construction	3⅞ 4⅛	3⅛ 4	..	..	3⅜	..
70,000	2	10/0	Elmore's Patent Copper Depositing	3/8 5/8	3/8 5/8	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1⅛ 2⅛	1⅛ 2⅛	..	..	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works xd	22 23	22 23	5 8 8	February & August	22⅞	22½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	104 106	104 106	4 4 11	March & September	105	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0 6/0	5/0 6/0	..	..	..	..
78,949	5	4/2½	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	3 3/16	3
37,350	12	12/0	Telegraph Construction and Maintenance	35 38	35 38	4 14 8	March and July.....	37	35
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July ..	..	..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	..	..	..	..
..	£5	..	Do. Preference (fully paid)	.. ..	.. ..	..	..	..	..
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	.. ..	.. ..	..	..	..	..
600,000	Stock	3⅜%	Do. Stock	35 37	35 37	3 0 9	May and November	..	..

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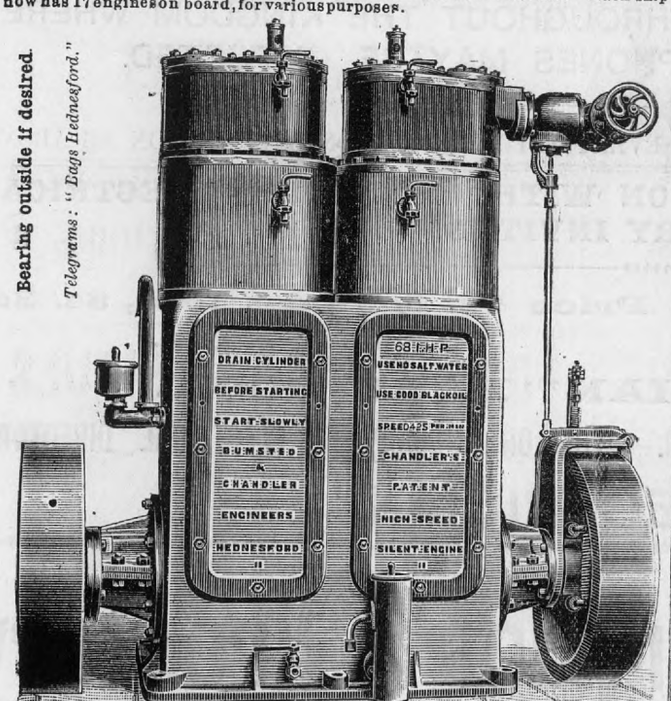

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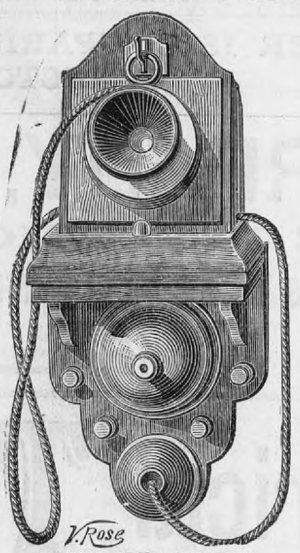

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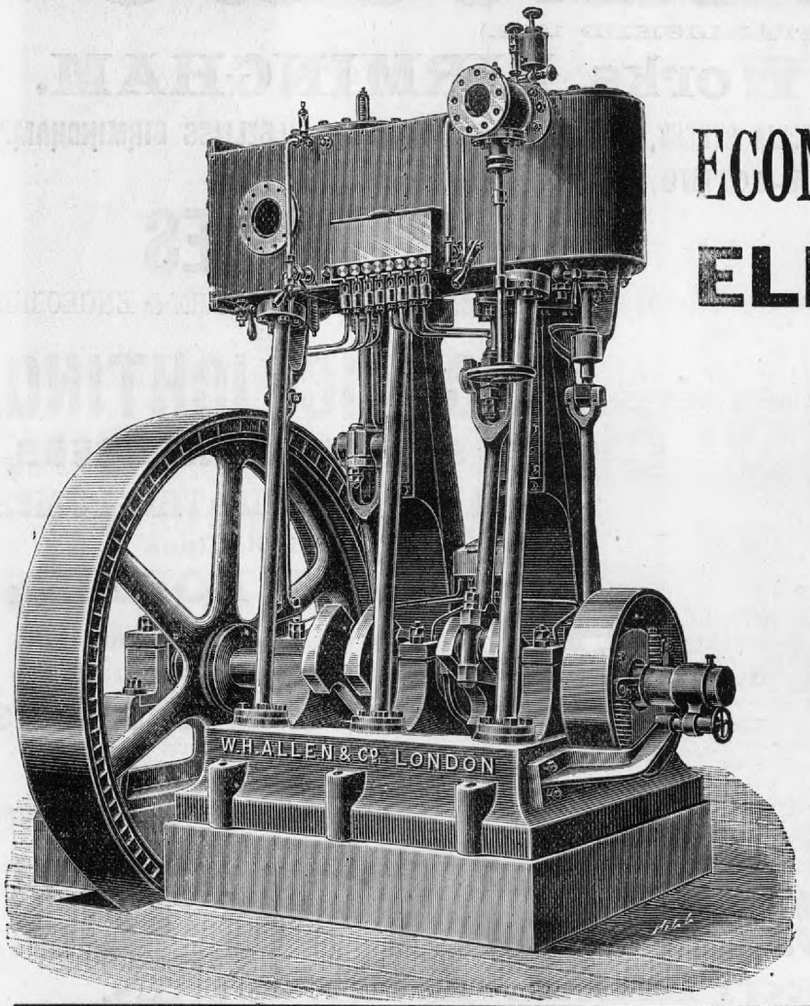

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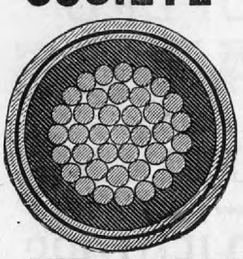

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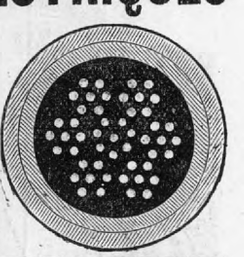

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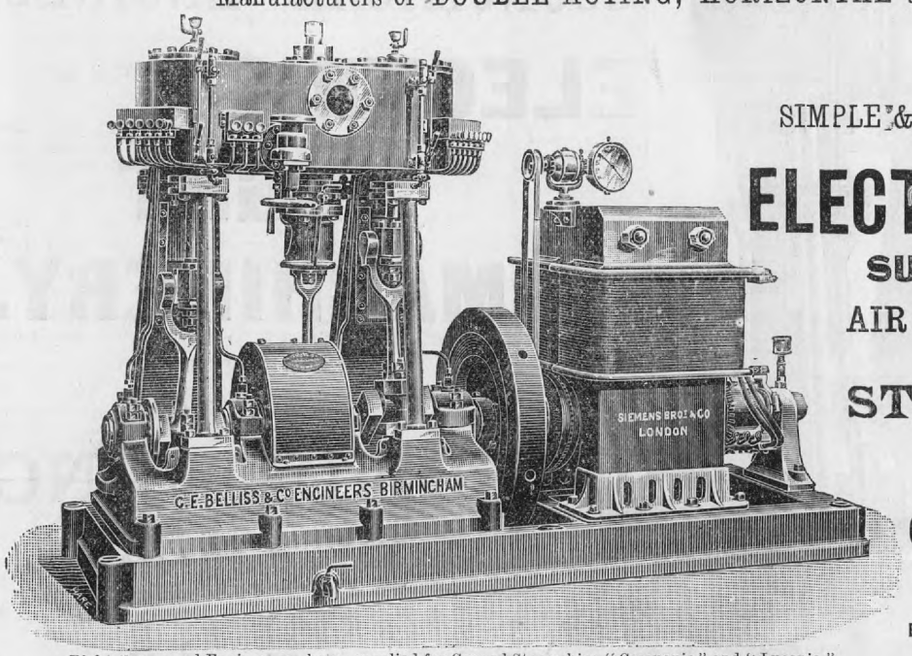

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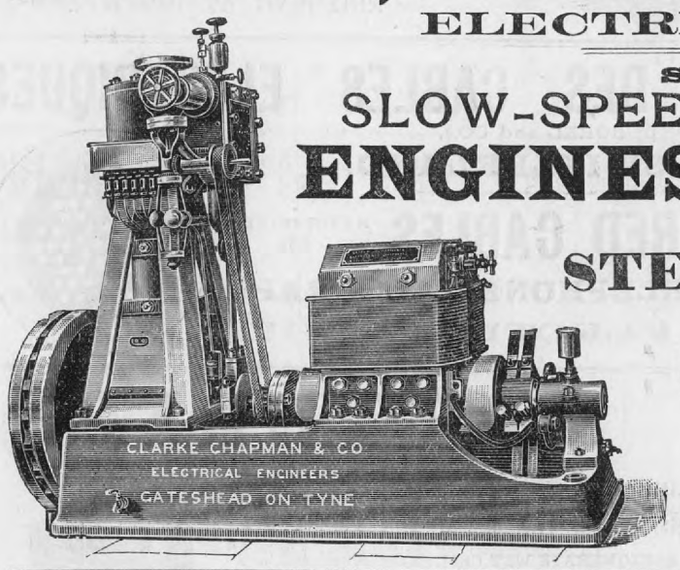

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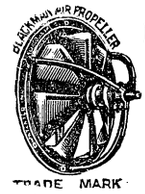

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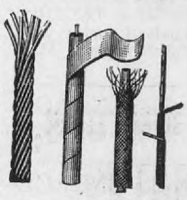

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The following Statement shows the Financial position of the Company on the 31st DECEMBER, 1891—

Capital Paid up	£366,702 0 0
Fire and other Reserve Funds, including Balance of Profit and Loss	2,981,078 0 0
Life and Annuity Funds	4,546.577 0 0
Total Invested Funds, 31st December, 1891	£7,894,357 0 0

INCOME FOR THE YEAR. . . . £2,230,635

The following Comparative Statement shows the progress of the Company :—

1881	...	Life Funds	£2,737,858	... Total Funds	£4,673,299
1886	...	,,	3,257,609	... ,,	5,672,041
1891	..	,,	4,546,577	... ,,	7,894,357

INCREASE OF FUNDS IN TEN YEARS, £3,221,058.

EXTRACT FROM AUDITORS' REPORT.

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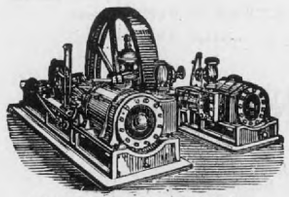

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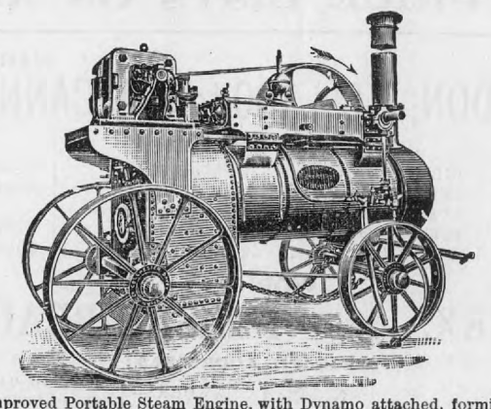

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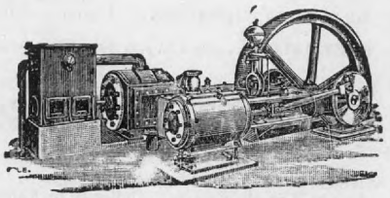

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No. 774.—Vol. XXX. FRIDAY, MARCH 17, 1893. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

The question which Prof. Unwin asks at the end of the second paragraph of the letter which will be found in our correspondence columns is, perhaps, the most important question of the day for electrical engineers. It is only during the last two years or so that they have realised the serious difference between the cost of a continuous load and of an ordinary electric-lighting load. Prominence was given to this question by the late Mr. Willans, by comparing the coal consumption at central stations with the consumption found during full-load tests. We are not disposed to accept the analysis of the Bradford figures for two reasons. In the first place, the accounts of Corporations cannot be compared with those of limited liability companies; for several of the various items to which Prof. Unwin alludes are treated in a different manner in the two cases, and the actual expenditure and cost, even if the books were kept in the same way, could not be compared. Interest on capital, redemption, insurance, depreciation, office rent, clerical expenses, collecting expenses, works in the streets, cartage, and other matters cost less to a Corporation than to a company; and herein lies the sole advantage that we can discover in allowing a Corporation to carry on the business of electrical supply, and in many cases, to seven or eight times.

It is possible, as was pointed out by Mr. Garcke in the discussion following Mr. Shoolbred's Paper before the Society of Arts, for a Corporation to present a favourable account of their doings, since they have great facilities for distributing their expenditure over the accounts of different departments; on the other hand, there is no trade bias. When it comes to discarding "half of the cost under the headings 'repairs and maintenance,' and 'depreciation,' because there appear to be included in these items more than is fairly chargeable to cost of power," we are getting a long way from the simple facts.

The Bradford coal is cheap, but is said to have but low calorific value. The cost of cartage to some of the London stations is, on the other hand, expensive. The only thing that can be compared with certainty would be the steam consumption per unit, or per horse-power-year. It is practically impossible to collect statistics on this point. When the Board of Trade returns for this year are complete, we shall make a careful analysis of the costs, as we did last year, and if the accounts of the provincial companies can be brought into any sort of common form, we shall attempt to examine them also, but hitherto nothing worthy of being called a comparison has been possible. There seems to be a general impression among the engineers of successful companies, that an ordinary load factor runs up the cost to at least three times that of a supply with a load factor of unity.

The system of rebates adopted by the London Electric Supply Corporation, unlike certain others, appears to encourage the small consumer, and to keep the ratio of lamps used to lamps fixed somewhere about unity. It is, moreover, easily understood, though, perhaps, the real value of the concession is not to be appreciated without a little calculation. The rebate begins when the consumption per 8 c.p. lamp exceeds 35 units per annum. At 32 watts per lamp, this means about 1,100 burning hours, excluding Sundays but including fogs; this is equivalent to each and every lamp being alight from dusk to 9 p.m. all the year round. If three-quarters of the lamps are turned out at 8 p.m., the remainder will have to burn till midnight, if a first taste of the rebate is to be enjoyed. The exact amounts of the rebates will be found in another column.

Whenever a public body succeeds in performing the feat popularly known as getting people's backs up, it may be predicted with some degree of certainty that all its subsequent acts will meet with an opposition altogether out of proportion to their intrinsic merits or demerits. That the London County Council has attracted to itself the dislike of a powerful section of the community is not to be gainsaid, and this circumstance, added to the fact that Mr. Pickersgill, with true County Council maladroitness, succeeded in ruffling the feelings of sticklers for Parliamentary etiquette, will account for the smart rebuff sustained by the County Council on Thursday last week in its attempt to secure the insertion of a purchase clause in the City and South London Railway Bill.

It is satisfactory to note that the confiscatory tendencies of the County Council have been subdued, and that it is now only anxious to acquire the electric railways "on *fair* conditions at the expiration of a certain term of years," the term to be such an one as would have "no effect on the financial prospects of the companies." It is reassuring, moreover, to be officially informed that there is "no wish on the part of the London County Council to crush out legitimate commer-

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cial enterprise." In face of such an attitude of sweet reasonableness, and in view of the fact that Manchester, Liverpool, Glasgow, and other large towns possess powers of purchase similar to those asked for by London, the refusal of Mr. PICKERSGILL's demand by an overwhelming majority can only be accounted for on the hypothesis propounded above.

WHAT seems to us one of the gravest of the objections advanced against municipalisation of this, that, and the other, was adverted to in this debate; we refer to the inadvisability of a public body directly employing a large percentage of its own constituents. From the point of view merely of the financial promotion of these long-delayed electric railways, the rejection of the County Council's proposals is, of course, an unqualified good. We trust that these railways will now be pushed forward on a sound financial basis, for the results so far achieved by the City and South London Railway are, when rightly interpreted, decidedly encouraging.

IN a recent number of *La Lumière Electrique* is described a special mode of winding transformers, the object of which is to diminish the loss of energy occurring on light loads. The core losses of transformers do not depend upon the output, and form the most important part of the losses when the load is small. They may be reduced by lowering the induction at which the iron is worked, and this end is secured by Messrs. SIEMENS and HALSKE by winding each coil of the transformer in two equal sections, and arranging these sections in parallel when the transformer is heavily loaded, and in series when the load is light. A special switch is arranged for altering the connections. In this manner the induction density used with small loads is only half that which is employed when the output is large, and the core losses are diminished in about the ratio of 5 to 2. But although a great saving is brought about in this way, it is accompanied by an increase in the coil losses, caused by the fact that the resistance of each coil has been quadrupled by rearranging the connections; and, until the output of the transformer is reduced to less than half full load, no real saving can be effected by this device. It would, no doubt, if properly used, bring about an important increase in the all-day efficiency of transformers; but it is hardly likely that the ordinary householder will appreciate the advantage of an attachment which has no apparent effect on the brightness of the lights; while, if the transformers are collected in sub-stations, no such device is necessary, since there is then no need to work any transformer at less than half load.

AMONGST "practicians," one of the best-abused of modern movements is that in favour of technical education. It is, therefore, a relief to find that such an old engineering hand as SIR FREDERICK BRAMWELL can see at least one potential advantage in the increased opportunities at present afforded for learning the science underlying most trades and professions. In an interestingly-anecdotal inaugural address recently delivered at the opening meeting of the current session of the Goldsmiths' Institute Engineering Society, SIR FREDERICK predicted that one great advantage of instruction in principles would be that inventors of the "flat-earth" and "perpetual-motion" order would, in process of time, become extinct. For our own part we are not so sanguine. To attempt impossibilities will always be the destiny of an appreciable proportion of mankind; and, if authentic statistics were available, we feel sure that it would be found that 90 per cent. of those who attempt the impossible do so by way of the Patent Office. A man possessed of an idea is not to be turned aside by such a venial error as an infraction of the law of conservation of energy. This propensity, in turn, has its compensation in the occasional upsetting of ostensibly well-established "laws" by those who refuse to take them for granted.

Dundee.—The "inauguration" of the municipal electric lighting station took place on Tuesday evening last at seven o'clock.

Chicago Exhibition.—The *Journal* of the Society of Arts for March 10th contains the regulations governing awards at the Chicago Exhibition.

Alloys.—Prof. Chandler Roberts-Austen's Cantor Lectures on "Alloys" will be printed in the *Journal* of the Society of Arts during the summer recess.

Electric Light Wiring.—The chief of the Electrical Department of the Philadelphia Fire Underwriters' Association is now in Europe to inquire into and examine the safeguards used for the protection of theatres lighted by electricity, &c.

Electrical Inspectors.—Inspectors are much *à la mode* in these days. In Switzerland they have an "Inspector of Strong Currents," whose duty it is to see that electrical currents, other than telephonic and telegraphic, are kept in the way they should go.

Electric Power Charges.—At Chambéry, in Savoy, M. Gacon, the electric light and power concessionaire, is to charge £18 per annum for a 1-horse motor, £10 per annum for a $\frac{1}{2}$-horse motor, £6 per annum for a $\frac{1}{4}$-horse motor, £3 per annum for a $\frac{1}{8}$-horse motor, £1. 10s. per annum for a $\frac{1}{16}$-horse motor.

Electrical Bills in Parliament.—On Thursday last week in the House of Lords the Baker-street and Waterloo Railway Bill was read a third time, and, after amendments had been inserted, was passed.—On Wednesday last the Kensington and Knightsbridge Electric Lighting Company Bill was read a second time in the House of Commons.

The Electric Lighting of the Houses of Parliament.—The First Commissioner of Works intends to ask for a vote of £12,000 to extend the electric-lighting arrangements in both Houses of Parliament. Only £1,600 will, however, be expended in the coming year. The cost of electric lighting last year in the House of Commons was £1,800.

The Electrical Utilisation of Water-power.—A concession, says *Industries*, has been recently granted to utilise the water-power available at the Todten Mountain, near Aussee, in Styria. About 8,000 H.P. will be obtainable, which will be utilised in the production of electrical energy for industrial purposes. The State has a financial interest in the undertaking.

The Lighting of the Embankment.—The London County Council has approved of the appropriation of the piece of land adjoining the Charing-cross District Railway Station for the purposes of a generating station in connecting with the electric lighting, for which the Council is seeking powers in its General Powers Bill of this session, of the Victoria Embankment and ornamental gardens, and the Westminster and Waterloo bridges.

Liverpool Overhead Railway.—This line was opened to the public on Monday, March 6th. The number of passengers

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carried on that day was 17,541, and the receipts were £164. 3s. The Company expect to be able to commence their five minutes' service shortly (at present they are content with a ten minutes' service) and also to run from 5 a.m. to 9 p.m., instead of from 7 a.m. to 7 p.m., as at present. Already there are loud complaints of overcrowding.

Hertford.—At a meeting of the Town Council, held on Thursday last week, a report by the Electric Lighting Committee was presented, recommending the adoption of an alternating current system, with transformer sub-stations and gas engines burning Dowson gas, at an estimated cost of £5,800. It is proposed to use two 35-kilowatt dynamos, mechanically coupled together, in order to obtain steady running. After some discussion it was decided to consult a leading electrical engineer.

Kensington Vestry.—At a recent meeting of this Vestry a letter was received stating that the Kensington and Knightsbridge Company were prepared to complete a supply of electric current to the district within a year and a-half. The Law and Parliamentary Committee reported in favour of the arrangement, but Mr. Braye moved that the matter be referred back. This was negatived. Later on, it was resolved, on the motion of Mr. Saunders, Q.C., that the question of the Vestry taking the lighting into its own hands be referred to a Committee.

Woodhouse and Rawson United.—When the late Mr. Otway Woodhouse, senior partner in the firm of Woodhouse and Rawson, died, shortly after the transfer of the business of that firm to a private limited company, the value of his estate, says the *Statist*, was sworn at £1,000, which was afterwards increased, presumably in respect of his share of the proceeds of sale, to £2,000, representing, apparently, one-half of the original capital of the parent business, of which the various existing Woodhouse and Rawson, Elmore, and Kensington Stores Companies are the offspring.

The Telephone in Lancashire.—The National Telephone Company's system in North-East Lancashire is, says the *Birmingham Daily Post*, threatened with temporary paralysis. A firm of Blackburn brewers, owning public houses in Blackburn, Burnley, Preston, Accrington and Darwen, over which the trunk wires to Manchester, Liverpool, and other towns have been carried, have made a demand for way-leave, with which the Company have refused to comply. As a consequence they have been ordered to remove the trunk wires and also 300 wires belonging to private subscribers.

Société Internationale des Electriciens.—The following is the list of the new "bureau" of this Society, which is to be elected on April 5th next for office in 1894:—President: M. Postel-Vinay. Vice-Presidents: MM. Hospitalier and Picou. General Secretary: M. Hillairet. Secretaries: MM. Gaston Roux, Thomas, and Violet. Treasurer: M. Dumoulin-Froment. Members: MM. Arnoux, d'Arsonval, Barbier, Benard, Bergon, Bordet, Bovet, Delaunay-Belleville, Gauthier-Villars, Géraldy, Javaux, Leblanc, Monnier, Saladin, Tresca, Lazare Weiller, and Williot. Auditors: MM. Armengaud (Junr.), Berthon, and Masson.

Obituary.—On the arrival at Hastings of the last train from London on Thursday night last week, the end window of a third-class carriage on the down side was found smashed, and the glass scattered on the seat. Subsequently the body of a man was found on the line between Frant and Tunbridge Wells. The body was identified as that of Mr. E. T. Mercer, manager of the Hastings and St. Leonards-on-Sea Electric Light Company. He left Hastings for London on business of the Electric Light Company on Thursday morning. He is supposed to have opened the door and been knocked backward against the side window.

The City and South London Railway.—In reply to Mr. A. C. Morton, Mr. Mundella stated in the House of Commons on Thursday last week that the Board of Trade had from time to time received complaints of overcrowding on the City and South London Railway, and had communicated with the Company. The Company stated that they were using every effort to meet the press of traffic which occurred for about an hour every morning and evening. To enable them to do this additional sidings were being constructed, and an application was now before Parliament for power to construct a duplicate line from the Borough to the City.

The London Electric Supply Corporation.—The following special notice of reduction in charge has been issued by this Company:—

From April 1st next the Corporation's standard charge for electrical energy will be 6d. per Board of Trade unit. All customers will also be entitled to the benefit of the following sliding scale, extending from the standard rate to 5d. per unit, based on their consumption of energy. Where the consumption per 8-c.p. lamp exceeds:—

35 units per annum ...	5¾d.	45 units per annum ...	5¼d.
40 „ „ ...	5½d.	50 „ „ ...	5d.

Accounts will be rendered at 6d. per unit, the deductions due under the sliding scale being allowed in the account rendered for the last quarter of the year.

Brighton.—The agenda at yesterday's meeting of the Town Council contained the accounts of the Corporation Electric Lighting undertaking for the year ended December 31, 1892. The revenue account shows a total expenditure of £2,457. 15s. 3d., the expenditure on generation being £1,643. 6s. 11d. The income is £4,687. 4s. 2d., divided as follows: Electricity sales, £4,543. 4s. 2d.; meter rents, £139; and work executed for customers, £5. Of the £2,233. 10s. 4d. gross profit, £2,221 6s. 1d. is transferred to net revenue account, and £12. 5s. 3d. is carried forward. The expenditure in the net revenue account is £1,238. 4s. 4d. interest, and £983. 1s. 9d. to sinking fund.

Cable Interruptions and Repairs.—

	Interrupted.		Repaired.
Cayenne-Vizeu.....	September 24, 1892.	...	March 10, 1893.
Accra-Grand Bassam	March 13, 1893.	...	March 15, 1893.

Cable actually interrupted:—

Gibraltar-Tangier ..... February 18, 1893.

According to a telegram from Teneriffe, some excitement has been caused there by the suspicious movements in the neighbourhood of a foreign war vessel, and a Spanish gunboat has been sent out to keep the stranger under observation. They are evidently unaccustomed to cable-repairing ships in these waters, as it appears to be the Eastern Telegraph Company's ss. "Mirror," at work near that island, which has caused the commotion.

Swedish Telegraphic Statistics for 1892.—During 1892 the number of paid telegrams transmitted by the Swedish State Telegraphs amounted to 1,866,692, against 1,849,533 the previous year, an increase of 0·9 per cent., the greater part of which meagre increase is due to foreign traffic. The receipts for these telegrams, so far as Sweden is concerned, amount to about £70,000, and show a decrease of some £660 compared with 1891. This decrease in the receipts may in a large measure be set down to the continuous diminution in the average number of words per message. About 70,000 telegrams were transmitted during 1892 free of charge, about half of these being meteorological. As to Press telegrams, transmitted at reduced rates, the number in 1892 was 23,847, which shows an increase of between 2,000 and 3,000 as compared with the previous year.

Electric Lighting at the St. Lazare Terminus.—In 1889 400 H.P. electric light plant was laid down by M. Cance to supply current to the St. Lazare terminus of the Chemin de Fer de l'Ouest. This plant having proved unequal to the increased demand, a new 770 H.P. generating station was erected a little more than a quarter of a mile off. This station is now supplying current to 250 arcs and 2,600 incandescents. The plant comprises five Belleville boilers, five 140 H.P. high-speed Corliss engines, by Lecouteux and Garnier, and one 70 H.P. vertical engine, and eleven shunt-wound Gramme dynamos, giving 550 amperes at 80 volts. Distribution is carried out by a ring main. The arc lamps are fitted with diffusing globes, and take 25, 8, and 6 amperes. The average illumination on the platforms is 1·27 bougie metres, or 0·127 candle-feet approximately.

Fire at a Chicago Electric Lighting Station.—A few weeks ago a fire was discovered in the feeder pit under the engine room of the Adams-street station of the Chicago Edison Com-

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pany. The fire was not a serious one, and could have been easily got under by the *employés* of the station, but an alarm was sent to the fire department. This proved very unfortunate. When the firemen came they were asked not to use water on the feeders until the station could be shut down. They were not, says the *Western Electrician*, to be instructed by any mere electricians, however, and insisted on deluging the cables with water despite the angry remonstrances of the station people. There was instantly a total short-circuit, flames mounting the wall of the engine room, and the entire plant was incapacitated, every light on the company's circuits going out. The firemen had put out the fire, but the remedy was many times worse than the disease.

The Relative Corrodibility of Pure and Alloyed Lead.—This subject has, says the *Engineering and Mining Journal*, lately received considerable attention from Dr. Lunge. After conducting a great number of experiments with various alloys, he draws the following conclusions:—1. There is no difference in the cold between the actions of sulphuric acid on pure and antimonial lead, when the admixture of antimony does not exceed 0 2 per cent. When the acid is warm, the difference in favour of pure lead is more marked. 2. The action of nitrous vitriol is in all cases stronger when air has access than when not; and is always greater than pure vitriol. 3. The addition of a small percentage of copper to the lead does not increase its power to resist the attacks of sulphuric acid when the temperature is below 200deg. C.; when the temperature is above 200deg. C. the addition of 0 1 to 0·2 per cent. of copper is advisable, though its effect is not very marked.

The Cable Ship "Norseman."—The new "Norseman," just built for the Western and Brazilian Telegraph Company, made her trial trip on Tuesday last. A large party embarked at Tilbury, and were carried at the guaranteed speed of 14 knots to within sight of Margate. Unfortunately, on the return journey a slight mishap occurred to the machinery, and a rather long stoppage had to be made. The "Norseman," which was constructed by Messrs. Ramgate and Ferguson, of Leith, is 235ft. long between the perpendiculars, has triple-expansion engines, and is furnished with all the most modern machinery to execute the work she is intended for on the coast of Brazil. Throughout, the vessel is fitted with electric light, and the accommodation for both officers and men is especially commodious and comfortable. Major Wood, the Managing Director, was particularly anxious that the ventilation should be as perfect as possible, and his ideas have been satisfactorily carried out by the marine architects (Messrs. John Thomson and Son). Captain Lacy (the commander) was cordially complimented upon the splendid capabilities shown by the "Norseman" on her trial trip.

The National Telephone Company and the Leeds Corporation.—The Leeds Corporation in their Bill this Session propose to take power for acquiring the tramways and to work or lease them. The National Telephone Company have presented a petition against the Bill, and before the Court of Referees, presided over by Mr. Sheress Will, the Corporation contested the *locus standi* of the Company Mr. Pembroke Stephens, Q.C., appeared for the Leeds Corporation, and Mr. Cripps, Q.C., for the Telephone Company. Mr. Cripps submitted that the question had already been disposed of, inasmuch as the Court had given a *locus standi* to the Company against the Blackpool Improvement Bill and other Bills, the circumstances of which were on all fours with the present case. On the other hand, Mr. Pembroke Stephens submitted that the cases differed, and that since the decision in the Blackpool case it had been shown that the Telephone Company could protect themselves without the insertion of any clauses in the Bills. The Court, however, without calling upon Mr. Cripps to reply, decided to allow the *locus standi* of the Company against that portion of the Bill relating to the tramways. Mr. Chandos Leigh, the Speaker's Counsel, appealed to the representives of the Leeds and Blackpool Authorities to agree upon an identical clause for the protection of the Telephone Company, and the representative of the Company stated that his clients were perfectly willing to accept the clause suggested by the Board of Trade in 1889.

Forthcoming Books.—The following are a few of the books of scientific interest announced as about to be published:—*The Electrician* Printing and Publishing Company (Limited) will shortly publish the following: "Electromagnetic Theory," by Oliver Heaviside; "A Pocket-Book of Electrical Engineering Formulæ," by W. Geipel and H. Kilgour; "Submarine Cable Laying and Repairing," by H. D. Wilkinson; "Drum Armature Winding, and Commutators," by F. M. Weymouth; and "Electricity as a Motive Power," by Albion T. Snell. "The Metallurgy of Iron and Steel," by the late Dr. John Percy, F.R.S., a new and revised edition, with the author's latest corrections, and brought down to the present time by H. Bauerman, with illustrations (Mr. Murray). Messrs. Longmans announce:—"Telephone Lines and their Properties," by Prof. W. J. Hopkins; "A Treatise on Electricity and Magnetism," by G. W. De Tunzelmann, in 2 vols. Among Messrs. Macmillan and Co.'s announcements are:—"A Uniform Edition of Prof. Huxley's Essays," in 6 vols., comprising Lay Sermons, Addresses and Reviews, Critiques and Addresses, Science and Culture, American Addresses, Man's Place in Nature, &c.; "Elementary Treatise on Modern Pure Geometry," by R. Lachlan; "Exercises in Euclid," by Wm. Weeks; "Utility of Quaternions in Physics," by Alexander McAulay. In the Clarendon Press list are:—"A Supplementary Volume to Prof. Clerk Maxwell's Treatise on Electricity and Magnetism," by Prof. J. J. Thomson, F.R.S.; "A Manual of Crystallography," by Prof. M. H. N. Story-Maskelyne, F.R.S.; "Analytical Geometry," by W. J. Johnston; "A Treatise on the Kinetic Theory of Gases," by Dr. H. W. Watson, new edition; "An Elementary Treatise on Pure Geometry," with numerous examples, by J. W. Russell. Messrs. Percival and Co. give notice of:—"Electricity and Magnetism," by L. Cumming; "Heat," by G. Stallard; "Light," by H. P. Highton; "Mechanics" (treated experimentally), by L. Cumming; "Practical Physics," an introductory handbook for the physical laboratory, in three parts, by Prof. W. F. Barrett; Part II. Heat, Sound, and Light; Part III. Electricity and Magnetism, Electrical Measurements.

The St. Louis Arc-Light Station.—In the fourth article of the interesting series on "The Electrical Side of St. Louis," now in course of publication in the *Electrical World*, a well-illustrated account is given of the great arc light station of the Municipal Electric Light and Power Company. This station, which is by far the largest of its kind in the world, is managed by Mr. James I. Ayer. The arc-lighting plant comprises 63 60-light, 13 80-light, and 2 75-light machines, all of which, except the last two, are of the Wood type. The Wood arc-lighter is of the Gramme pattern, and normally supplies a current of 9·6 amperes. It is worked up to over 2,500 volts. Sparking at the commutator is mitigated by an auxiliary brush placed a few sections ahead of the working brush, and the volts are varied by varying the position of the brushes. The Company has now in operation 36 municipal arc-light circuits of a total length of 532 miles, ranging from 8 to 22 miles each, and averaging 15 miles per circuit, to which are connected 2,100 arcs. It has also 30 commercial arc-light circuits, aggregating 240 miles of wire, to which are connected 1,500 arcs. Thus the arc light circuits have a total length of 772 miles and supply current to 3,600 lamps. Steam is generated by 19 vertical boilers, and supplied to seven Hamilton-Corliss, each of 640 H.P., and one of 50 H.P. The seven large engines are each belted to a countershaft situated on the floor above, the seven sections giving a total length of 400ft. of 6in. hammered iron shafting. Each section is driven by a 48in. double belt running over a steel-rimmed 56in. pulley with 52in. face. The dynamos are situated on the floor above the countershafting, and each one can be thrown into or out of action by friction-clutches operated from the dynamo room. By means of a huge plug switchboard with flexibles and spring jacks any dynamo can be connected to any circuit, and any desired number of machines can be coupled in series. The bearings receive oil through a system of pipes; the oil is carried thence by drain-pipes to the filter in the basement, from which it is pumped to the fourth floor to be used again. The spent oil is filtered upward through water, sand, and charcoal. The Municipal Company, in addition to a Slattery alternating plant, also runs a 500-volt 300-H.P. plant.

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ELECTRICITY AS A MOTIVE POWER.*

BY ALBION T. SNELL.

§1. The General Scheme of Electrical Transmission of Power.

Prime Source of Power.—The consideration of this part of the working plant belongs more properly to a treatise on prime motors; but the requirements of electrical work have introduced quite a revolution in the building of both steam engines and turbines, and probably a few hints as to the class of plant most suitable will not be unacceptable or out of place.

The dynamo is essentially a high-speed machine, one of the fundamental factors of both output and efficiency being a high peripheral speed of the armature. Practical considerations confine this to about 3,000 feet per minute; and hence, for a given output, economy of material and labour will limit the diameter and length of the armature so as to make the speed a maximum. Now the stationary engine of 15 or 20 years ago was, on the contrary, a slow-speed machine, *i.e.*, the flywheel made relatively few revolutions per minute, although the piston velocity may have been in some cases as high as 300 or even 400 feet per minute. The cylinders were of large diameter and long stroke, being designed to work with low boiler pressures. Therefore, when it became necessary to drive dynamos by this type of engine, difficulties arose in belting the dynamo pulley to the flywheel; and it soon became evident that the engine was in many ways unsuitable. Firstly, it was inefficient for the class of work; secondly, it governed badly; thirdly, it was costly in relation to its output; and, fourthly, it required foundations of a strength out of all proportion to the load. These weak points in steam-engine design were gradually forced on the notice of mechanical engineers by the introduction of the efficient and high-speed dynamo. But improvements were made before long. Boilers were built for higher pressures, enabling engines to be designed with smaller cylinders and to rotate at higher speeds. Next, governors were improved, and soon the tell-tale pilot lamp scarcely showed the variations of speed, and now it is by no means uncommon to find engines governing to within 2 per cent. or even less. Compound and triple expansion engines have now become general. The vertical type of engine, with inverted cylinders, is most in favour to-day for driving dynamos. It is used either single, compound, or triple, with or without condensers, according to output and circumstances. It is coupled direct or by belting, requires small foundations, gives a minimum of trouble, and is cheap and efficient. Compared with the beam or horizontal engines of from 20 to 30 years ago, it is as David to Goliath.

The change in boiler design has been equally remarkable. Fifty pounds to the square inch used to be considered a fair working pressure with boilers of the Lancashire type, now 80lb. is not uncommon; and with multitubular and water-tube designs 140lb. or even a greater pressure frequently occurs; and water-heaters, economisers, and mechanical stokers are being gradually appreciated. All these improvements, it is needless to say, tend to raise efficiency and decrease the running charges.

In choosing steam plant for an electrical transmission installation, therefore, the rules and precautions adopted in laying down a central station for lighting should be followed. First choose a convenient unit of power, *i.e.*, select the best size of dynamo to give the minimum work required during the twenty-four hours, and then if this be of convenient size keep to it as the standard, and simply multiply the unit as the work increases. If the minimum output be very small, it will probably be best to have a separate plant to deal with this part of the work, and to select a larger unit for the main installation. Having fixed the output of the dynamo, the size of the engine which has to run it, either direct or by belting, is easily determined; and the boiler power is also known. The boiler unit may be sufficient to run one or two engines; this will depend on their size, and cannot be definitely fixed without a knowledge of each case. The boilers should each be coupled with a stop-valve to the steam main, so that any boiler can have the fires banked or be shut down separately. One boiler and an engine and dynamo should be held in reserve in all large installations.

If water power be used, the turbine or water-wheel can advantageously drive the dynamo direct, or belting may be used. The general considerations for determining the size of dynamo unit will hold just the same as with the steam plant, and, indeed, the whole station arrangements will be similar, except that the turbine will replace the boiler and engine. It is unnecessary to point out the simplicity of such a power station, or to refer to the advantages of the utilisation of waste water power by electricity—they are self-evident. It is not surprising that magnificent transmission plants have sprung into existence during the past few years; the wonder is that the number of such plants is not tenfold greater.

The Dynamo.—The function of the dynamo is to convert mechanical into electrical energy, and the machine, if well made, accomplishes this end in a most satisfactory manner. The ratio of conversion of a good dynamo at full load varies between 90 and 94 per cent., and this high efficiency is maintained through a considerable range of output; at half load it is about 85 to 90 per cent., and at one quarter load will not fall below 75 per cent.; while running on open circuit the energy absorbed is only sufficient to overcome the mechanical friction. If the plant be divided into suitable units, it will always be possible to run at nearly the full output of the dynamo, and so secure a high working efficiency. In addition to the high-speed dynamo already referred to, there is a so-called slow-speed type, which is steadily gaining favour among certain engineers. It is of recent development, and is the outcome of a desire to couple dynamos directly to the engine shaft.

The output of a dynamo is roughly proportional to the length of the armature into the square of its diameter = say $l D^2$. Let the surface velocity be fixed. If D be large then l will be small, and *vice versâ*. In order to design a slow-speed dynamo it is necessary then to take a large diameter and a short length for the armature proportions. This type of machine is heavy and costly, in consequence of the large field-magnets, yokes, and extended beds, and increased cost of machining and labour; but these disadvantages are, in the eyes of some designers, more than counterbalanced by the decreased speed.

American practice favours dynamos running at from 800 to 1,000 revolutions per minute, coupled with belts to high-pressure engines making from 200 to 350 revolutions. Continental engineers are leaning to the slow-speed steam dynamos, and recently huge plants, with units of 500 H.P. and upwards, with triple expansion condensing engines, have been laid down for town lighting. English engineers are very much divided on the subject at present; but there certainly seems to be a tendency to use steam dynamos of about 100 unit capacity, running at from 175 to 250 revolutions per minute.

Viewing the question of the electrical power station from all sides, and laying particular stress on the high tension that will be required, it appears that the dynamo should be belt-driven, and therefore it will be permissible to use high-speed dynamos. A convenient size high-tension transmission dynamo for work in British mines is 50 or 100 H.P.; the speed may be from 450 to 600 revolutions per minute.

The Line.—The success of an installation will very largely depend on the care and forethought shown in the selection of the gauge of copper and the erection of the line. As the general conditions to be observed will be discussed hereafter *seriatim*, it need only be noted here that the energy wasted in the conductor may be made as small as desired, for the loss varies directly as the length and inversely as the area of cross-section. There are, of course, limits both to gauge and length of conductor; but these are determined as much by financial as by practical considerations. The essential conditions of a successful line are:—Firstly, a continuous metallic circuit between the dynamo and the motor; and, secondly, high insulation resistance, so that the current does not leak to earth; for defective insulation means not only a direct loss of power but may also entail a risk of fire.

The Motor.—A motor presents to the eye an appearance similar to that of a dynamo, though its function is the converse, viz., to convert electrical into mechanical energy; it is, in fact, a reversed dynamo, is governed by precisely the same

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laws, and its action is accompanied by similar phenomena; and, moreover, it is quite as efficient. The reversibility of the dynamo is said to have been discovered by an accident in the first place, though more probably it was the result of the steady and laborious study of early inventors. Be this as it may, the fact has been thoroughly recognised, and full advantage has been taken of the opportunities afforded by it.

The Driven Machines.—The machines to be driven need no special reference, but care must be taken to couple them to the motors in a suitable manner. High-speed machines may often be connected directly to the motor-shaft; or they may be coupled by gearing or belts; and countershafts, friction clutches, and other devices may be used. But whatever arrangement be adopted, care must be taken that the motor speed and current be approximately those designed by the makers. If either of these two points be neglected, the motor will not be working under the best conditions, and there will be a loss in efficiency.

The general idea involved in the expression an "electrical transmission plant" has now been explained, and the way is cleared for a more minute study of the subject.

(To be continued.)

VARIABLE GEAR FOR ELECTRIC TRACTION.

The importance of a variable gearing for starting electrical tramcars or trains has been repeatedly urged in these columns, but the application of motors has up to the present been in the hands of electricians rather than engineers, and while the former have been busy in finding uses to which electrical power may be applied, engineers have hardly been awakened to the enormous losses which take place when a motor is started under full load. The usual system of resistances is simply barbarous, but nine electricians out of ten seem to be satisfied with it. By the use of a variable gear, not only would the waste of current be prevented, but the motor might be considerably reduced in size. A number of complicated and very ingenious gears have been proposed in Papers read by Mr. Aldrich before the Franklin Institute of Philadelphia, but they were all very bulky, and for the most part required two armatures. There are many theoretical solutions to the problem, and hitherto the most practicable have been the use of several distinct motors coupled in parallel or in series. This has been carried out to an extreme by Mr. Holroyd Smith, who used four motors at Bradford.

A really mechanical and satisfactory design of a variable gear has recently been made by Mr. W. Worby Beaumont, and, although restricted at present to an alternative rather than a variable gear, it is evidently the invention of an engineer rather than of an electrician. Two forms of this gear are illustrated herewith.

In one of these, Fig. 1, is shown an arrangement of gearing, partly in section, for electric tramcars. In it A represents a motor shaft, and A^2 a car-axle arranged as for single-reduction gearing. On the motor-spindle is fixed a double-faced disc magnet, B, current being sent into either of the two energising coils through the conductors + + and the return conductor −, according to which side of the magnet it is desired to use. On either side of the double magnet are pinions, J and J^1, connected to the keepers H and H^1, the pinions running loose upon the shaft of the motor and gearing with the wheels K and K^1, the one or the other, as may be desired. In starting a car, current would be sent through the left-hand coil by the conductors + −, and a brush, E, resting upon one of the collector rings, D. The keeper, H, would thus be drawn to and held by the magnet, the frictional hold being increased by the use of the pole-pieces or rings G, with annular projections fitting into grooves in the armature H. The small pinion J will thus be clutched to the magnet, and thereby to the motor shaft, and the car-axle A^2, will be driven at a speed corresponding to the ratio subsisting between the diameter of the pinion J and the wheel K. This in the diagram is a ratio of 4 to 1. The car having been started, or having ascended a hill by this means at the slow speed (the motor running at full speed), may now be driven at the higher speed due to the larger pinion J^1 and smaller wheel K^1, by cutting the current out of the left-hand coil and sending it through the right-hand coil. The keeper H is thus allowed to run loose upon the motor-spindle and the keeper H^1 is fixed to it, and the car will now be driven at the higher speed. This, in the case shown, would be double the lower speed.

As there are several arguments in favour of direct driving of cars or locomotives by armatures on the driving-axles, an arrangement of gearing for this system has been designed, and is shown in Fig. 2, partly in section. In this case the maximum

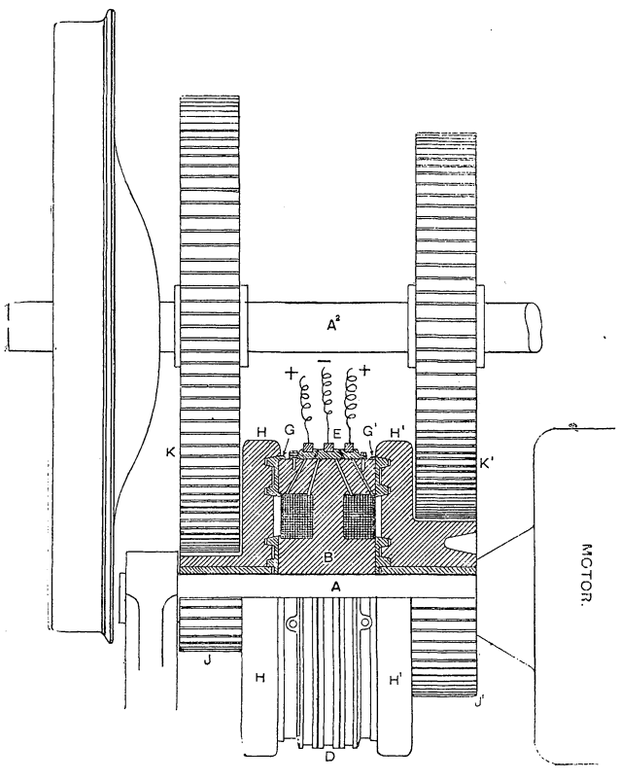

FIG. 1.—Electromagnetic Variable Speed Gear. Single Reduction Gearing.

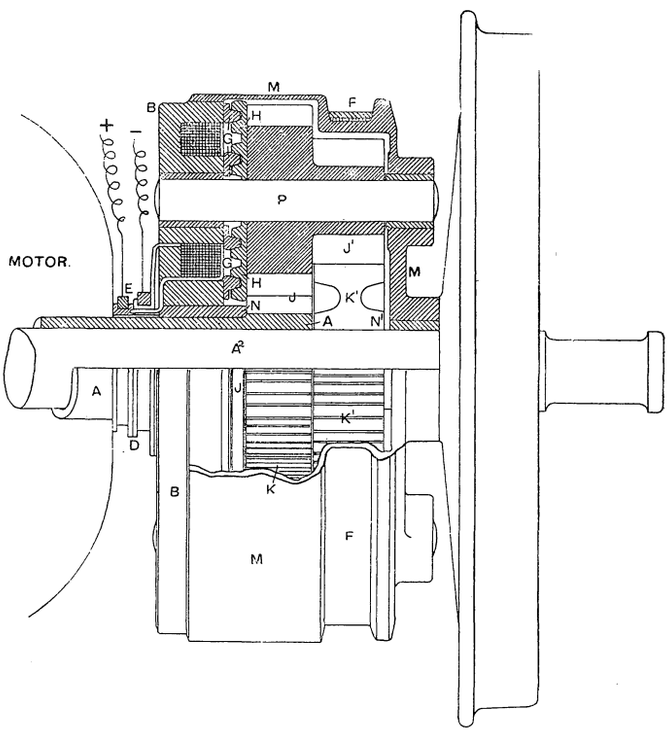

FIG. 2.—Electromagnetic Variable Speed Gear. Direct Driving.

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speed is that of the motor, the shaft of which, A, is hollow and is mounted and runs upon the shaft to be driven, A^2, namely, the car or railway-axle. Upon the hollow motor-shaft A is fixed a pinion, J, gearing into an idle wheel, K, carrying, a pinion J^1, which gears into the wheel to be driven K^1 fixed to the shaft A^2. Fixed upon one face of the idle wheel K is an annularly-grooved disc-keeper H, into which the rings G, G on the pole-pieces of the disc-magnet B fit, forming a magnetic clutch. Two such clutches are employed in the arrangement shown. Current for energising the coils of these magnets is supplied through the conductors + − the brushes E and collector-rings D. By means of these magnetic clutches so formed, the idle wheel K and the connected pinion J^1 may be held fast, and when this is done the shaft A of the motor the whole of the gearing and containing case are locked together, so that the speed of the driven shaft becomes that of the driving shaft. For starting an electric car or locomotive current is cut out of the coils of the magnets B B, and is instead directed into a magnetic clutch-break, not shown in Fig. 2, except in so far as the clutch-break band is shown in section at F upon a part of the case M, which is made circular for the purpose. When this clutch break, F, is in action the case M is held fast, and the idle wheel K revolving with the spindle P drives the car axle A^2 at a speed which is proportional to the dimensions of the gearing. In the example shown, the motor shaft A would make two and a-half revolutions to one revolution of the car or locomotive-axle A^2. It will be seen that for ordinary running—that is to say, after starting and when not climbing a hill, the whole of the gearing was inactive.

Mr. Beaumont's invention is evidently capable of taking a number of different forms, and in his patents, we understand, a considerable number of these will be found. We do not know whether the following modification is one of them. Suppose in Fig. 1 that the pinion J^1 is fastened to the motor which runs upon a sleeve on the driving-axle. Let the magnetic clutch B, be keyed to the driving axle, and let A^2 be a counter-shaft, the arrangement may then be worked as the back gear of a lathe. For starting the car the left-hand annular magnetic coil would be energised, and the power would be transmitted from the pinion J^1 through the K^1 to K, and thence to J, the keeper, H, being clutched to B. On attaining speed, the right-hand coil would be energised, and the pinion, J^1, with the armature motor, would be clutched direct to B by means of the keeper, H^1. The only possible disadvantage that we can see in this arrangement would be that the gear-wheels, running idle, might cause some vibration and noise, but they would only be running at a differential speed, and, doing no work, should not cause any serious trouble.

In the above description we have not described the method of switching the current from one coil to another, but it is clear that the current, and, therefore, the clutching friction may be so controlled that passage from one gear to the other may be effected without shock. An electric clutch has a great advantage over the mechanical clutch in that the friction may be adjusted and controlled with perfect ease, without being dependent upon very minute differences of pressure produced by end-movement of parts upon a shaft. We hope before long to see Mr. Beaumont's invention actually put into practice.

THE DESIGN OF TRANSFORMERS AND CHOKING COILS.

BY JAMES WHITCHER.

If any apology is needed for touching upon this familiar theme, I put one forward in the belief that there is still much of mystery in it for some practical men, as well as for many of the new hands that are crowding with hasty enthusiasm into the trade. So that if perchance the subject demands their attention, and, as more often, with a call quickened with all the disconcerting urgency that commercial exigencies can devise, they are found wanting, or else must make a hasty painful gleaning along the thorny paths of empirics.

Generally the mathematical design of transformers and choking coils runs on common lines up to a certain point; and the fundamental formulæ of the one apply equally to the other, though there are usually very different conditions. To establish our first mathematical conceptions of a transformer we should regard it simply as a choking coil designed theoretically to choke off all current. Thus, if in simile we describe a choking coil as a magnetic sluice gate, a transformer would correspond to the condition of a sluice gate shut right down. The primary coil alone comes into these preliminary considerations, the secondary being only concerned therein in respect of the space it will occupy. And we would here remark it is well to dismiss once for all one's vague notions of mutual induction; the term is a mere catch phrase, a snare for the unwary. The truly logical method of treating the subject is to keep the two steps quite distinct—the production of an alternating magnetic field by the primary current, and the consequent production of an alternating E.M.F. of opposite phase in both the primary and secondary coils. The reaction of a secondary current upon the field, and through the field upon the primary current, maintaining equivalence of the ampere turns of each coil, can then be more readily seen and appreciated than if it is attempted to arrive at it by reasoning around mutual inductions without reference to the field.

The following symbols will be used :—

E = The maximum E.M.F. of electrical source or supply. The alternations will be assumed to be true harmonic variations; and therefore E will equal the nominal or virtual E.M.F. of supply in C.G.S. units multiplied by $\sqrt{2}$ or $-E = 10^8 \times \sqrt{2} \times$ nominal volts.

e = Any instantaneous value of the E.M.F. of supply : being a harmonic or sine variable $e = E \sin pt$.

B = Maximum induction in C.G.S. lines per square centimetre.

b = Any instantaneous value of the induction : it is also a sine variable and $b = B \sin (pt - 90)$.

n = Frequency or number of complete alternations per second.

I = Maximum current in primary supposing secondary absent or on open circuit: usually called exciting current, being that current which produces the alternating magnetic field :—in C.G.S. units. 10 amps. = 1 C.G.S. unit.

i = Any instantaneous value of the exciting current : it is a complex variable, and, paradoxical as it may seem, is a function of b, the induction it generates.

S = The number of primary turns. The word "turn" may mislead, as I have known it to do: it may be better defined as the number of times the conductor repeats itself upon the field, which includes the case of a straight conductor in relation to its adjacent field without regard of the remainder of the electric circuit.

A = The sectional area of the magnetic circuit in square centimetres.

l = The mean length of the magnetic circuit in cms.

μ = The permeability of the iron : it is an irregular dependent variable of b.

$p = 2\pi n$. A multiplier for converting linear measure of time into cyclic measure.

t = time in seconds measured from any moment e is passing through its *nil* value from negative to positive sign.

Now for a transformer, we have as our first consideration to design the primary as a choking coil which, while of very low resistance, shall permit only the smallest practicable current to pass through it when put across the supply mains; that is one in which this small current is sufficient to generate an alternating field of such strength that its reaction on the primary coils is to produce in them an opposing E.M.F. of self-induction equal to the E.M.F. of the supply. It should here be observed that in all inductive coils put on constant potential supply, the current through them will rise until the consequent E.M.F. of self-induction, together with the E.M.F. lost on resistance, are equal to the E.M.F. of supply; the object in transformers is to obtain this equality within a low range of current, and on the assumption that the ohmic E.M.F. is negligible.

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Therefore, we must have the following relations :-

Induced E.M.F. varies directly as the rate of variation of the induction; and for a coil of S turns it is expressed thus in the language of the calculus which cannot easily be avoided :—

$$e_1 = \mathrm{S\,A}\,db/dt \quad . \quad . \quad . \quad . \quad (1)$$

therefore must $$-e = \mathrm{S\,A}\,db/dt \quad . \quad . \quad . \quad . \quad (2)$$

and $$-\mathrm{E}\sin pt = \mathrm{S\,A}\,db/dt \quad . \quad . \quad . \quad . \quad (3)$$

integrating $$\mathrm{E}\,cospt/p = \mathrm{S\,A}\,b \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Now, b is a sine variable because e is a sine variable, but the variation is not co-phasal, as may be seen from equation (2); that is to say, e and b do not reach their maximums at the same time. For by the rules of maxima and minima b is at maximum when $db/dt = 0$; and as $db/dt = -e/\mathrm{A\,S}$, b is maximum when $e = 0$. Now $e = \mathrm{E}\sin pt$ is only $= 0$ when pt is 0deg. or any multiple of 180deg.; and since $b = \mathrm{B}\sin x$ there must be a difference of 90deg. between pt and x; and x must be behind pt or $= pt - 90$, since b is an effect of e. Therefore

$$\mathrm{E}\cos pt/p = \mathrm{S\,A\,B}\sin(pt - 90) \quad . \quad . \quad . \quad (5)$$

$$\mathrm{E} = \mathrm{S\,A\,B}p = 2\pi n\,\mathrm{S\,A\,B} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$\mathrm{A\,S} = \mathrm{E}/2\pi n\,\mathrm{B} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$= 0{\cdot}2251\ \mathrm{E_1}/\mathrm{B}n \text{ and} = 22510000\,\mathrm{E_2}/\mathrm{B}n \quad (8)$$

where $\mathrm{E_1}$ and $\mathrm{E_2}$ are the virtual E.M.F. in C.G.S. units and volts respectively.

This is a very important relation: given the voltage and frequency of the supply, and having determined on a suitable induction maximum, we have a simple numerical relation which must subsist between the cross sectional area of uniform field and the number of primary turns, altogether irrespective of the size or capacity of the transformer.

Having worked out the numerical value for the right side of the equation, changes may be rung on the possible values for A and S and likely ones chosen for trial.

The next process is to determine the exciting power or magnetomotive force necessary to produce the magnetic flux of maximum intensity B. In working this out we may find the number of turns fixed upon in the first place insufficient or otherwise unsuitable, and other values must be tried. Here the output of the apparatus comes in question. The size of wire for the coil is determined by the current to be carried at full load. Account must be taken of the drop of volts through the coil due to the $\mathrm{C^2R}$ loss; as the total length of wire is at first indefinite the full load density may be put at, say, 750 per square inch, and altered subsequently if desirable. The cross-sectional area of coil space can now be determined: in a transformer this should be doubled to provide for the secondary coil, which will have approximately the same area, having to convey an equal energy, and an allowance made for any outer taping or extra insulation.

Then, for a transformer or coil of the closed iron circuit type, the mean length of the magnetic circuit may be found from a diagram of the contour of the core, in the usual way by measuring along the centre lines of symmetry—a method near enough for practical purposes, but not entirely correct, as the induction is not in any form spread uniformly over the area as it assumes. An allowance must be made for joints; for lapping joints an addition of 10 to 30cms. to the length may be sufficient: butt joints are not advisable.

Magnetic flux is directly proportional to the magnetomotive force divided by the sum of magnetic resistances; that is

$$\mathrm{N} = \mathrm{A}\,b = \mathrm{M/R}. \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Magnetic resistance varies directly as the length, and inversely as the area and permeability of the magnetic circuit. For a continuous circuit of iron, therefore,

$$\mathrm{R} = l/\mathrm{A}\,\mu \quad \text{and} \quad \mathrm{A}\,b = \mathrm{A\,M}\,\mu/l \text{ or } b = \mathrm{M}\,\mu/l \quad . \quad (10)$$

$$\mathrm{M} = 4\,\mu\,\mathrm{S}\,i \text{ and} \quad b = 4\,\pi\,\mathrm{S}\,i\,\mu/l \quad . \quad . \quad . \quad . \quad (11)$$

taking maximums $$\mathrm{B} = 4\,\pi\,\mathrm{S\,I}\,\mu/l \quad . \quad . \quad . \quad . \quad (12)$$

and $$\mathrm{I} = \mathrm{B}\,l/4\,\pi\,\mathrm{S}\,\mu \quad . \quad . \quad . \quad . \quad (13)$$

Here we have the maximum exciting current: if it exceeds, say, 10 per cent. of the effective amperes at full load, S should be increased till I comes within that percentage. In good practice the effective amperes of exciting current as measured by dynamometer is usually made from 2 to 5 per cent. of the full load effective amperes.

All the requisite dimensions can be satisfactorily determined from these simple relations: and the best relative weights of iron and copper found for the particular design. A few tentative experiments with the formulæ, substituting various values for the principal factors, will exhibit the influence these factors have over the result more clearly than much explanation.

The design of the secondary coil of transformer is a very simple matter. The required ratio of transformation gives the ratio of primary and secondary turns, unless there is appreciable magnetic leakage; with modern closed circuit transformers working at the low inductions usual, there is none to speak of. The respective sections of conductors should be to one another as the inverse of the same ratio; though sometimes the disposition of the two coils may cause the lengths and weights of wire in each coil to be disproportionate; so much so that in regard to the drop or ohmic loss it may be advisable to alter the relative sections. Generally the sum of the $\mathrm{C^2R}$ losses in both coils at full load should not exceed 2 per cent. of full load in watts; and commercial considerations show that it is folly to reduce it below 1 per cent.

The design of choking coils with closed magnetic circuits is practically identical with the preceding. Usually the conditions are that the coil shall generate in itself an opposing E.M.F. of given magnitude with the passage of a certain current. For instance, for working arc lamps on an alternating 100 volt circuit a coil is required to present a counter E.M.F. of about 50 volts with the lamp current of, say, 10 amperes flowing through it. The maximum value of these factors may be inserted for E and I in our formulæ, a value chosen for B and its dependant variable μ, and convenient dimensions found for A.S. and l. There is some uncertainty as to the maximum of the current, due to the irregular character of its curve, but practical calculations are usually sufficiently near if made on the assumption that the maximum is, say, 1·5 of the effective amperes.

It will probably be found that the amount of iron required is excessive; for the available magnetomotive force being large, b will need to be large, or S very small, in which latter case A becomes unwieldy. Making the induction larger causes waste and heating and noise, which should be avoided. But the iron may be reduced by any amount by the use of an air-gap in the magnetic circuit. A very narrow gap has a marked effect; and it is extremely useful for making the final regulation by a slight opening or closing of it.

The effect of the gap is exhibited in our formulae, thus—

$$\mathrm{N} = \mathrm{A}\,b = \mathrm{M/R} = \frac{\mathrm{M}}{\frac{l}{\mathrm{A}\,\mu} + \frac{l_1}{\mathrm{A_1}}} \quad . \quad . \quad . \quad . \quad (14)$$

where l_1 and $\mathrm{A_1}$ represent the length and area of the gap. This method only applies when l_1 is small. Presuming there is no polar enlargement, $\mathrm{A_1}$ may be taken as equal to A + a surrounding fringe of width equal to the length of gap as usual in dynamo design, or less accurately as equal to A. Then

$$b = \frac{\mathrm{M}}{\frac{l}{\mu} + l_1} = 4\,\pi\,\mathrm{S}\,i\left(\frac{\mu}{l + \mu l_1}\right) \quad . \quad . \quad . \quad . \quad (15)$$

Comparing this equation with that for closed circuits,

$$b = 4\,\pi\,\mathrm{S}\,i\,\mu/l \quad . \quad . \quad . \quad . \quad . \quad (11)$$

and remembering that the value of μ is numerically large compared with that of l: the great influence of an air gap can be seen. Here is a strong argument against the use of butt joints in transformers unless fitted in a perfect and therefore costly manner.

Choking coils, as well as being almost wasteless substitutes for resistances, have a further utility over dead resistance. Thus a resistance offers only what may be described as a linear regulation; that is to say, if the E.M.F. on it is altered in any ratio—for instance, doubled—the current through it is doubled too. But choking coils offer greater flexibility of design in this particular. If the working induction is chosen so that μ is near its summit value the regulation in one direc-

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tion will approximate to that of a resistance: but by putting the induction at such a point that the permeability is on the rising slope of its curve, regulation of a sharper kind may be secured. In other words, the current is restricted to a shorter range than the volts; and if an induction be taken with the permeability on the downward slope this condition is reversed.

This property may prove of use in connection with apparatus that are liable to make sudden and disturbing demands for current on a constant potential supply; for example large arc lamps. Supposing it a 50 ampere lamp on 100 volt circuit; with resistance the current at starting will range up to about 100 amperes; and if at lower voltage the limit will be proportionately greater. With a coil designed with induction of 5,000 the range of current under some conditions may be kept under 65 amperes about. This can only be obtained with coils having complete magnetic circuit of iron; the presence of an air-gap masks the effect.

In an even more emphatic effect of this kind is required it might be obtained by making coil with an air-gap which opens and closes automatically with fall and rise of current. The magnetic condition of the core will generally yield a sufficient tractive force to do this against an opening spring the force of which can be readily regulated.

Thus much for the simple mathematical design of these important appliances. There is much to be said of the mechanical design of the same, also of the design of transformers for particular load factors or conditions of working, and of the whole question of the pre-estimation of losses; but it must be left for other occasions. Open circuit coils and transformers, and alternating current solenoids, are much more difficult of treatment than the simpler cases taken, yet they have some very important practical bearings.

The above must not be regarded as more than a plain statement of first principles put in practical form with as little mathematics as possible. More refined methods of designing transformers there are, involving less tentative work, but they require more mathematical gymnastics than some may like to venture on at first.

TEMPERATURE COEFFICIENT OF MERCURY.

BY KREICHGAUER AND JAEGER.

A series of very elaborate and careful researches on this point are among the latest work of the Reichsanstalt. The resistances of the copies of the mercury standard (about half a-dozen in number) have been measured in the most accurate manner possible, with results published in full in Wiedemann's *Annalen*.*

The authors of the article give as the formula for the alteration of resistance of the mercury in Jena glass tubes

$$r_t = r_o[1+0{\cdot}000875t+0{\cdot}00000125t^2],$$

and for the true alteration of specific resistance of the mercury

$$r_t = r_o\,[1+0{\cdot}0008827t+0\ 00000126t^2].$$

These values agree very well with those of Benoît and Guilleaume, principally on account of the identity of temperature scale used. The observations are between 0 deg. and 28 deg. Centigrade.

A NULL METHOD OF MEASURING SPECIFIC INDUCTIVE CAPACITY OF CONDUCTING LIQUIDS.†

BY F. HEERWAGEN.

The author's null method consists in the use of a differential electrometer, which is so constructed that two electrometer needles are fixed to a common axle and hang in quadrant pairs over one another.

The needles, case, and one pair of quadrants in each instrument are connected together, and to a certain point A of a circuit, while from two other points B and C in the same circuit wires are led to the remaining pair of quadrants in each instrument. When B and C are so chosen that there is no deflection of the needle-axle, the ratio of the sensibility of the two electrometers is inversely proportional to the ratio of the squares of the respective potential differences—that is, to the ratio of the squares of the resistances between AB and AC.

* No. 12. 1892. † Abstract from *Wied. Ann.*, No. 1, 1893.

If W_e / W_f be this ratio when air is the dielectric, and W_L/W_F be the ratio when the lower electrometer is filled with the liquid to be measured, then the specific inductive capacity of the liquid is

$$K=(W_L/W_F \,.\, W_f / W_e)^2,$$

alternating currents must, of course, be used.

The upper electrometer should be more sensitive than the one which is filled with the liquid.

The resistance of the suspension prevents the needles from being accurately at the same potential as the case—a fact to which the author calls particular attention. An equivalent resistance should be provided between A and the case and quadrants.

The author finds the value of the specific inductive capacity for pure water, after allowing for all corrections

$$K=79{\cdot}56 \text{ @ } 20{\cdot}75°C.$$

BOOKS, &c., RECEIVED.

"Journal of the Institution of Electrical Engineers," Vol. XXI., No. 102. Edited by F. H. Webb. (London: E. and F. N. Spon.) Price 2s.

"Memoir of James Prescott Joule." By Osborne Reynolds, F.R.S. 200 pp., demy 8vo. (Manchester: Literary and Philosophical Society.)

"Discussion of the Precision of Measurements." By Silas W. Holman, S.B. (New York: John Wiley and Sons.) 180 pp., 8vo.

Junior Engineering Society. Record of Transactions. Vol. II. 1891-92. Edited by W. T. Dunn. (London: Junior Engineering Society.)

"Proceedings of the Electrical Section of the Franklin Institute." Vol. II. 1892. (Philadelphia: Franklin Institute.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 17th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "Turbines," by C. V. Drysdale.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Ancient Egyptian Pigments," by Dr. W. J. Russell, F.R.S.

SATURDAY, March 18th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Sound and Vibrations," by Lord Rayleigh, F.R.S.

MONDAY, March 20th.

SOCIETY OF ARTS.

5 p.m. Cantor Lecture (3): "Alloys," by Prof. W. Chandler Roberts-Austen, F.R.S.

TUESDAY, March 21st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be discussed: "The Break-down of the 'Umbria,'" by Thomas Sopwith, M.Inst.C.E.; and Monthly Reception by the President and Council.

WEDNESDAY, March 22nd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Manufacture of Non-Poisonous White Lead," by Perry F. Nursey, C.E.

THURSDAY, March 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Papers to be read:—(1) "On a New Form of Portable Photometer," by Sir David Salomons, Bart., M.A.; (2) "Earth Currents in India," by E. O. Walker, C.I.E.; (3) "Notes on the Influence of Electricity on Tanning Operations," by C. K. Falkenstein.

FRIDAY, March 24th.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "On the Differential Equation of Electric Flow," by T. H. Blakesley, M.A.; (2) "Experiments on the Viscosity of Liquids," by Prof. Perry, J. Graham, and L. W. Heath.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Some Points in the Regulation of Direct-Current Motors," by Francis G. Baily, B.A.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Interference Bands and their Applications," by Lord Rayleigh, F.R.S.

SATURDAY, March 25th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Sound and Vibrations," by Lord Rayleigh, F.R.S.

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ALTERNATOR AND DYNAMO TESTING.

The very interesting communication which has been made by Mr. MORDEY to the Institution of Electrical Engineers would have been accepted with less criticism, and would have led, perhaps, to a more useful discussion, if it had been put forward as an account of experiments to be performed with alternators. These experiments, being purely electrical, will, no doubt, contribute to the elucidation of the obscure phenomena which complicate the action of alternators. In one sense the author is perfectly right when he disclaims any intention of testing the mechanical features of the design; the only mistake is to call his method a test at all. Many interesting and valuable experiments have been made with steam-engines by Mr. DONKIN and others, but these are not called tests. The more is the title of the Paper to be regretted since the result which is obtained by these experi-

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ments has a superficial resemblance to a true efficiency test. We do not for a moment desire to depreciate the importance of the study of the losses which occur in alternators, and welcome this ingenious and promising experimental method as one which will doubtless conduce to improvements in electrical design. It is hardly fair to criticise remarks which may be let drop in the course of a reply to a discussion, but if it was really meant that no test of dynamo shafts is necessary because the maker knows quite well what size of shafts to put in for various powers, and that he can ignore bearings because he is quite satisfied about his own, why not extend the principle and send out the dynamos without any "test" at all? Some caustic remark, which was not caught by the reporter, was made about "people who have had no experience of running machinery." It was, perhaps, of no great importance, but the attitude thus adopted is just sufficient to widen the distinction between electricians and electrical engineers. If there need be any choice of one of two tests, we would rather have a common-sense mechanical test, say, a full load run for a few hours, and in the case of an alternator a light run also, and take the electrical efficiency on the maker's word.

The rise of temperature after a run is an excellent but too lightly valued indication of the efficiency of a dynamo or alternator. Disparaging remarks about dynamos are sometimes made by rival makers or by disappointed users, and very low efficiencies are attributed to large machines in forgetfulness of the fact that all losses must appear as heat. We have been assured that a certain 20-kilowatt machine had an efficiency of only 65 or 70 per cent, but, nevertheless, it ran fairly cool at full load, while, according to our informant, some 10 kilowatts must have been disappearing, and could only have disappeared as heat. If a machine heats badly its efficiency must be low, whatever the wattmeters and tests may say. The converse will not always hold, for heating may be dispersed by careful ventilation. Losses may be roughly localised by examination of the heating, but Mr. Mordey's method will, no doubt, prove exceedingly useful in measuring and identifying them. His contention that the losses in side pull on the bearings is not serious, is supported by the fact that well-designed and well-kept bearings run cool enough. Absence of heat is quite sufficient proof of absence of loss, whether by friction, by current, or by hysteresis. Belt losses, however, cannot even be guessed at in this way, since so great facilities are given for cooling by passage through the air; similarly, the heat of an armature, as is well known, soaks out after stopping, the surface having been kept cool while it was in motion. While preferring a full load run to a scientific test on the "internal circulation" principle, it is obvious that makers may not have the means of running large dynamos at their works. Here Dr. Hopkinson's original method is invaluable, for they must be able engineers or good salesmen who have not left on their hands one or two machines with which such an "external circulation" can be carried out. No sooner was the account of Dr. Hopkinson's method published than several engineers at once put into practice the purely electrical method soon afterwards suggested by Lord Rayleigh. A firm of dynamo makers, a few years ago, received an order for some large machines under the stringent and then new specification of the Admiralty. A four or five-hour well-loaded run was necessary, but although they had a good engine devoted to testing, the boiler was quite unequal to the task of running both the dynamo and the factory. Runs at low speed and at under-excitation were tried but were not relied on, but a Sunday or all-night test was avoided by shutting down the factory engine, and running the shafting from the dynamo generally used for lighting the shops, but run with part of the waste power as a motor.

Mr. Mordey's directions for running alternators in parallel will no doubt be useful to those who desire so to use his machines, but we are not so sanguine as Prof. Ayrton that anyone can now perform the operation with any alternator. It is easy enough to give recipes, as for example, "To catch hares, stand behind a tree and make a noise like a turnip," but it is not always easy to put them in practice. Having caught your hare, or having got your alternators into step, how are they to be kept equally loaded? Mr. Swinburne has discussed this at considerable length, and while his directions have never been shown to be misleading, other people seem to be coming round to his idea, under the impression, apparently, that it is their own, namely, that only a single governor (other than run-away governors) should be provided in a central station in which alternators are run in parallel.

SPARKING AT COMMUTATORS.

BY F. M. WEYMOUTH.

(*Concluded from page 543.*)

We may now take note of some general effects and conclusions. In the first instance, it is to be observed that the effect of the short-circuit currents is to divert the flow of the main current from its natural path or paths, which it would take according to Ohm's law. The effect of this is thus seen to be most disastrous, where, as in the cases of the brushes at A and B, these are moved too far back. For here the whole of the main current is being made to pass through the lug of the receding segments. When the brushes are too far forward, on the other hand, there is only light back-sparking of short-circuit current, and the whole of the main current is made to flow through the heels of the brushes.

Another point that may engage our attention, concerns the position of the plane of commutation in relation to the variously misplaced brushes. On an earlier page we stated that this followed the brushes, but *but with some degree of elasticity.* It will be observed that this plane, lettered *C n P* in the diagrams, is shown in Fig. 15 (lettered *C n* only) with each pair of brushes. At brushes A and B it runs through the points, while at C and D it passes through just within the heels of the brushes.

If we thus examine Figs. 16 and 18, showing brushes A and B, we shall observe that on the recession of segment *r*, and the breaking of the assumed current of 650 amperes, a *sudden* reversal is *forced* to take placed in the coil *b*, by its being thrown completely among the series *c* in the former, and *d* in the latter. The coils *b*, in fact, in both these cases are thus suddenly commutated at that exact instant. Hence the plane they are then in is the plane of commutation for those positions of the brushes; and if the plane of the coil runs through the points of the brushes, as shown in the diagrams, so also will the plane of commutation.

To turn now, however, to Figs. 17 and 19, showing brushes C and D, we find here that it is not the forward coils *b* that are first reversed, but the hindmost coils, *f*; and in the diagrams this reversal is assumed to have taken place, and *b* and *f* are both prepared to be thrown among the other series of coils they are approaching, excepting in so far as they are carrying a current which is too great. It will be noted that directly on the two segments *t* making contact with the heels of the brushes, the coils *f* will have become short-circuited. But up to that instant they have had within them the current direction and polarity of the coils *behind* the brushes. This has now to be reversed. But it has to be further remarked, that the E.M.F. in the coils between *f* and the *N P* plane, has already been weakened by the fact that, with brush C, there has been a counter *c* E.M.F. taking effect in them, due to their being on

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the c side of that plane; and a counter d E.M.F. acting similarly with brush D. The reversal is thus so far prepared for; and it is now accomplished by the electromotive force of coil f. As we have already pointed out, this reversal is not here necessarily sudden, for it takes place after a *making* of contact between the brush heels and segments t, and not at a break. Hence the exact position of the plane of commutation will be that plane occupied by the coils f when they have an infinitesimally small amount of the reverse current from b commencing to run in them—with which, it will be borne in mind, the current in the series of coils forward of the brushes, is assimilated. And this position, with the plane of the leading short-circuited coil cutting through the points of the brushes, we have assumed to be just forward of the heels, as indicated by the lines $C\,n\,P$ in the diagrams of the brushes C and D under discussion, and lines $C\,n$ in Fig. 15.

We have alluded to the fact that in the cases of the brushes at C and D, the currents broken at the recession of the segments r are merely short circuit currents. A question might arise as to exactly in what manner the self-induction of these short circuits takes effect, so as to produce sparking. Inspection, however, will show that this is due to the sudden reduction at the moment of recesion, of the 500 amperes in the coils b, to the normal 200 of the series of coils among which they are being thrown. For by the operation of Lenz's law, already dwelt on, so sudden a reduction will be resisted, in like manner, though not to the same degree, as a sudden reversal. Hence at the recession of r, a momentary very high E.M.F. will accumulate at the point of the brush, causing a discharge of disruptive sparks into r, followed by arcs, in the case of brush C; while the discharge will be from the segment r to the brush, in the position D. Both being contrary in direction to the main current, there is thus formed what has been termed back-sparking.

It is at this juncture that we may allude to the comparative absence of sparking that attends the use of carbon brushes, to which reference was made at the outset of these remarks. There was some correspondence in *The Electrician* for July 15th of last year, on the subject of carbon brushes, in which this peculiar feature was mentioned. Some hints were then also thrown out as to the causes; while a full explanation appeared wanting. We would thus now venture to take this point into consideration, allowing it to fall within the general line of our argument.

With carbon brushes there are two causes in particular that tend to prevent sparking. Of these, the first is the higher resistance of the substance as compared with metal: while the second is the resistance of the *contact* between the brush and the segments of the commutator. It is the latter which we shall thus endeavour to show is by far the more important in accounting for the absence of sparking; though the former has also its effects.

Now, when carbon is used in any shape to form part of an electrical circuit, it is an understood thing that great care is always necessary in securing a good contact between it and any metal connection. Thus, in the case of carbons for a cell, we find the upper ends carefully encased in lead, and so a large surface of the actual carbon put in contact with that metal, to which latter terminals may be attached. Or again, as with the brushes now under discussion, it is considered distinctly advisable to thoroughly copper-plate the outer ends that go into the brush holders, and not merely the ends but a great part of the whole brush. The conclusion is thus negatively deducible, though indeed generally recognised, that the contact between carbon and metal, even when the contact surfaces are as bright and smooth as they can become, is yet not nearly so efficient for the passage of current as the contact between two bright metal surfaces.

Figs. 20 and 21 herewith illustrate the top of a commutator, as in previous diagrams, rotating in direction indicated by curved arrows. The hatched portions represent the contact surface of a carbon brush, shown in a different position in each. In Fig. 20 the brush is half on each segment, r and s. Let us now suppose the brush to be some way behind the neutral plane, like the brushes A and B, in immediately preceding diagrams, where with metal brushes there would be heavy sparking. Then, comparing Fig. 20 with Fig. 16, we know that the whole current of the armature, as well as the greater part of the short-circuit currents, are reaching the brush through lug g and segment r. It will thus be observed that this total of current is dependent for its entry into the brush on the contact surface $w\,x\,y\,z$, which is only, as shown, about half the total surface available. We may now note the effect of the gradual alteration to the conditions depicted in Fig. 21. The contact surface $w\,x\,y\,z$

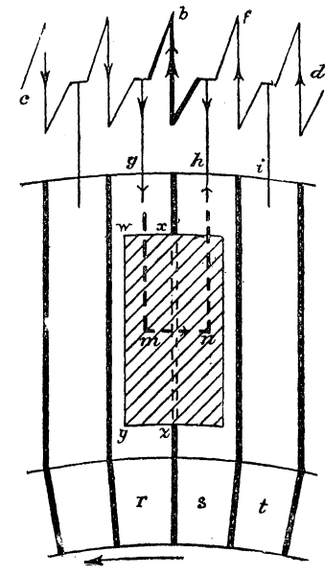

FIG. 20.—Carbon Brush. Short-Circuited Coil not reversed.

has become much contracted; and during contraction has become less and less able to let all the current pass. Hence the current, by the *resistance* of this decreasing contact surface has been *forced* to go through the coil or section of winding b and lug h, and so reach the brush. Hence by the time the recession of segment r actually takes place, the advance coil b has been commutated, and its polarity reversed, and it is carrying nearly or quite all the c current; and nearly the whole current

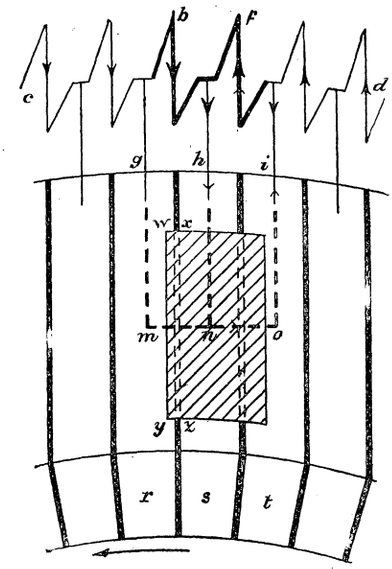

FIG. 21.—Carbon Brush. Reversal of Short-Circuited Coil prior to recession, owing to Resistance of Contracted Contact.

of the armature is entering by the lug h. Thus there is little or no current to break at the recession, or any self-induction effect to be incurred. Consequently there is little or no sparking.

It is found in practice that the forward edge of the brush $w\,y$ sometimes gets very hot, though there are no sparks. This is thus accounted for by the resistance of the contracted contact surface, which naturally becomes heated. Such an effect in the light of the above argument would thus point to

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the fact that the brush would then be too far behind the proper neutral plane; as otherwise there would not be so much current endeavouring to pass through this small contact surface up to the moment of recession.

The short-circuit currents, however, have to be borne in mind. It will be remembered that when the brushes are *ahead* of the neutral plane, as at C and D, Figs. 15, 17, and 19, we showed that the sparking was due entirely to the breaking of short-circuit currents. Now we have pointed out that though under some circumstances such short-circuit currents may be large, they are yet impelled by but *small* electromotive forces, and they are large simply from want of resistance. It is palpable, that if such a current be due to a very small E.M.F., a very small resistance will reduce it to a negligible amount. Hence, by the comparatively great resistance of the contact, with the additional resistance of the carbon forming part of the short circuits on the line *m n o*, the short-circuit currents will be practically eliminated. Consequently, as there will be no current to break at the recession of the segment *r*, in these cases also, there will be no sparking.

OSCILLOGRAPHS FOR THE INVESTIGATION OF SLOW ELECTRIC OSCILLATIONS.*

BY A. BLONDEL.

The object of this communication is to describe some new galvanometric apparatus or *oscillographs* allowing one to determine by direct observation, and with sufficient accuracy, the periodic curves of alternating currents. It is only necessary to devise an instrument, the moving parts of which oscillate according to the law of variation of the current which traverses it. When this is done we can by means of well-known optical arrangements transform the oscillatory movement into a periodic curve and register it photographically. The problem is not new, and several instruments have been devised to solve it, such as the d'Arsonval galvanometer, the use of which was suggested both by M. d'Arsonval himself and by Prof. Éric Gérard; the mirror galvanometer, proposed by M. Colley; and the telephone, as proposed by Elihu Thomson, Fröhlich, and others. None of these instruments, however, have fulfilled the conditions imposed, which are five in number, the two first being of general application, and the three last being peculiar to the problem under consideration.

1. The instrument should have a natural period of oscillation very short when compared with that of the electric oscillations. In the case of ordinary alternating currents particularly, which have a frequency of between 40 and 100 periods per second, the galvanometer should vibrate with a frequency *at least* twenty times greater, *i.e.*, more than 1,000 to 2,000 complete periods per second.
2. The damping should be brought to as low a figure as possible, and as near as possible to the critical degree of dead-beatness, whenever the electrical oscillations are not quite continuous.
3. The self-induction should be sufficiently small not to affect the law of variation of the current measured.
4. Hysteresis and Foucault currents should be negligible.
5. The sensitiveness should be sufficient. This condition is the most onerous of all, and involves exceedingly small moving parts.

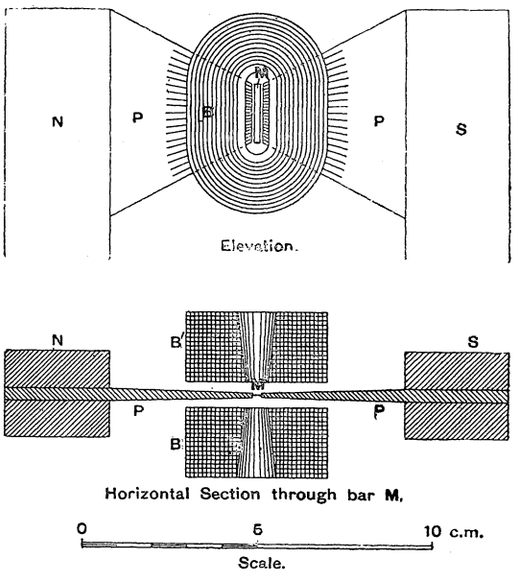
I examined three types of vibrators satisfying the first four conditions, but only the last was sufficiently sensitive.

Movable Coil Pattern.—The coil, similar to that of a siphon recorder, but carried by a spring or an elastic bifilar, must have dimensions much smaller than those realised up to the present, that is to say, the coil must be only a few millimetres in size. We can, it is true—and this is in some respects the best solution—suppress the coil, and only retain the bifilar traversed by the current to be examined, and carrying a mirror at its middle. The bifilar should be placed between the poles of an electro-magnet as elongated and as close together as possible. The instrument has practically no self-induction.

Vibrating Diaphragm Pattern.—This is a kind of telephone, improved in view of this special purpose by the employment of an independent magnetic field perpendicular to that produced by the current under examination. Between the poles of a horse-shoe magnet or electro-magnet a vertical diaphragm is arranged; this is as small as possible, and is recessed into one pole piece, and is free as regards the other. On either side of the diaphragm are placed two coreless coils, traversed by the current under examination.

Movable Bar Pattern.—This is quite naturally evolved from the preceding pattern, to which it is superior, owing to the smaller dimensions and smaller moment of inertia which it enables us to give to the vibrating part. Between the poles N, S (*see* Figure) of the magnet or electromagnet are placed two sheets, P, P, acting as pole pieces, and preferably cut V-shape to increase the field between their tips. A three or four millimetre gap is left, into which is inserted a little bar of soft iron M, two or three millimetres broad, and slightly thinner than the tips of the pole pieces (one to two millimetres). To enable this little bar to move under the influence of the two coils B, B, arranged on either side of the pole-pieces and traversed by the current under examination, without jamming against the poles, it is maintained in the required position either by two needles penetrating into very minute holes at the top and bottom of the little bar or by means of a spring or a specially shaped elastic bifilar to which it is soldered.

Without a spring the directing couple due to the magnetic field alone produces more than a thousand vibrations a second, and without the flat shape of the pole-pieces, which gives rise to considerable magnetic leakage, the figure obtained can be made much higher. With bifilar suspension or a spring it is easy to reach two or three thousand vibrations with sufficient sensitiveness, in many cases, for direction observation. The sensitiveness may be still further augmented by means of a microscope with a magnifying power of 10 to 20 diameters.



Diagrammatic Sketch of Oscillograph (half actual size).

The deflection being, all things being equal, proportional to the product $G I l P^2$, where I is intensity of magnetisation, l the width of the bar, P^2 its natural period of oscillation, G the "coefficient of action" of the coils, we see it is convenient to employ a very soft, very narrow, and very saturated piece of iron.

Owing to the shape of the pole-pieces, P, P, and of the magnetic circuit, and to the presence of a few horizontal saw-cuts along the plates and, if necessary, along the movable bar, hysteresis and Foucault currents are rendered quite negligible. Self-induction need only be feared if one employs the oscillograph as a voltmeter and uses fine wire coils; but, as a rule, it is possible to reduce the lag caused by self-induction to a small amount by the addition of a tolerably large dead resistance.

The chief difficulty I met with was in connection with damping, which I investigated by means of a photographic record of the vibrations on a revolving drum. At these high frequencies electro-magnetic damping becomes insufficient, for the damping necessary at the critical degree of dead-beatness is proportional to this frequency, and we are obliged to have recourse

* *Comptes Rendus*, Vol. CXVI., No. 10, March 6, 1893, p. 502.

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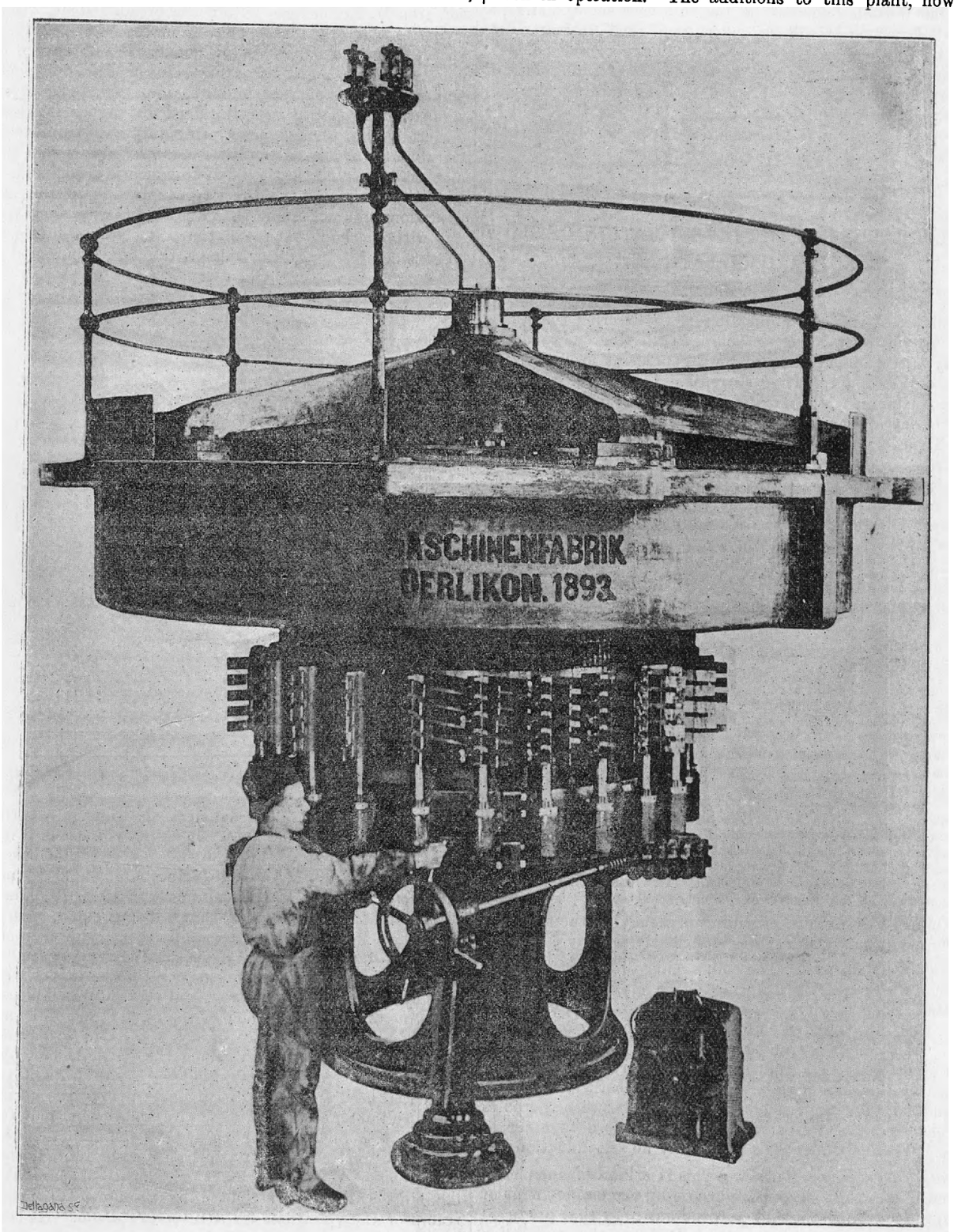
to mechanical means. I have passed over, for the time being, damping by aid of india-rubber dampers, because it is difficult to analyse and control them, and I had recourse to liquids of increasing viscocity—water, glycerine, resinous balsams, &c., which were introduced into a little closed ebonite box provided with a window and surrounding the ends of the pole-pieces and movable bar. Amongst the liquids tried, only the resinous balsams, especially the syrupy Canadian balsam, enabled me to attain the required degree of dead-beatness. I hope to be able to make known very shortly the results attained by means of this instrument when investigating certain particular cases of alternating currents.

OERLIKON 7,500-AMPERE 55-VOLT DYNAMO FOR ELECTROMETALLURGY.

One of the most prominent electrical plants in existence is that of the Aluminium-Industrie-Actien-Gesellschaft Neuhausen, of Neuhausen, Switzerland, which utilise water-powers of the celebrated falls of the Rhine. Up to the present, four dynamos of 150-H.P. each, one of 300-H.P., and two of 600-H.P. have been in operation. The additions to this plant, now nearly completed, comprise four new generators, designed to give 7,500 amperes at 55 volts pressure, and to run at 150 revolutions per



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minute. There will then be six dynamos of 600-H.P. and one of 300-H.P. in one room, representing an aggregate capacity of 3,900-H.P.

The work is continuous. The huge commutators and the sets of 120 brushes per machine must, and do, work absolutely without sparking. There is but one man in charge of three or four of these dynamos. The throttle of the turbines and the brushes of the respective dynamos are handled from the same point.

The accompanying illustration is the reproduction of a photograph taken in the erecting-shop of the Maschinenfabrik Oerlikon, near Zürich. It represents a dynamo of over 400 kilowatts directly coupled with the turbine shaft. The star-like bracket on top of the magnet frame contains the top bearing of the dynamo shaft; the magnet has 24 radial inward pole-pieces, the whole being of cast iron, and supported by heavy iron structures, not shown in the picture. The dynamo shaft carries the armature and the commutator, a total weight of revolving masses of about 12 tons. The 120 brushes can be moved within certain limits by means of a hand-wheel. The magnetic proportions are such that there is but very little shifting of the brushes at varying loads. The machines are shunt-wound and self-exciting. To give some idea of the size of the dynamo, a medium-sized man and a small continuous-current Oerlikon 2½-unit dynamo has been photographed with the large machine.

The turbines are by Escher, Wyss, and Co., of Zürich. They are provided with a device to hydraulically counterbalance the weight of the revolving parts, and to thus relieve the bottom bearing of the vertical shafts. The buildings and the tunnel to carry the water, have been carried out by Messrs. Locher and Co., of Zürich.

RECENT TESTS OF FERRANTI METERS.

Some interesting particulars of the test of two disputed meters have been sent to us by Messrs. S. Z. de Ferranti, Limited. The test was carried out on the following understanding, that if the calibration of the two meters, which had been working independently in a London shop, agreed within 2½ per cent. either way, the check meter to be supplied by Messrs. Ferranti, the amount registered was to be paid for in full. The makers supplied a Ferranti meter calibrated between currents of from 10 to 60 amperes, and declared its constant. After the test this meter was sent to Faraday House Standardising Institution, who calibrated it. By Messrs. Ferranti's calibration the meters over-registered 1·4 per cent., by the Standardising calibration they had under-registered 0·83 per cent. This difference is due to the variation in the standard, no doubt.

A full description of this type of meter was published in *The Electrician*, Vol. XXVIII., p. 537. The following is a general description:—

All meters up to and including the 300 ampere size start registering with an 8 c.p. lamp. There is no shunt-current wasted in the meter, the initial friction being compensated for by steel pole-pieces, the remaining iron parts of the meter being made of soft iron. The form of field is a closed magnetic circuit, the gap between the pole-pieces, in which is the mercury chamber, being surrounded by a steel ring which acts, as it were, as a keeper. The maximum working current which passes through the meter magnetises the steel pole-pieces to the required degree for compensating the meter on starting. The rotating parts of the meter, which are exceedingly light, are of a metal which is non-magnetic, and is not attacked by mercury. The whole of the revolving part is entirely submerged beneath the mercury, and the spindle which conveys the motion of the mercury to the train of wheels, is made of very small diameter so as to avoid, as far as possible, the surface tension of the mercury, this being found to be one of the initial difficulties in 1883.

The curve of one of the meters taken when working with a smooth insulated surface on either pole-piece is one which is not proportional to the current passed. The meter tends to run faster as the current increases. This is ingeniously corrected by radial roughening of the two insulated surfaces, and by this means it is easy to get the curve of the meter straight. The dial of the meter is now made so that a ratio wheel can be put in, in order that, as soon as the meter has been calibrated and the curve found to be straight, the meter can be made to read direct in Board of Trade units on the dial at any declared voltage without alteration to the meter internally. The speed of rotation of the meter is kept down to about 250 revolutions maximum.

The two disputed meters, Nos. 386 and 404, had been at work from June 25, 1892, until January 23, 1893, and had registered respectively 968 and 2,440 units.

Test of Two 100-ampere Ferranti Meters *at the generating station of Supply Company, reading in B.T.U. at 110 volts.*

Time in hours.	Approximate current by ammeter.	Meter. 386	Meter. 404	By Ferranti Company calibration.	By Stand. Inst. calibration.
1·0	40-60	5·0	5·0	4·93	5·16
1·5	40-60	7·4	7·4	7·34	7·59
1·75	40-60	7·9	8·0	7·83	8·07
1·33	25-30	4·1	4·0	4·0	4·03
	Total	12·0	12·0	11·83	12·3

Meter (check meter). 1425

All the above meters 100 ampere size. This showed the two meters to be:—By Ferranti Company's calibration, 1·4 per cent. high; by the Standardising Institution calibration, 0·83 per cent. low.

PARTICULARS OF TEST.

Present: Engineers of Supply Company, consulting engineer of customers, and Messrs. Ferranti's representative.

Ferranti meter, 1,425; constant declared as below:—

$\frac{3{\cdot}05 \times 60}{18{\cdot}300}$ revs. per ampere per hour.

$\frac{10}{1{,}830{\cdot}00}$ revs. with 10 amperes per hour, per B.T.U. at 100 volts,

$\frac{1{,}830 \times 100}{110}$ = 1,663·0 revs. per B.T.U. at 110 volts.

Constant as declared by the Standardising Institution:—

22 amperes, 1,652·0 } at 110 volts. See copy below.
43 amperes, 1,608·0 }

CERTIFICATE OF EXAMINATION *issued by the Electrical Standardising, Testing, and Training Institution, Faraday House.*

Ferranti direct-current meter, No. 1,425. Range, 100 amperes.

Amperes.	Duration of test.	Revs. per B.T.U. at 110 volts.
43·0	20 minutes	1,608
21·9	20 minutes	1,652

For the Electrical Standardising, Testing, and Training Institution,
(Signed) H. FOULKES.

Faraday House, Charing Cross-road, London, W.C., Jan. 24, 1893.

The following are some recent tests of the 300-ampere size of meter:—

CERTIFICATE OF EXAMINATION *issued by the Electrical Standardising, Testing, and Training Institution.*

Instrument, Ferranti direct-current meter, No. 2,006. Range, 300 amperes.

Amperes.	Revs. per amp. per minute.
300	1·118
201·5	1·107
100	1·090
50	1·076
10	1·115

Started with a current of 0·5 ampere. Temperature after running for two hours 300 amperes, 25·5°C.

For the Electrical Standardising, Testing and Training Institution,
(Signed) H. E. HARRISON.

Faraday House, Charing Cross-road, London, W.C., Feb. 28, 1893.

CERTIFICATE OF EXAMINATION *issued by the Electrical Standardising, Testing, and Training Institution.*

Instrument, Ferranti direct-current meter, No. 2011. Range, 300 amperes.

Amperes.	Revs. per amp. per minute.
301·7	1·215
204·0	1·233
124·0	1·195
50·0	1·173
10·25	1·23

Started with a current of 0·45 ampere.

For the Electrical Standardising, Testing, and Training Institution,
(Signed) HUGH ERAT HARRISON.

Faraday House, Charing Cross-road, London, W.C., Feb. 23, 1893.

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ON TESTING AND WORKING ALTERNATORS.

The following is an abstract of the discussion on Mr. Mordey's Paper which took place on February 23rd and March 9th, at the Institution of Electrical Engineers. Speakers whose remarks are prefaced by an asterisk have returned their proofs revised.

*Mr. MILLER, introduced by Prof. Ayrton, said that some months ago Mr. Mordey described to Prof. Ayrton the ingenious method of measuring the output and efficiency of an alternator which had formed the subject of the Paper just read. This method appeared at first sight to be only practicable when the armature was stationary. But it subsequently occurred to Prof. Ayrton and Dr. Sumpner that the principle of using one-half of an alternator as a generator and the other half as a motor was quite as applicable to a rotating armature and many-poled field. If the stationary field magnet were electrically divided into two parts and the connections of one-half reversed, then, without any other change in the rotating armature, one-half of the machine acted as an alternating motor while the other remained a generator. Messrs. Fleming, Nicholson, and the speaker had carried out a series of experiments on the 12 H.P. Ferranti alternator at the City and Guilds Central Institution, and the results confirmed the idea that this method of testing an alternator with a rotating armature could be practically employed. The field magnet coils of the Ferranti dynamo were connected in parallel so that the current passed round the upper and lower coils in opposite directions. The alternator was driven direct by a continuous-current motor. Throughout the experiment the currents in the two halves of the field of the alternator were so adjusted as to produce sufficient electromotive force in the armature (which was short-circuited by an ammeter) to send 20 amperes through the armature. The alternator was run at different-measured speeds and the power required to drive the motor measured. Subtracting the power wasted in heating the two armatures, they obtained the power expended on eddy-currents and friction. The power wasted in the motor was then separately determined by ascertaining the power required to drive the motor at the same speed when its spindle had been uncoupled from that of the alternator. So that finally they had the power wasted in the Ferranti alternator. Having obtained this it was then quite easy to calculate the efficiency at different speeds by aid of the characteristic curves.

*Prof. AYRTON said it would be seen that that method of testing an alternator with a rotating armature by dividing the field into two parts was equally applicable to direct-current multipolar machines. Such a machine could be tested at once by simply disconnecting one-half of the field, and joining it up electrically the wrong way, so to say, to the other half. It was not necessary, as Mr. Mordey suggested, to have two commutators on the armature. Of course there was one point about all the methods, one objection, which did not apply to the original method suggested by Dr. Hopkinson some years ago In Dr. Hopkinson's method there were two distinct direct-current machines with their shafts coupled together, one working as a motor and one as a dynamo, and the power that each machine was developing was actually transmitted through the shaft. Now it was to be observed in the interesting method which Mr. Mordey had described, and the extension of it described by Mr. Miller, that the stress on the shaft was not tested at all, and it might be that the shaft would be weak or the bearings might heat when the shaft was required to transmit 100 H.P., which would not come out at all in the method of testing described. It was quite clear that if one had not an engine giving more than 10 H.P. one could not in any way transmit 100 H.P. through the shaft. It might be objected that the method he had spoken of resulted in a distortion of the field, and the result would not truly represent what would happen if there were no distortion. That was true to some extent, and it was also true of Mr. Mordey's method. With a multipolar field that was not a very serious matter. With two poles, no doubt, it would be a serious matter ; the whole of the lines of force would be distorted. What Mr. Mordey had said about the currents in parallel coils of an armature flowing back through the coils was very interesting, and the students had noticed it in a very marked way in connection with a transformer where the secondary consisted of two coils in parallel. Prof. Perry pointed out some time ago that if one portion of a transformer, whether the primary or the secondary, consisted of two coils in parallel, then there was the liability to have the currents circling round that coil with the two halves in opposite directions if the numbers of convolutions were not exactly the same, but he had not seen, apparently, that the difference in magnetic leakage alone would cause circling of the current in two parallel coils, whether of the primary or secondary, and such circling to a surprising amount had been noticed with such a transformer at the Central Institution. They had heard that evening an extremely interesting Paper, interesting from a variety of reasons—interesting, first, because it proposed a new method of testing alternators, which enabled the alternator to be tested with a very small amount of power, and especially interesting, he thought, from the last part, which gave rules for the parallel working of alternators. It had been urged by those who were in favour of direct-current working that it was impossible to work alternators successfully in parallel, but with the instructions which Mr. Mordey had drawn out so fully, it would seem that that difficulty was got over, and that it would not, therefore, any longer be an argument against alternators that they could not be worked in parallel.

*Prof. SILVANUS P. THOMPSON said they had once more to congratulate Mr. Mordey on a thoroughly happy Paper. There were two or three points in the Paper that perhaps called for a little more than passing comment. For example, the very curious and interesting diagram of the current required in the field of the motor at different stages of excitation brought home to them, in a way that nothing else would do, the meaning of Dr. Hopkinson's prediction, that they could run a motor with a higher electromotive force than the generator that was feeding it. That was a matter of practical importance too, because it was obvious that motors ought always to be so run, that the current running up and down the mains should be a minimum. There were one or two little points of criticism which he hoped Mr. Mordey would not object to his raising. When Mr. Mordey divided the armature into two parts, as in Fig. 1, or any of the others, and ran the machine thus, that surely was not quite exactly the equivalent of running a generator and a motor, because the generator and the motor were not rigidly coupled together so that the volts were necessarily in entire opposition of phase, and if there was any self-induction in the circuit in between, if there was any capacity in the circuit in between, then there would be a difference of phase between the two machines, that was to say, they would not be exactly in opposition of phase as they were in the motor-coils and the generator-coils in the divided machines. Again, Mr. Mordey made the assumption that the efficiency of a machine as a motor was the same as when used as a generator. Well, that depended to some extent on the conditions of the circuit. Again, Mr. Mordey said "Running at full current and small power may also be done by using simple choking-coils for the external circuit, but this introduces disturbing influences which make it of very little use." Those were exactly the disturbing influences that did come in, in running. He would make the same criticism as he should have done on Dr. Fleming's paper if he had had the opportunity. It was a very valuable paper, but the conditions under which the tests were made, excellent as they were for giving something like a distinct view of the subject, were really not those of actual practice. Some years ago there were alternating-current machines brought into the market, mainly, he thought by Messrs. Siemens Bros., that worked at a very low voltage, 40 or 50 volts. Of course, such machines had no *raison d'être* for modern work. Those machines had a large number of circuits in parallel, and it was at first a source of wonder to him how much power those machines contrived to absorb when running light and doing no work. At first he assumed it was due to eddy-currents in the clamps holding the coils together. Then he found those clamps did not heat, and he could not account for it on the assumption that it was all due to eddy-currents. He came to the conclusion, then—and all that Mr. Mordey had said confirmed it—that the cause of that very low efficiency, that relatively enormous waste of power at light load and no load was simply the cross-connections in parallel of the different coils, the coils themselves not being equal among themselves, or the pairs of poles not being of equal power, therefore the internal currents running in and out the cross connections of the armature wasted the power given to the machine.

The meeting then adjourned

THURSDAY, MARCH 9TH.

*Prof. SILVANUS P. THOMPSON said that if they could run a motor without any load whatever, even without friction on the armature, they would, of course, require no current to drive it round ; it ought to run without any effort. In that case the curve, which in Fig. 6 bends down, and comes to a minimum at some point above the zero line would, of course, go down to zero. They would then have for the curve two straight lines meeting at a point. If the field-magnets of a motor were excited exactly up to the proper point, its electromotive-force would precisely balance in every instance the electromotive-force coming in from the outside. The two waves were absolutely symmetrical, but opposed. But if it were not excited at exactly the right amount, a machine running at its proper speed will give back an electromotive-force not equal to the applied electromotive-force ; and then there would be a current, either leading or lagging in phase, according to whether the motor was under-excited or over-excited If the magnetism of the motor-field were at any moment proportional to the exciting number of amperes, then he presumed those two sides of the curve would be straight lines. But they knew the magnetism was not proportional. The only reason why it was nearly symmetrical was because near these lines the field was not excited to anywhere near what one called the saturation point of excitation. He happened to have been reading that day the proceedings of one of the American Societies, and was very much amused to see a communication, a formal communication, read by an engineer who was running a certain Manhattan station with alternating-current machines in America He was describing the advantage of the newest system of switchboards, which he said was a beautiful switchboard, "marbleised in imitation of Tennessee marble," a real ornament to any station. It was contrived on the following principle :—There were 17 different circuits going out from that station to the lamps, and 19 different alternating machines, and the arrangement was such that by no conceivable possibility could a man, desiring to make a mistake, put one of those machines into parallel with any other machine. There could hardly be a more striking commentary upon the difference between one country and another than the Paper discussed here to-night and that read in America, showing how the practice in the two countries has gone so absolutely in two different directions.

*Dr. FLEMING then exhibited and described a new wattmeter, in which the shunt coil was excited by means of transformers. In ordinary wattmeters the fixed or series coils were firmly fixed, but in this instrument they were carried by two pieces of wood, and were capable of being pushed together or drawn apart from the screw, so as to bring them nearer or move them farther from the movable coil. Instead of fixing the mercury-cups, they were carried on the coil itself. The object of that was to induce perfect symmetry in getting a current into the movable coil.

*Dr. HOPKINSON was of opinion that the general method of testing the electrical appliances, a particular case which Mr. Mordey had so well described in his Paper, had really two advantages. The first was that they were able to test their appliances with the expenditure of a very small power, namely, the power which is wasted in those instruments ; the other was that they could carry out their test with a very much greater degree

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of accuracy. Suppose, for example, in the combination of the two appliances there was a loss of 10 per cent., and they could make their measurements with a power of only 1 per cent., then they could make their test of efficiency to an accuracy of one-tenth per cent., or thereabout. That second advantage he was not sure whether Mr. Mordey put in sufficient prominence. The advantage, however, existed whether the dynamometer were used or whether they used an arrangement, proposed afterwards by Lord Rayleigh, in which all the measurements were made electrically. About a year ago he tried some experiments with transformers by this method. The method then adopted was substantially the same—that is to say, they measured the power transmitted from one instrument to another, and measured directly the loss in those two instruments. As applied then, that method had only the second of those two advantages ; it had not the first, of economising the power required to drive the combination. Immediately afterwards almost, Prof. Ayrton and Dr. Sumpner published a description of tests of transformers which realised both those advantages. They were such that economy of power was secured as well as greater accuracy of testing. His method, however, was designed to give other information than the mere testing of efficiency. As the transformers were sent to him, undoubtedly the test of efficiency was that to which he was asked to address himself, but having them in his hands he desired to get out of them all the information that was obtainable. Mr. Mordey had referred to the possibility of testing a single continuous-current machine in which there were two equal circuits with separate commutators by connecting the two commutators together in such wise, that the power developed electrically in one circuit would be used in the other to generate mechanical power again. A method applied in that way was, of course, as Prof. Ayrton had pointed out, open to the objection that it did not give a complete test of the mechanical properties of the machine ; they did not get the mechanical tortion applied to the shaft, and generally the mechanical properties of the machine were not tested thereby. It had also another objection, that if they had two coils connected in that way they would have no distortion of the magnetic field, for the current in one section of the armature would be counterbalanced by the current in the other, and the sparking-point of the transformer would be the same as if there were no current at all passing in that machine. In the generality of continuous-current machines this was no great inconvenience, and probably did not introduce any serious error into the accuracy of the efficiency tests, but he could well imagine machines in which there would be a greater efficiency shown when tested in this way than if tested with two separate machines coupled together mechanically and coupled together electrically. In the case of the brush-dynamo used as a generator, it was well known that the pole-pieces heated, and that they heated particularly in that part where the armature was pulled away from the pole-pieces ; if, on the other hand, the machine was used as a motor, they heated at that part of the pole-pieces to which the armature approached. If they arranged a machine with two commutators upon it in such wise that the current in one section of the armature opposed that of the other, they would have this heating considerably diminished, and he thought it probable that they would in the latter case get a higher efficiency than in the first. Mr Mordey's method of testing alternators in the single machine was open, to a certain extent, to the same objection.

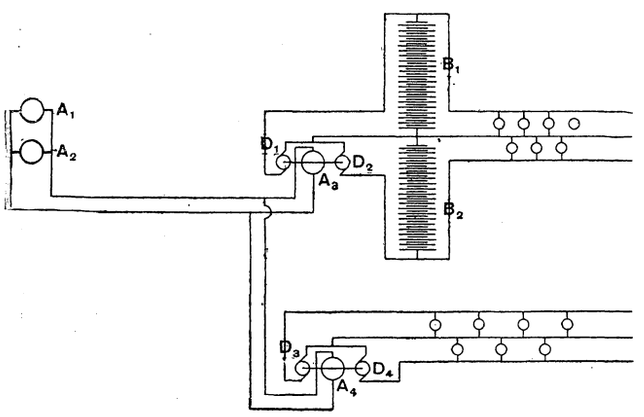

Diagram I.

*Mr. KAPP said it might be interesting to the meeting if he mentioned a practical example where the behaviour of alternators when used as motors had been verified in accordance with Mr. Mordey's, Fig. 6. He referred to the power transmission by alternating-current put up two years ago in Cassel. Let diagram I. represent both the generator and motor stations. Imagine A_1, A_2 to be two alternators coupled in parallel. The current was sent to Cassel several miles distant through a concentric cable having considerable capacity. The current at Cassel splits up into two branches leading to two stations in different parts of the town, where the dynamos D_1, D_2, D_3, D_4 were driven by the alternators A_3, A_4. The supply was by low-pressure continuous-current. At one of the sub-stations there was a battery, and both sub-stations were connected to the main on the three-wire system. That was to say, each sub-station had two continuous current generators, and between them was an alternator coupled rigidly to the continuous-current machines. When this plant was started the man in charge made the discovery that he could vary the armature-current by adjusting the current through the fields. The man there simply discovered it for himself ; he found, "If I can work my station with 20 amperes instead of 30, so much the better," and adjusted his rheostat in the field until he got minimum current. He (Mr. Kapp) then investigated the matter, and worked out from the characteristic curve and from the self-induction of the motor-alternator what would be the armature-current in order that the machine might do a certain amount of mechanical work. The result of this investigation was plotted on the curve (Diagram II). It referred to a 10-kilowatt 2,000-volt machine. He found that if the excitation was such that it would give 2,000 volts when working as a generator, it would have minimum armature-current, when giving 10 kilowatts as a motor : if it was excited to a higher degree, so that it would, as a generator, give 3,000 volts, the armature-current required for the same 10 kilowatts would be greater. It would also be greater if they excited the machine less. There was a still more interesting point in connection with that curve. If they looked at the curve they would find that it was not a straight line ; that they also found in the other diagram. Now, what did that mean? It meant that if they reduced the excitation below a certain point, the armature current would become very large—about $2\frac{1}{2}$ times the minimum. But if they reduced the exciting current below that point, they would miss the curve altogether ; that was to say, the machine would electrically break down—fall out of step. That was rational, for by experience they knew that alternators would support from two to three times their normal loads before being thrown out of step. The dotted curve was the curve which resulted when they neglected, and the full curve when they took armature reaction into account. When the curves bent back on the left it showed that the working was unstable, in fact, the dotted portions of the thick curves referred to impossible working conditions. He had drawn the curves for three different powers —20 kilowatts, 10 kilowatts, and 1 kilowatt—and he then tested the machine ; he did not get any test exactly at 20 kilowatts, or 10, or 1, but the circles showed the curves which were obtained to be of the same general character as those which had been determined theoretically.

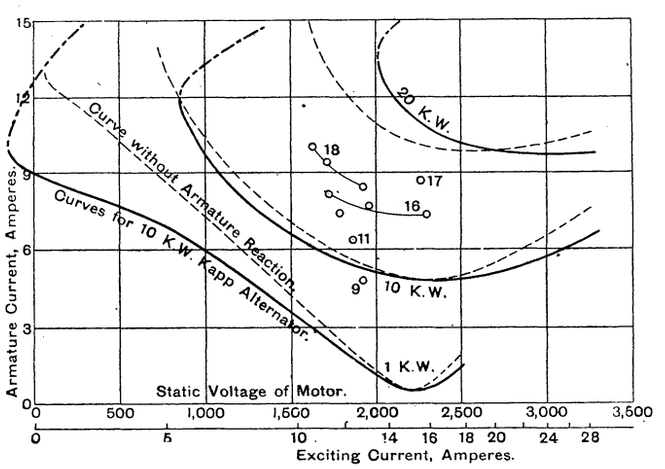

Diagram II.

*Mr. HARRISON said that Mr. Mordey had acknowledged his indebtedness to Dr. Hopkinson's earlier Papers on this subject, and had stated that his experimental results had been anticipated. He was afraid that most practical engineers regarded those earlier Papers of Dr. Hopkinson's rather in the light of that block of marble in which there lay a statue of great price, and he doubted if many engineers had ever chipped off the mathematics in which these great truths lay hidden. If the curves in these Papers were read side by side with the mathematics which followed, the whole matter was explained simply enough. But, unfortunately, there were those who read the curves without the text. There was an electromotive force which was not shown on the curves. They did not in fact tell the whole tale. If they had three Daniell cells in series, they had a battery which had an electromotive force of three volts ; if they reversed one of these cells, it neutralised the electromotive force of a second cell, and they had a battery electromotive force of one volt. Apply Ohm's law to any circuit to which it might be applied and it would work ; but if it were still maintained that the electromotive force of such a battery was three volts, there would be an apparent contradiction of Ohm's law such as is frequently supposed to be the case with alternating currents. The statement that a 100-volt alternator could drive a 200-volter as a motor was true only with the qualification that when it was doing so, the 200-volter was not giving 200 volts. Mr. Harrison then described some experiments with an old Siemens alternator at Faraday House in which the alternating current from the armature throbbed, or pulsated, when run as a motor from the London Company's mains, and the needle of the ammeter in the field circuit excited from secondary cells pulsated in the most marked manner also.

*Mr. SWINBURNE, in a written communication, observed that a full load test did four things. It tested the armature for mechanical strength, the bearings for full load behaviour, the armature coils for heating, and the field for heating under full excitation. If an efficiency test were also needed, the test gave it, including losses in bearings with belt or ropes on, losses in the armature due to full-load current, and losses in the field under full excitation. These tests were not fully carried out in Mr.

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Mordey's method. Mr. Mordey seemed to think an efficiency test should be taken with the belt off. He would submit that was absurd. The loss due to the belt occurred in practical use and must therefore be included in the machine losses. The engineer might equally justly say his engine should be run without a belt, because the belt was not part of the engine. Of course the efficiency came out higher without the belt, but the too common habit of making out a high paper efficiency was to be deprecated. He could not agree with Mr. Mordey as to the details of parallel running. To secure parallel running they must not consider the dynamos only, but the whole station. A factor commonly neglected, and not referred to by Mr. Mordey, was the engine-governor. To run a number of alternators in parallel off separate engines, each with its own independent speed-governor, was as foolish as to run independently-governed engines on to one shaft. When dynamos were in parallel, the excitation controlled the idle component of the armature current, and the steam admission controlled the active component, that is, the output. Every station dynamo should, therefore, have a wattmeter to show whether the steam supply was right and whether the machine was doing full work, and an idle current indicator to show whether it was over or under excited. At present, people did not study the question as a whole. They looked at a little bit of the problem, the dynamo for example, or its armature, and they neglected the engine, the exciting arrangements, the governors, the throbbing of a slow-running engine, and the steam-pipe connections. They then coupled two alternators in parallel. If they burned up they said the alternators did not run in parallel; if they did not burn up they wrote a testimonial for the maker of the alternator.

Mr. CROMPTON said that Mr. Willans had been working with various forms of electrical governors for keeping alternators equally loaded, but he thought the view he took latterly was that it would be better to do away with separate governers completely, and put one governer on the main steam-pipe. All methods that took off the side pull of the belts gave far too favourable results of the efficiency of the machines from a mechanical point of view. The effect of the absence of the side pull was shown very plainly in the very high efficiency that makers of direct-driven dynamos had been able to show. If makers of steam engines removed the side pull, efficiencies of 94 and 95 per cent. were obtained in practice. He would like to ask Mr. Mordey whether he had not availed himself of the means of which they had all availed themselves in the past, and that was attaching an alternator to a Willans engine and submitting it to the very excellent series of tests which had been going on for some years past at Messrs. Willans' works. It would be most interesting to see how far tests thus obtained would corroborate the efficiencies obtained by Mr. Mordey with the method laid down in this Paper.

*Dr. SUMPNER said that every alternator really consisted of a number of small machines in series, and what Mr. Mordey had done was to connect some up as motors and some as dynamos, and to use the Hopkinson method in connection with the combination. One of the great advantages of Dr. Hopkinson's method was that they could not only measure the losses accurately and do the whole thing with a very small amount of power, but they could very easily separate the losses from one another. He had tested a 100 H.P. Phœnix alternator having 20 pole-pieces, first dividing them into 10 and 10 and using 8 amperes in one half and 18 in the other, and afterwards dividing them into 8 and 12 poles and using the same current through both. The results were not very accurate, but agreed together.

Mr. BAILEY described a method which had been adopted by Mr. Gordon in testing the Paddington alternators with a view of finding out defective coils.

Mr. WEEKES described some experiments with a Ferranti alternator to find if the self-induction of the alternator altered with an increased load.

*Mr. MORDEY said that there was one point that was raised by Mr. Harrison, and, as it really was a criticism of some of the results referred to by Dr. Hopkinson, he should be very glad if Dr. Hopkinson could briefly reply to that, or add it to his remarks.

The PRESIDENT said that he would be very glad if he would add it to his remarks. Unfortunately he had already ruled Dr. Hopkinson out of order. He took that opportunity of saying that as long as he was President he intended to confine the discussions as much as he possibly could to the Paper under discussion.

*Mr. MORDEY, in reply, said that Prof. Ayrton had criticised the method of circulating power, and had said that no indication was given as to whether the shaft was strong enough in the machine. That was quite true. As far as that was concerned, they knew quite well what shaft to put in for various powers and conditions, and he thought most engineers were always able to put in shafts they had every confidence in. They were quite satisfied about their bearings. Dr. Thompson had said that the conditions in a machine running in this way were not quite the same as when running as a generator or as a motor. That was quite true. There were slight differences, for example, the torque was in opposite directions in the two parts, but he did not think they amounted to anything as far as the accuracy was concerned or the Foucault currents were concerned, or any practical conditions which the test seeks to determine. Something had been said as to the unequal effect on the fields of the two parts of the machine, running with one portion running as a motor and the other as a generator. Some two years ago he described an experiment with an alternator in which one coil was taken out of the circuit and merely connected to a voltmeter. The other coils were then loaded from nothing up to full load and the excitation kept constant, and the volts shown by the idle coil remained perfectly constant. He took that to indicate that the reaction of the armature on the field was not appreciable. He thought Mr. Kapp's curve was not a good curve. It appeared that the machine was going to break out of synchronism at $2\frac{1}{2}$ times the best current. In his curve he got up to 20 times and did not break out of synchronism. With reference to Mr. Harrison's experiments, he (Mr. Mordey) had had a good deal of experience of alternators, and had tried to find the faintest difference of field-current when the whole of the armature-current was thrown off suddenly, and had never seen in his own machines the slightest flicker in the exciting current. Mr. Swinburne had criticised the modification of Dr. Hopkinson's method on grounds that were not quite fair. He was trying to test an alternator; he was not trying to test an engine, or a boiler, or a belt. Really the alternator had to be driven somehow, and for the purpose of his argument his machine might be direct-driven. As to the side pull of the belt, he did not think that was a very serious matter. He did not think the loss in the bearings was a difficulty, and did not think the reduction of efficiency by side pull of the belt was to be traced to the bearing, but to the belt.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF COMMONS—THURSDAY, MARCH 9TH.

City and South London Railway Bill.

Mr. PICKERSGILL rose to move that it be an instruction to the Committee on the City and South London Railway Bill that they do insert a clause reserving to the London County Council a power to purchase the undertaking, after the expiration of a limited period, on terms similar to those provided in section 43 of "The Tramways Act, 1870." He remarked that he brought forward this motion on behalf of the London County Council. There were now before the House a batch of London Electric Railway Bills, by which it was proposed to provide London with a series of underground railways, traversing the metropolis in various directions, and worked by electricity, and all the projected lines were practically within the area which was now controlled by the London County Council. He asked the House to affirm the principle that the London County Council, as a local authority, should be empowered to acquire those railways, on fair conditions, at the expiration of a certain term of years, which he would leave the Committee to fix. The Joint Committee which, in the last Parliament, had considered the question of similar Bills, had in their report neither approved nor condemned the principle of purchase; they had simply ignored it. The question was, therefore, still an open one. These electrical railway schemes differed in one very important respect from other underground railways, as it was proposed to give them the right to acquire way-leaves at a certain depth under the surface, and even where the lines would pass under private property they would be subject to the Lands Clauses Act in regard to compensation. In order to avoid, as far as might be, the necessity for payment of compensation, the routes had, whenever practicable, been marked out so as to follow public thoroughfares. A great advantage would thus be secured to the railway companies, and the public ought to receive some equivalent in return for parting with their rights. It was no answer to his contention to say that the companies would be put on terms of having to provide cheap trains, for this condition was now imposed upon all new lines running into the metropolis and having a suburban traffic. This was, he contended, emphatically a case in which compensation could most properly be given by providing that, under certain conditions, the community should have the right to acquire the undertakings after a specified number of years. This was no new principle. Under the Act of 1844, the public had a right of acquiring, under certain conditions, every railway in the country. From the point of view of the promotors of this Bill the sting of the proposed instruction seemed to rest on the term of years at the end of which the right of purchase might be exercised. It was clear that a term might be fixed which would have no effect on the financial prospects of the company. The essence of the case turned entirely on the number of years at which the term was fixed, but that matter would be for the Committee to decide hereafter. There was no wish on the part of the London County Council to crush out legitimate commercial enterprise, but the conditions of purchase might be—and must be—adjusted in such a way as not to interfere with the development of electric railways. In this connexion the story of electric lighting was not uninstructive. By the original Act the term was fixed at 21 years, which, undoubtedly, had the effect of checking electric lighting enterprise, but this term was afterwards altered to 42 years, and this stimulated electric lighting again. The right course was not to reject the principle of purchase, but to be careful that a term of years was fixed which would be suitable to the particular enterprise concerned. In this case the duty of fixing the term would devolve upon the Committee. The promotors of these electric railway Bills had shown great inconsistency. At one time they drew a most glowing picture and said that within seven years, if the means of getting about which these projects would afford were provided, the number of passengers annually carried in London would be no less than 400,000,000. In the case of the Baker-street and Waterloo line it was estimated that the number of passengers would be 60,000,000 annually, which was far in excess of the number carried on the Metropolitan District Railway. The broad ground upon which he based this instruction to the Committee was that the public had a right to acquire, upon reasonable conditions, all the means which were essential to the life of a great city and which partook of the nature of monopolies, whether concerned with water, gas, or locomotion. It was this simple proposition which he asked the House to affirm. He concluded by moving the first instruction which stood in his name.

Mr. BOULNOIS said these questions did not receive proper consideration in the London County Council. They were brought forward on the reports of committees, and those reports were usually circulated by the last post on Saturday night, so that members got them on Monday, the day before the discussions took place. Almost every proposition brought before the Council was closured after insufficient debate, and in the interest

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of the ratepayers of London he opposed this proposal on principle, because to carry such an instruction would be absolutely in restraint of all private enterprise. The County Council did not intend to stop at tramways; they wanted to acquire the railways, the omnibuses, the steamboats, and the docks.

Mr. STANSFELD regarded the instruction as mandatory, directing the Committee to pursue a certain course whatever their own opinion might be; and, though the instruction was in order, it was unusual.

Mr. WHITMORE urged that the effect of the instruction would be to render private enterprise in tramways impracticable. Even if the proposal had any weight, the proper way to proceed would be, not in this piecemeal and accidental manner, but by a general public Act, which would have every opportunity of being considered in the House. He asked the House to reject the instruction, which would prevent most necessary railway projects from being carried out.

Mr. BURNS said it seemed to him that hon. members wished to deny to the largest city in the world powers which they were prepared to give to Birmingham, Glasgow, Manchester, Liverpool, and other large towns. The County Council had no desire to restrict private enterprise, provided it was consistent with something like the homogeneous government of London from a physical point of view. The request now made was, he held, perfectly reasonable, and ought to be conceded.

Sir J. LUBBOCK hardly thought the House would be disposed to refuse to London in a matter of this kind powers which it would give to Birmingham or Manchester. But that was not the question. He did not think the London County Council had reconsidered this matter since the Joint Committee reported upon it; and, therefore, though they were last year in favour of such powers as were sought by the instruction, the House could not regard the hon. member's claim to speak for them now. There was a great deal to be said for giving local authorities power to acquire railways; but, speaking for the present, the real interest of London was to improve its means of communication with as little delay as possible. Therefore, having regard to the statement of the Chairman of the Joint Committee, that such an instruction as that proposed would discourage private enterprise, he thought it better that the Bill should go to the Committee in the usual way.

Mr. MELLOR said, while he expressed no opinion as to the purchase of railways by the State or by local authorities, that if that were to be done it ought to be done by a public Bill. The present proceeding was a mode of evading the Standing Orders of the House; and, if it were assented to, it would be possible to engraft upon some small, and perhaps insignificant, Bill a great public change, which the House might wish to take some time to consider. A mandatory instruction ought to be very carefully scanned before being adopted, because under it the hands of the Committee were tied and their jurisdiction was practically nullified on matters of very considerable importance.

Mr. BALFOUR said the House would be grateful to the Chairman of Ways and Means for the very able guidance he had given them. He had shown that, whatever might be the merits or demerits of the abstract proposal of the hon. member, at all events, the House was asked to consider it in a shape which made it absolutely impossible for the House to accept it. For his own part, apart from that which was more an objection of form, he had two objections in point of substance. The first was that the acceptance of such a proposal would absolutely kill the investment of capital in the metropolis, and would render it unsafe for capitalists to come forward with projects of this sort, knowing that they would not reap the benefit of them. Secondly, he looked with very grave apprehension upon any scheme that would enormously increase the position of municipal bodies as direct employers of labour. They had seen in that House how much their own business was hampered by the fact that the country was itself an employer of labour, and night after night was taken up by discussion arising out of that fundamental fact.

The House divided and the numbers were:—

For the instruction	129
Against	242
Majority against	113

MONDAY, MARCH 13TH.

On Monday, before a Committee of the House of Commons, presided over by Sir John Kennaway, the two Bills of the City and South London Railway Company, for an extension of time for the construction of the line from Stockwell to Clapham, and for the extension from the City to Islington, were considered. Mr. Pembroke Stephens, Q.C., Mr. Rigg, and Mr. Claude Baggallay appeared as counsel for the promoters. Against the Clapham Extension there was only the Lambeth Vestry, represented by Mr. H. J. Smith, the vestry clerk. Against the Islington Extension Bill Mr. Meysey Thompson appeared for Mrs. Dora Twyford and Colonel Twyford; Mr. Worsley Taylor, Q.C., for the Orphan Working School, Mr. Littler, Q.C., and Mr. Monckton for the Corporation of London; and Mr. F. A. H. Terrell for Mr. Marcus H. Voss.

Mr. PEMBROKE STEPHENS in opening the case for the promoters explained the manner in which the Bills proposed to extend the existing lines at both ends, and said that when the original line was sanctioned, the idea was that it was to be worked by cable, but, as the Committee knew, there had been a very rapid advance in electrical knowledge of late years, and before the line was carried out, what at one time was only a theory was found to be quite within practical limits, and the system then adopted for working the line was that of electricity. The line had now surmounted all the difficulties which were experienced in the early part of its career. Its success had been so great and so rapid that they were hardly able to carry the traffic, over twelve million passengers having been carried during the short period which had elapsed since its opening. The Bill did not propose to interfere with the present station at King William-street, but to get the advantages of a second line on a different level which, starting from the Borough Station, would pass under the river to the right of London Bridge and beneath the King William-street Station up to the Angel, so that the two lines would be distinct. There would be four new stations between King William-street and the Angel, at Lombard-street, Moorgate-street, Old-street and Duncan-terrace.

The CHAIRMAN: Do you connect with the Oxford-street line?

Mr. PEMBROKE STEPHENS said that they would cross that line, and there would be a means of exchange with it. There would not be a physical running into it, because the lines were at right angles; but there would be the usual power of interchange by means of a subway. Having referred to the congestion of traffic and the thickly-populated character of the district which the line traversed, he proceeded to explain the method of construction and the advantages of the electrical working. Counsel urged upon the Committee the conclusions which had been adopted by the Joint Committee of both Houses which sat last year. He further explained that it was proposed to have subway communication with the London and Brighton and South-Eastern Railways at London Bridge; and, referring to the petition of the City Corporation against the Bill, said that that body had met them fairly and honourably, and there were no questions outstanding except with regard to a block of property at the northern portion of the line to which they attached considerable value, and for which they wished some special protection.

Mr. J. H. GREATHEAD, the engineer to the line, was then examined by Mr. Rigg, and bore out the opening statements of counsel, and said that as the original line from the Elephant and Castle to the Monument was laid out for working by cable traction the gradients and curves were rather severe for electrical traction, and the new line from the Borough into the City would give both better curves and better gradients. The sharpest curve on the new line would be twice the radius of the sharpest curve on the existing line, and the gradients would be 1 in 90 as compared with 1 in 30. The line would be laid in the London clay at a depth of from 50ft to 100ft. below the surface. There would be two generating stations, one at each end of the line.

Mr. RIGG: What has been your experience of electricity as a motive power on the City and South London line?

The WITNESS: At first, soon after the opening, we had a good deal of trouble with the motors, but now that is entirely overcome and the working of the line is exceedingly smooth, and certainly much more so, I think, than that of any other suburban railway coming into London. There is hardly any delay, and there has never been any trouble at all at the generating station in connection with the supplying of power to the trains.

Do you find that, using electricity as the motive-power, you can run a number of light trains at very short intervals?—Yes. One great advantage is that you can run your trains at very short intervals with no great addition to the expense. For instance, last half-year the trains ran 26,000 miles more than they did in the previous corresponding half-year and carried half a million more passengers, but the working expenses were not increased at all.

In response to further questions, the WITNESS said that the average speed on the new line would be 14 miles an hour, including stoppages, the whole journey from the City to Islington being done in about eight minutes, while from Lombard-street to London Bridge would occupy two minutes. Access to the stations would be by means of lifts and stairs, and the total cost of the railway, including land and contingencies, but exclusive of equipment, would be £706,633.

The WITNESS was cross-examined by various learned counsel as to possible damage to property of the clients whom they represented, but said there was nothing which could not be covered by protective clauses.

Mr. PEMBROKE STEPHENS, in reply to the Chairman, said they were prepared to call witnesses who wished to have the travelling benefits which the line would give, but

The CHAIRMAN said it was self-evident that there were a great many people to be carried in the direction in which the line went, and the Committee would not require any evidence on that point. He understood that since the matters were under consideration last June the financial position of the Company had very greatly improved.

Mr. PEMBROKE STEPHENS said he believed the debentures were fully-paid, the Preference Shares fully-paid, and that there was a certain modicum of return to the original shareholders.

The CHAIRMAN said that a great deal was made in regard to the new lines last June, that the whole scheme was an utterly impossible one as regarded any financial success; but he took it that that had been settled now. The Committee were satisfied on that point.

Mr. PEMBROKE STEPHENS said that if the Committee were satisfied as to the traffic and finance, as he had given them the best engineering evidence, he would close the case for the promoters. The preamble was practically unopposed, as regarded both Bills.

The CHAIRMAN declared the preambles of both Bills proved, and adjourned the consideration of clauses till Wednesday.

At the sitting of the Committee on Wednesday it was stated that clauses had been agreed to between the City Corporation and the promotors, and the Committee subsequently adjusted clauses for the protection of the Orphan Working School and other petitioners.

The City Lighting.—Some of the City arc lamps were recently extinguished by a short-circuit brought about in a somewhat curious way. One of the night stokers inadvertently tipped hot ashes over a conduit, and melted the insulation at this spot.

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LEGAL INTELLIGENCE.

Unauthorised Telephone Poles.

At Glasgow last week Sheriff Murray had before him a petition at the instance of the Glasgow Police Commissioners against Mr. A. Erskine Muirhead, Cart Forge, Crossmyloof, in which the Commissioners craved that the defender be interdicted from erecting or continuing to erect in Norfolk Lane and Abbotsford Lane telephone poles and wires thereon, or in connection therewith, until he first obtained the permission of the pursuers to do so, and that the defender be ordained to remove any such poles and wires, or part thereof, that he may have already erected without permission, and, failing his doing so, that the Commissioners be authorised to remove these at the expense of the defender. The pursuers averred that the public streets of the city were vested in them, that Norfolk-lane and Abbotsford-lane were public streets, that within the last few days the defender had commenced to erect poles in these lanes, that the poles were 25ft. high, 3½in. in diameter at their base, were fixed to the adjoining walls, and that the wires, when attached, would run over the public streets, and that they had never authorised or permitted their erection. They further averred that in October, 1890, the defender applied to them for permission to erect telephone poles in Abbotsford-lane, and was refused, and that he had now, in disregard and defiance of their decision, commenced to erect the poles and wires in question.

Mr. JOHN LINDSAY, assistant Clerk of Police, asked his Lordship to continue the interim interdict he had granted on Saturday last.

Mr. MUIRHEAD explained that having got the consent of the private owners in the lanes he did not think it necessary to apply to the Police Commissioners for authority, and he referred to certain lanes in the west end where he had erected similar poles without further authority than that of the private owners. He explained, too, that since the interdict had been served he had applied to the pursuers for the necessary authority.

Mr. LINDLEY, in reply, pointed out that the west-end lanes referred to by the defender were private streets, whereas the lanes in question were public streets, and that, therefore, there were more than the private owners to consult.

The SHERIFF continued the interim interdict already granted till further orders, reserving all pleas.

Challis v. Woodhouse and Rawson United (Limited.)

This was an action brought in the Lord's Mayor's Court on Tuesday, before the Recorder and a common Jury, by Mr. C. E. Challis to recover £50, two years' royalties payable in respect of a certain patented invention licensed to the defendant company. The plaintiff was the joint patentee of a certain invention for electric switches, which by an agreement of June 20th, 1890, he licensed to the defendants in consideration of an alleged minimum payment of £25. He claimed two years' royalties under this agreement, and a letter was put in in which the defendants offered £25 in settlement. Ultimately it was agreed that a verdict should be returned for the plaintiff for the amount claimed, leave being given to apply for a new trial, which it was understood would be granted.

Thomas Connolly v. The International Okonite Company (Limited).

An action was brought last week by Mr. T. Connolly, late Works Manager of the International Okonite Company (Limited), of Manchester and London, at Manchester, to recover damages for wrongful dismissal, and arrears of salary and expenses. The Company paid into Court the amount of arrears of salary and expenses, but denied all responsibility for wrongful dismissal. The case was brought before Mr. Justice Wills at the Assize Court, and after Mr. Connolly had been put into the box, and came under cross-examination by Mr. Gully, Q.C., M.P. (for the Company), the Judge and jury stopped the case, and gave a verdict for the defendants, with costs, the amount of money paid into Court for arrears of salary and expenses to remain there pending the taxation of costs.

CORRESPONDENCE.

COST OF A STEAM HORSE-POWER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There was an article in *The Electrician*, of January 24th, dealing with the cost of power, in which there were some courteous references to myself for which my thanks are due.

Towards the end of this article you state that "to these figures may be added the annual cost of steam-power according to the independent, but remarkably coincident, estimates of Mr. Swinburne, and of Messrs. Cross and Bevan, namely, £6. 11s. per horse-power per year of 8,760 hours." This estimate is, no doubt, a low one, but I should not greatly dissent from it, if certain conditions favourable to economy of production of steam-power were understood to be assumed. But what I should like to know is, what are the causes of the difference of this estimate and the actual cost shown in the returns of electric lighting stations.

From a table published in *Lightning* and, which, probably, is very well known to electricians, I find that an electrical unit is generated rather more cheaply at Bradford than at any other central station in England. In dealing with the Bradford figures, I discard the cost under the heading "Redemption Fund," and the cost under the heading "Salaries." Further, I discard half the cost under the headings "Repairs and Maintenance" and "Depreciation," because there appear to be included in these items more than is fairly chargeable to cost of power. The result is that at Bradford the cost per unit, mainly attributable to cost of producing power, is 2·1 penny. Now the mechanical value of an electric unit 1⅓ H.P. hours, and if we take the average efficiency of the dynamo at 0 85, then 1·57 effective horse-power hours must correspond to a unit.

Calculating on this basis, it appears that the cost of an effective horse-power per year of 8,760 hours at Bradford is £49, or, say, seven and a-half times the estimate given in your article. This is at a station where the cost per unit is lower than at any other station in England, and where the coal used is, according to Mr. Shoolbred's statement, partly "nuts," costing 8s. to 10s. a ton, and partly slack, costing half as much.

I am really interested in understanding how so great a difference arises. Of course, I suppose it will be said at once that Mr. Swinburne and Messrs. Cross and Bevan estimated the cost for an unvarying load, and the difference is due to the fact that an electric-lighting station works with a varying load. Be it so. No doubt the variation of load is disastrous, but the most careful estimate of the effect of a varying load on the efficiency of engines and boilers leads me to think that this cause alone ought not to be so disastrous as to explain more than a third of the difference between the estimate and the Bradford result.

However this may be, I think the cost, looked at in this way, is instructive, even if necessarily the method of calculation is open to some criticism. I add some other figures obtained in the same way.

—	Cost per unit (pence).	Cost per effective H.P. per annum (pounds).
Bradford, 1891	2·10	48·76
St. James's, 1892	2·60	60·37
Kensington, 1892	2·90	67·34
Westminster, 1892	3·49	81·04
Chelsea, 1892	4·07	94·50
Metropolitan, 1891	4·35	101·01
Eastbourne, 1891	5·51	127·94

—Yours, &c., W. C. UNWIN.

P.S.—It occurs to me to take the cost of coal and petty stores only, which I suppose must be exclusively charged to production of power. Proceeding so, the following is the cost per horse-power per annum, exclusive of all charges for labour, for repairs, for interest, or for depreciation :—

Cost per horse-power per annum for coal and petty stores only.

—	Cost per unit (pence).	Cost per effective H.P. per annum (pounds).
Bradford	0·63	14·6
St. James's	1·06	24·6
Kensington	1·11	25·8
Westminster	1·29	30·0
Chelsea	2·93	68·0
Metropolitan	2·55	59·0
Eastbourne	2·40	56·0

SINGLE-PHASE ALTERNATING MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to an article appearing in your valuable journal on "Non-synchronous Motors for Ordinary Alternating Currents," by C. E. L. Brown.

I beg to state that motors of the kind he describes were not unknown to the art, as a reference to my United States patent

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No. 407,844, filed November 17, 1888, will show. In fact, I sent to the Paris Exposition of 1889 a small single-phase alternating-current motor with arrangements for starting, which motor was built in accordance with the principle pointed out by Mr. Brown as arising from his own observations. Not long after I made my experiments which led to the transformer motors, I found that such a motor could have its armature coils kept on short circuit and run in either direction after a start had been given to it. The original motor had a single inducing or field circuit, and an armature with three coils and a commutator similar to that of a Thomson-Houston arc machine, and connected, movable, straddling brushes, whereby the period of short-circuiting of the armature coils could be increased, after starting, to include the whole period, and maintain them on closed circuit.

This was followed by the construction and working of many such machines, with different arrangements of winding and means for starting. I have no hesitation in saying that had it not been for the comparatively high frequency of alternating currents in use, namely, 125 to 130 per second, a large extension of the use of such motors would have taken place by this time in the United States.

The motor on this principle, which was exhibited at Paris in 1889, was described in a number of the technical journals at the time. It had a commutator which was only used in starting. The rotating part had its coils connected with the commutator, and the brushes at starting were included in the alternating-current circuit driving the machine in series with the inducing field. At a fairly good speed a centrifugal device inside the commutator short-circuited the segments and placed the revolving coils thereby on a maintained short circuit, and the motor at once speeded up to nearly synchronism. Even at 125 periodicity the motor was efficient, the only drawback being that its weight output was less than could have been obtained with lower frequency. The principle of such single-phase motors may be illustrated very prettily as follows:—Let a coil with iron wire core be energised by alternating currents so as to produce an alternating field, and let a wheel be made up of iron discs at the centre, around which is a rim or band of copper overhanging the edges of the discs. This wheel is mounted on pivots and started in rotation mechanically in either direction. After this it will increase in speed and torque up to a certain point, depending on the frequency of the currents in the coil and the friction to be overcome. That the direction of motion is indifferent may be shown by turning the wheel on a vertical axis so as to present to the pole the opposite end of a diameter. The rotative action I have formerly described as being due to translation lag—that is a lag due to the traverse of a conductor conveying current past the pole, whereby the action of the current in that conductor becomes displaced in the direction of motion, and produces a moving field, the iron mass or body tending to accommodate itself to the direction of the lines in the moving field.—Yours, &c., ELIHU THOMSON.

AMERICAN INSTITUTE DEFINITIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your editorial notes on page 377 of your current volume, dated February 3rd, you point out that the definition of "impressed electromotive force" suggested by the sub-committee on programme for the Chicago Congress, appointed by the American Institute of Electrical Engineers, is not well worded. Will you kindly permit me, as a member of that committee, to defend this definition against your criticism?

Your argument as to a flaw in the accuracy of the definition may presumably be expressed as follows:—If the impressed E.M.F. in a simple circuit containing both inductance and resistance is "the ratio of the total activity to the instantaneous value of the current," this ratio should become zero the moment that the impressed E.M.F. is made to vanish. But we know that the current does not then immediately vanish, and as the existence of that current implies the expenditure of work, therefore the activity, contrary to the definition, is not zero. Our word "total," however, is intended to include the electromagnetic as well as the galvanic activity. In this sense I think you will admit that the definition is true. For if the impressed E.M.F. be denoted by e,

$$e = cr + l\dot{c}$$

$$\therefore ec = c^2 r + lc\dot{c}$$

In the latter equation the left hand member ec is, of course, the instantaneous activity in the circuit, positive when e and c are of like sign, and negative in the opposite event. But if, with c finite, e is suddenly made to vanish $c^2 r = -lc\dot{c}$, and $\dot{c}$ must have contrary sign to c. As you have stated it, the dying magnetism sustains the current; but that dying magnetism is a loss of energy to the circuit, and as such a negative activity, equal and opposite to the activity always positive in $c^2 r$.

Or regarded from a slightly shifted standpoint, if we could envelop the whole circuit with a shell of material perfectly impervious to heat at the instant the E.M.F. was withdrawn, the energy then in the circuit would remain unaltered. For the magnetic energy existing as vortical motion, stress, or in some other manner, through the environing medium, would, we know, be withdrawn, and would exist thereafter as molecular activity in virtue of an exalted temperature of the conductor or medium. The spin motion would become oscillatory motion. Since the space within the shell as a whole would neither gain nor lose energy, its total activity at any moment must be zero.

While you may, perhaps, replace our definition by some alternative more clear or desirable, I would submit that you will not, in so doing, take one that is more nearly true. The alternative you allude to applies to voltage in general, rather than to impressed voltage.—Yours &c.,

Orange, N.J., March 2, 1893. A. E. KENNELLY.

[The distinction consists merely in the meaning of the word activity. If the activity of the source means the rate at which it supplies energy to the circuit, the definition is quite accurate —ED. *E.*]

AMBERLEY ROAD STATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the article on the above in your last issue, we regret that the writer should have thought fit to charge us with supplying so-called "cheap German instruments" without knowing the facts of the case. The instruments mentioned were supplied with the full approval of the engineer of the Metropolitan Company under a very sufficient guarantee from the makers, Messrs. Hartmann and Braun, for their correctness.

The reason that the alternators were not made at our works was, that at the time the contract was placed with us (now more than four years ago) we were not equipped for building such large machines, and as we were exceptionally busy, and hurried delivery was required under heavy penalties, we were forced to place the order with our licencees in Switzerland. We need hardly say that since then we have set ourselves out for building machines of any size on the shortest notice.

In describing the means used for obviating the "hum," we would mention that the wood filling was placed between the pole-pieces of the field-magnets, and not between the armature-coils, as stated.—Yours, &c., JOHNSON & PHILLIPS,
Contractors for the Plant.

Old Charlton, Kent, March 14, 1893.

[We find nothing material to modify in the remarks in the article referred to. The instruments were, no doubt, "supplied with the full approval of the engineer," but, in thus approving, he obviously expected something better than the quality which was supplied. The instruments having been fully guaranteed, it does not appear that Messrs. Johnson and Phillips have any responsibility in the matter. It has been suggested that the serious errors were due to an erroneous adjustment for frequency, but this had been clearly specified in ordering the instruments. Allowance should always be made for little hitches or mishaps on the opening day, but at Amberley-road nothing of the kind was to be seen, and the performance of these instruments certainly cannot be called a mishap when any English instrument-maker of repute could supply instruments from stock not only guaranteed, but actually reading to one-half per cent. We willingly withdraw the word "cheap" if it can be construed to reflect upon the contractors.—Ed. *E.*]

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DOUBLE-BRONZE WIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 3rd inst. we read the following:—"A new kind of telephone wire is being experimented with in Germany, consisting of an aluminium-bronze core with a copper-bronze envelope. It is said to have a low resistance, and to have great tensile strength."

The material to which reference is made in these lines is the patent double-bronze wire which we manufacture, and possibly it may interest your readers to learn something more about this wire. Besides the advantages mentioned in the above notice, it possesses the property of a quite extraordinary toughness. The wire stands a considerably larger number of bends than any bronze wire in existence, which, as every user of telegraph and telephone wires will know, is especially important in the work of erecting lines.

We make patent double-bronze wire to the following specifications:—

Gauge of wire (standard gauge).	Guaranteed		
	Breaking strain (lbs.).	Maximum electrical resistance (ohms per mile, at 60°F).	Bends of 180° over 5mm. radius alternate.
11	857	4·43	8 to 10
12	691	5·55	8 to 10
13	549	7·03	8 to 10
14	382	9·37	10 to 13
15	364	17·20	15 to 20
16	311	21·70	15 to 20
17	238	28·60	15 to 20
18	174	38·70	15 to 20
19	121	55·50	15 to 28
20	100	69·60	15 to 20

The above figures being guaranteed, the tests in reality will be found still more favourable.—Yours, &c.,

FELTEN AND GUILLEAUME.

Mülheim-on-the-Rhine, March 14, 1893.

THE HEILMANN ELECTRIC LOCOMOTIVE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On page 503 of your issue of March 3rd there is a note headed "The Heilmann Electric Locomotive," into which an error has crept. As a matter of fact, the locomotive which I am constructing, and which is shortly to be tried on the State railways, is not worked off accumulators. It comprises, as you say, a Lentz boiler, a Brown steam-engine, and a dynamo-generator; but the current produced actuates directly the electric motors keyed to the axles. The axles are four in number per bogie, and the entire locomotive is mounted on two exactly similar bogies. The generator is a 600 H.P. machine. The Northern Railway Company proposes to experiment with an accumulator locomotive, but I repeat that there is nothing similar in the two schemes. I am ready to give you any further particulars that you may wish.—Yours, &c.,

R. SCHMID.

Traction Électrique (Système J. J. Heilmann),
30, Rue de Grammont, Paris, March 15, 1893.

"THAT BLESSED WORD, 'INSTALLATION'!"

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Selby-Bigge's reply is an intellectual treat that I have much enjoyed, and I regret that for want of time I am prevented from improving my mind by taking further part in a discussion with one so well versed in dialectics; but I must point out that the word which Mr. Bigge says is "happily not in general use" has long since been appropriated by bishops, priests, and others, in reference to whom it is very commonly employed in accounts of *the act of setting on a seat and giving possession of an office, rank, or order, with the customary ceremonies.*

In these circumstances ordinary folk should be content with some shorter, but none the less comprehensive, word, the use of which would, in my opinion, undoubtedly lead to a precision of statement now sadly wanting in most of the installationistical documents I have seen. If Mr. Bigge will send to me privately one of the numerous agreements he alludes to, I will turn it into bad English and return it to him.—Yours, &c.,

WM. H. MASSEY.

Twyford R.S.O., Berks, March 12, 1893.

[Mr. Massey might try his hand at editing our Trade Notes. To exclude the word "installation" from our editorial columns is not difficult, but we have long since given up any attempt to repress it in "Trade Notes."—Ed. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This useful book contains over 1,000 pages, and several new and handy features have been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. Comparison with any similar electrical publication is specially invited.

TENDERS INVITED.—The Corporation of Huddersfield invite tenders for the electric wiring and fittings required for lighting a portion of their Market Hall by electricity. Specifications, &c., may be obtained from Mr. A. B. Mountain, Borough Electrical Engineer, Gas Works, Huddersfield, to whom tenders must be sent not later than April 1st next. Further particulars are given in our advertisement columns.

——— The date for the opening of tenders for the electric lighting of Santiago, Chili, originally fixed March 1st (see *The Electrician* for November 25, 1892), has been postponed until June 1st.

TENDERS ACCEPTED.—The Southend Town Council have accepted the tender of Messrs. R. E. Crompton and Co. for additional plant in connection with the Southend Pier Tramway, to the amount of £1,988.

——— The Burton-on-Trent Corporation have accepted the tender of Mr. H. Slater, of Ashby, for the erection of buildings for the central electric lighting station, at Wetmore-road, for the sum of £2,715. 2s., and that of Messrs. Hill and Smith, of Brierley Hill, for the construction of wrought-iron roofs for the central station, at £820. 19s. 5d.

RE MESSRS. F. SILVESTER AND CO.—The statement of affairs in this bankruptcy is published, and shows total liabilities of £3,869. 3s. 1d., assets estimated to produce £1,516. 9s. 9d., leaving a total deficiency of £2,352. 13s. 4d. The debtor ascribes his failure to bad trade and debts. The firm consists of Mr. Frederick Silvester, who purchased the business and stock-in-trade of the Castle Hill Foundry, Newcastle-under-Lyme, in 1884, and the loss of business appears to have arisen during the past three years. Included in the statement made by the bankrupt is the cost incurred in starting new electrical engineering, &c., business, viz., £500. There are 122 creditors.

BANKRUPTCY.—Edward James Bayly, electrical engineer, of 2, Selborne-street, Liverpool, has been adjudicated a bankrupt. ——Proofs of debts in the bankruptcy of Montagu J. Scott, trading as Montagu J. Scott and Co., electrical engineers, 11, South Molton-street, and 134, Regent-street, must be sent in to Mr. E. L. Bennett, 55 and 56, Bishopsgate-street, E.C., by March 28th.

TELEGRAPH MANUFACTURING COMPANY (LIMITED).—This Company, coincident with the completion of an enlargement of their cable department, and more particularly of their rubber plant, are issuing new editions of their copyright price lists of electric light cables, wires, mains, and flexibles, suitable for house, ship, under-underground, and aerial circuits. These lists are issued for office use, and also in pocket form, at a nominal charge of 1s. 6d. In all 1,371 varieties of insulated conductors are described and priced, the lists containing a specification, the resistance of the conductor, the current-carrying capacity at 1,000 amperes per square inch for a loss of one volt per 100 yards, and for a rise in temperature of 18°F. in casing, the thickness of insulation and the minimum guaranteed megohm per mile after 24 hours immersion in water

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at 60°F. and one minute's electrification for vulcanised rubber cables and wires, the finished diameter, and the weight per 100 yards. There are 22 sizes of cables, each with 20 varities of insulation and finish, the same number of wires with 16 varieties of each, 22 sizes of twin and concentric flexibles for currents of from 0·43 to 50 amperes, with 20 varieties of each; also mains up to 1 square inch section for 1,000 volts, and concentric mains up to 37/14s. for 2,500 volts. In addition prices are given of cables and wires for concentric wiring. Perhaps the most noticeable feature of the lists is the ease with which prices can be found and compared with others, as the costs of different qualities of insulation for any conductor are given all in one line. Contractors will find the pocket lists useful, all the above information being given on a mounted sheet, which, when enclosed in its case, measures only 6¾in. × 3⅛in. × 3-16in., and yet the sizes of conductors and the prices are printed in type of a very prominent character.

Messrs. Rashleigh Phipps and Co.—This firm have secured contracts for lighting the following premises:—The Scottish Metropolitan Life Insurance Society, King-street, Cheapside: Messrs. Hudson Bros' Stores, Devonshire-square; Mr. J. L. Langman's house, Stanhope-terrace; Messrs. Kirkman and Sons', piano manufacturers, new premises, George-street, Hanover-square; The Pure Bread Company, Queen Victoria-street; and Dr. F. W. Andrews' new house, Welbeck-street; all of London.

The K.M.B. Portable Testing Set.—The testing set illustrated below has been specially designed by Messrs. King, Mendham and Co., of Bristol and London, for testing insulation resistances by the direct deflection method. The galvanometer, which has a 4in. silvered dial, is provided with a suspended needle; a series of shunts $\frac{1}{9}$ and $\frac{1}{99}$ is connected across the galvanometer, and terminals are provided for the battery connections and also for the insulation of cable and earth or return. The necessary contacts for testing are made by means of a spring held midway between two brass blocks with platinum points.

One block is connected with a 10,000-ohm coil which is provided for the purpose of taking the galvanometer reading with a known resistance; the remaining block is connected with the "insulation" terminal. By holding this spring against one block or the other, the two required readings can be taken. By this arrangement loose plugs are avoided and lists are quickly made; connections are engraved on the ebonite top, and printed instructions are inserted inside the cover of the box.

Mr. Guy C. Fricker.—The whole of the electric lighting arrangements for the forthcoming exhibition at Earl's Court have been entrusted to Mr. Fricker, who is also engaged in laying down a complete plant of gas-engines, dynamos, and accumulators, for the new offices and printing plants, of Messrs. Kelly and Co., at High Holborn, the installation being for about 400 lamps. Amongst recent plants completed by Mr. Fricker, is one for Messrs. Colls and Sons, at Lime Street-square, for 200 lights.

A Reservoir Drawing-Pen.—Messrs. Jackson Brothers, of Leeds, have brought out a drawing-pen with an ink reservoir in the handle. They have submitted a sample, and we have given it a trial. A cylinder, fitting in the handle, may be filled with ink. by pulling out a plunger. A slight push to the plunger serves to feed the pen with ink. The pen is necessarily larger and heavier than an ordinary one, and feels rather clumsy in the hand. The back nib in the sample which has been sent us is too springy, but this could easily be remedied. The reservoir arrangement works well, and is easily managed. The pen will doubtless be useful for some kinds of work, especially where heavy lines are wanted, and where an ordinary pen will only run a few inches without re-dipping and wiping.

Oil Engines.—We have received from Messrs. Robert Stephenson and Co. (Limited) a circular relating to the "Rocket" oil-engine, for which simplicity, ease and certainty in starting, and economy in working are specially claimed.

Dee Oil Company (Limited).—At Wednesday's sitting of the London Bankruptcy Court Mr. Registrar Emden presided at an inquiry into the promotion, business operations, and failure of the Dee Oil Company (Limited), which was promoted in May, 1888. The winding-up order was made in April, 1891, upon a creditor's petition. The accounts filed thereunder show total liabilities £58,410. 14s. 7d., of which £3,768. 10s. 2d. are expected to rank. The assets, valued at £51,582. 2s., were entirely absorbed by loans on debenture bonds, and the deficiency as regards contributories was estimated at £103,768. 10s. 2d. Sir John Stokes, one of the original directors, and a former chairman of the Company, Mr. W. F. Orris, the promoter of the Company, and other witnesses having been examined, the inquiry was closed.

Liège.—A concession is offered at Liège by the Administration Communale for the construction and working of a central station in that town for twenty-five years, the town having the option of purchasing the undertaking at certain intermediate periods. At the expiration of the concession the whole of the concern passes into the possession of the town without any payment whatever. Particulars may be obtained of the Administration Communale, Liège, Belgium.

Seel Glow Lamp Co. (Berlin).—The falling off in prices and the competition of the incandescent gas light, have, according to the Directors of this Company, rendered the manufacture of this type of lamp unremunerative, and it has been resolved to liquidate the Company.

Aberdeen.—A motion to instruct the Docks and Pilotage Committee to report as to the propriety of lighting the harbour quays by electricity was discussed at the Harbour Board at its last meeting, but an amendment to the contrary was approved.

Barrow.—The Barrow County Council have referred to a Committee the question of the advisability of applying for an Electric Lighting Provisional Order.

Baths Lighting.—The St. Marylebone Baths Commissioners propose making extensive alterations which will probably include the laying down of an electric-lighting plant.——A proposal to light the public baths of Paddington is also under consideration by the Commissioners.

Bedford.—A proposal has been made to the Sanitary Authority by Mr. F. H. Medhurst, electrical engineer, Cambridge, asking permission to negotiate and settle the terms of the transfer of the Electric Lighting Order to a company to be formed by that gentleman for carrying out the works and obligations of the Order. Mr. Medhurst proposes that the company should refund to the Corporation any sum up to £500, which had been expended in obtaining the Order, and suggests that the high-tension alternating current transformer sub-station system should be adopted. It was proposed to discuss the proposal in a committee of the whole Council, and to call a public meeting on the subject of electric lighting generally.

Belfast.—After reading and discussing the report of Prof. Kennedy, the Belfast Corporation instructed the Town Clerk to write for further information upon certain details of Prof. Kennedy's scheme.

Bideford.—Mr. Coham, of St. Austell, Cornwall, is engaged in preparing plans and estimates for lighting the centre of the principal establishments in the town of Bideford, including the Royal Hotel.

Blackpool.—A resolution of the Electric Lighting and Tramways Committee of the Town Council that the charge for electrical energy for incandescent and alternate-current arc lights shall be fixed at 6d. per unit, subject to discounts varying from 5 to 25 per cent., and that the rentals for meters, transformers, and other apparatus provided by the Corporation shall be fixed at from 7s. 6d. to £1. 5s. per quarter for installations of from 1 to 25 c.p. lamps to 300 8 c.p., and for larger installations by special arrangement, was, owing to the absence of the Chairman or the Committee, sent back for reconsideration, it being the opinion of several members of the Board that the discounts allowed to large consumers was too great.

Bowness and Windermere.—It has now been finally decided by the Local Boards of Bowness and Windermere to adopt the electric lighting scheme, about which there has been some friction between the two local bodies. A clause has been added to the agreement, that if either of the Boards decline to enter into the arrangement for purchase the other Board should be at liberty to negotiate alone.

Braintree.—A discussion upon the subject of providing steam-power for the purposes of electric lighting at the last meeting of the Local Board, was summarily cut short by the Chairman stating that

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the town was not likely to go in for electric lighting just at present, and that, therefore, he did not feel particularly interested in the matter. A little healthy agitation on the subject evidently would not be out of place in this district, several members of the Board being in favour of the adoption of the electric light.

BUCKINGHAM.—The tender of Messrs. Parr and Gillies for supplying bracket lamps and lighting the entrances to the Town Hall and Post Office at 25s. per lamp per annum has been accepted ; this charge to include renewals.

CARDIFF.—The *South Wales Daily News* of the 9th inst. contains an account of an interview with Mr. W. H. Massey on the subject of the utilisation of water-power for the Cardiff lighting scheme.

CHESTERFIELD.—An expert is to be engaged to advise the Electric Lighting Committee on the subject of lighting the town by electricity.

CHURCH LIGHTING.—The first church to be lighted by electricity at Glasgow is Free St. Paul's. Lamps varying in candle-power from 16 to 200 are used. In the pulpit a switch is placed, so that the minister can turn on the pulpit lamps when required. The work is being carried out by Messrs. A. MacLellan and Co.

DERBY.—Some months since it was determined by the Directors of the Midland Railway Company that the electric light should be established in the new offices which were at that time being built for the engineer of the line and the general manager's department, as also in all other offices where clerks were required to work late at night. The main object of the Directors was to secure hygienic advantages for the large staff employed at Derby. Every effort was made to bring the lighting into operation shortly after the autumn of last year, but it has only recently been started. The lighting authorised consists of about 2,000 16-c.p. lamps, distributed through what may be called the station offices proper, the engineer's department, accountant's, goods offices, and mineral offices. It is also intended to light the Railway Literary Institute, a building now under construction, and which is to take the place of the old Literary Institute, absorbed in other alterations now being carried out. As even this amount of lighting does not light the whole of the Company's offices, an extension of about 1,500 lights will ultimately be required. Some difficulty has been found in selecting a suitable site for the generating station, the area over which the lighting had to be carried being of a rather widely extended character. A site has been selected some short distance from the Derby Station itself, fairly situated for reaching the many outlying points required to be served, and from which a network of cables has been laid with ample flush-box accommodation. Cables are carried direct to the distribution board in the engine house, so that there are but very few, if any, joints throughout the system. The "three-wire" system of distribution is employed, but arrangements are made for forming this into the ordinary two-wire parallel system during light loads, when one engine and dynamo is sufficient. The generating station is a well-arranged building, with boiler house, engine and dynamo room, office, store room, and workshop. The two boilers at present laid down are of the locomotive type ; the engines are supplied by Messrs. Willans and Robinson, coupled to Siemens (simple shunt) dynamos (two of 500 amperes at 120 volts, and one of 275 amperes), the latter being for the light loads, the two others for the heavier loads. A special switch has been designed by Mr. Sayers, a member of Mr. Langton's (the Company's telegraph engineer) staff, the object of which is to prevent any inconvenience in turning over from the two to the three-wire system, or *vice versâ*. The dynamo room possesses a fine switchboard, fitted with special switches, Lord Kelvin's ampere meters, distribution boards, and safety fuses. About 1,000 lights have already been brought into use, and the remainder will follow immediately.

EDINBURGH.—On Tuesday the Edinburgh Town Council decided that the report presented by Prof. Kennedy on the subject of the electric lighting of the district should be printed and distributed. There is little difference in the cost of the various schemes suggested, the estimated amount being about £85,000. Prof. Kennedy discusses the question of low and high-tension in his report, which, we understand, includes recommendations for the adoption of both systems in certain conditions.

FALKIRK.—The Hospital Committee of the Town Council recommend the establishment of telephonic communication between the Burgh buildings and the hospital, and the Council's inspector has been instructed to prepare a report on the subject of lighting the hospital electrically.

FALMOUTH.—A report has recently been presented to the Falmouth Urban Sanitary Authority, recommending the adoption of public electric lighting at an annual cost of not exceeding £650.

FOLKESTONE.—The Town Council will again consider the question of lighting the town by electricity.

GLASGOW.—At a meeting of the Glasgow Lunacy Board last week an important discussion arose on the question of the introduction of the electric light at the Board's Asylum at Gartloch. It was estimated that a total number of 1,300 lights would be required, and Messrs. Mavor and Coulson had supplied the Board with a report upon the subject, estimating that the cost of plant, exclusive of building, would be about £7,000 and the annual expense about £840, and further estimated that a saving of £86 per annum would be effected over this estimate by the use of oil gas. A discussion ensued, and it was finally agreed that the minutes of the Lighting Sub-Committee be taken and schedules issued to electric-lighting and gas-oil companies asking for estimates of plant and working expenses for lighting and heating ; the schedules to be submitted to a subsequent meeting of the Board. There seems every probability that, ultimately, the advantages of the electric light will prevail.

GRIMSBY.—The cost of the electric lighting installation for the new council chamber and banquet room will be about £1,200.

HACKNEY, LONDON, N.E.—The Board of Works for this district have finally decided upon applying to the Board of Trade for a Provisional Order to enable them to supply electric light and power for the district.

HENLEY.—The Electric Lighting Committee of the Town Council have received an offer from Mr. W. H. Massey to provide them gratis with certain information in regard to the electric lighting of the district. Mr. Massey is a resident in the neighbourhood.

HOVE (SUSSEX).—The Town Hall Committee have still under consideration the designs and offers sent in for wiring, fitting, and preparing the Town Hall for lighting by electricity

HYTHE.—The Hythe Tramway has been disposed of, and will be worked by electricity.

KINGSTON.—A public meeting has been held to consider the proposal of the Corporation to spend £16,000 on electric lighting. A motion that the meeting approve of the Corporation's action in the matter was ultimately carried by a very large majority.

LECTURES.—Prof. Fitzgerald lectured last week in Dublin on Tesla's experiments. He took occasion to point out that Ireland stood in need of endowment for scientific research.

LLANGOLLEN.—Mr. Davies, at the last meeting of the Local Board, obtained leave to defer the introduction of the electric light into the town for a month.

OSWESTRY.—A communication from the newly-formed Oswestry Electric Lighting Company (Limited), notifying the Local Board that they were about to apply for a Provisional Order for lighting the district, has been referred to the General Purposes Committee.

PORTRUSH.—At the last meeting of the Town Commissioners a lengthy discussion arose upon the proposal to light the town by electricity, and it was ultimately decided that the Commissioners should subscribe privately the amount required for a survey by a competent engineer, and his estimate as to the probable cost.

RUGBY.—The mansion of Mr. A. H. E. Wood, at Newbold Revell, Rugby, is being equipped with an electric lighting plant of considerable extent, which consists of two Cornish boilers and two combined sets of engines and dynamos of the Parsons steam-turbine type, indicating 50 H.P. and capable of running 500 incandescents, and accumulators estimated to supply 350 16 c.p. lamps. About 560 lamps are included in the installation, from 8 to 50 c.p., making a total of 7,800 c.p. in all. The current is to be supplied to the mansion, stables, laundry, fire-engine house, kennels, swimming bath, gymnasium, racquet court, &c. ; and the machinery in the refrigerator house is to be driven by a 1½ H.P. electric motor. The installation is under the supervision of Mr. A. A. Campbell Swinton, and is on the lines of the plant completed for the Earl of Durham at Lambton Castle.

SOUTHEND.—At the last meeting of the Town Council it was resolved to borrow £4,000 for providing further electrical plant and cars for the Southend Pier.

WESTON-SUPER-MARE.—The result of the correspondence between the Brush Company and the Town Commissioners is that the Commissioners have notified the Company that they are prepared to consider a proposal for the transfer of the Commissioners' Provisional Order to a local company, to be formed by the Brush Company ; but any proposition for payment for goodwill on the expiration of the term fixed will not be entertained.

YARMOUTH.—A proposal of the Electric Lighting Committee adopting a scheme which it is estimated will entail an expense of £15,000, came up for discussion at the last meeting of the Town Council, and was agreed to. Mr. Preece is to be asked to accept the position of consulting engineer under the scheme, and the authorities are applying to the Local Government Board for a loan of £15,000.

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COMPANIES' MEETINGS & REPORTS.

Birmingham Electric Supply Company (Limited).

The third annual meeting of the Birmingham Electric Supply Company (Limited) was held on Thursday at the offices, Dale End, Birmingham, Mr. H. Buckley in the chair.

The CHAIRMAN, in moving the adoption of the annual report (which appeared in *The Electrician* of March 3rd), said that the Company had made slow but steady and satisfactory progress. The number of lamps supplied at the close of 1891 was 5,480, and at the close of 1892 the number was 8,329, the average for the whole of last year having been 6,830, as compared with 3,135 for the nine months preceding. The number of consumers increased during last year from 133 to 223, and was still increasing. It was satisfactory to note the increasing demand for the arc light, showing that consumers were fully alive to the fact that no light was more economical, not even the city gas. The Company's cost of production compared favourably with that of any other company in England, but it was a matter of regret that in contracts for fittings the margin of profit was so small. Last year the profit under that head amounted to £260. In the majority of cases the Company could not attempt to do work at the prices at which other contractors under the pressure of competition were prepared to it. Since the last annual meeting they had issued the whole of the remaining share capital, and the Company was now in the satisfactory position of having its entire share capital placed, and being entirely unfettered by Preference shares or debentures, a state of affairs that was rather unusual with electric supply companies in the United Kingdom. The Directors proposed to add to the depreciation reserve fund £1,279, bringing that fund to £1,636. This was considered ample for the time the Company had been in existence. Before recommending the payment of a dividend, the Directors thought it wise, in view of the existence on the other side of the balance-sheet of the item of £1,685 preliminary expenses, that something should be done towards creating a general reserve fund. They therefore proposed to carry £250 of the year's profits to that fund, and to declare a dividend of 3½ per cent. This dividend, he thought, would be considered satisfactory by the shareholders, considering the time the Company had been at work. It was rather astonishing to him that some of their large banks and other establishments had not yet adopted the light, to the advantages of which the proprietors seemed to be fully alive. The chairman of one of the largest banks in Birmingham remarked that he did not hesitate to say that the entire cost of the change would be saved to the bank in the improved health of the staff. In reference to the proposed extension to Edgbaston and the jewellers' quarter, the Company had been treated, as it always had been, with the greatest courtesy by the Corporation, but in view of the attitude of the Committee to which the matter was referred, they had abandoned the intention to apply for increased powers this session. The Company, however, would bring the matter forward again as soon as possible, and would press its claim upon the Corporation, unless the Coporation decided to supply those districts itself.

Mr. C. A. HARRISON seconded the motion, which was carried unanimously.

The retiring Directors (Messrs. G. S. Albright and Mitchell) and the auditors (Messrs. Sharp, Parsons, and Co.) having been re-elected, the meeting closed in the usual manner.

City of Bath Electric Lighting and Engineering Company (Limited).

The second annual meeting of the shareholders of this Company was held at the works in Dorchester-street, on Saturday, Mr. Emile Garcke, Chairman of the Company, presiding.

The annual report of the Directors, which was taken as read, was as follows:—

"The business of the Company has steadily increased during the past year, the number of lamps now connected being 6,420, as against about 5,000 at the end of 1891, and the receipts from current sold to private consumers have amounted to £2,129. 14s. 4d., as compared with £1,295. 13s. 7d. for the previous year. Notwithstanding, however, this large increase in the amount of current sold, the result shown by the profit and loss account is a loss of £300. This unsatisfactory result is due to a large number of the consumers still being charged on the rental system instead of by meters, so that the all-day supply which the Company is now giving has led to an increased expenditure, which is out of all proportion to the increase of revenue. The rental system was introduced before the Company took over the business, and before the all-day supply was given. The Directors are now, however, terminating these arrangements as quickly as is practicable, and they firmly believe that the customers as well as the Company will benefit by the adoption of meters. Some of the customers, who have already adopted meters, have, as a result of greater economony in the use of the light reduced their bills below the former contract amounts. This is an advantage to the Company, because it is better that the customers should consume less current and pay for all they have than that they should unnecessarily consume a larger amount of light for which, under the rental system, the Company is not paid. The electrical and other plant of the Company has been kept in thorough repair and perfect working order, and the several improvements affected in the station during the year have placed the Company in a satisfactory position for dealing with the increased demand for light. The Directors have during the year issued £800 debentures bearing interest at the rate of 4½ per cent., part of the total issue of £3,000. The Directors have in view of the loss waived their fees for the past year. The auditor retires and offers himself for re-election."

The CHAIRMAN referred to the retirement of Colonel Vaughton from the chair and to the many services he had rendered to the Company. He commented with satisfaction on the large increase in the receipts of the Company compared with the previous year, and pointed out that the loss referred to in the accounts had been caused by the unlimited use of the current by those who still had it on the rental system. The meter system, however, which they were introducing, tended to induce the customer to economise, and would greatly improve matters. With regard to the balance-sheet, they had expended £4,838. 17s. 2d. on increasing the mains and apparatus, a general extension of the system enabling them to supply a larger number of customers. This expenditure had been met by raising a mortgage on the premises, and by issuing some debentures at a moderate rate of interest to the extent of £3,800. He did not think the balance-sheet called for any other comment on his part, but he would be happy to give any information that was required. He pointed out that in view of the loss in question the Directors had declined to take any fees. For two and a-half years the Directors had taken no remuneration whatever, and they had also enjoyed the time and services of Mr. Massingham, the Managing Director, without any remuneration other than what he obtained as a shareholder. The plant, the mains, and the apparatus by which they carried on their business generally, were in a very satisfactory condition. They had taken pains during the year, not only to maintain the efficiency of the entire system, but they had spent some money in addition to the figures appearing in the capital account on the ordinary working of the business which was fairly chargeable to the capital account, or rather to the maintenance of the plant. He had also to inform them that the plant had not only been ample for the present lighting requirements, but left them a very satisfactory margin for extensions, and they were thus prepared to carry on a much larger business than they did at present without very materially increasing the capital account. He concluded by formally moving the adoption of the report of the Directors and the accounts.

Mr. GARRETT seconded the motion, which was carried after a short discussion, and the auditor having been re-elected, the meeting terminated.

Scarborough Electric Supply Company (Limited).

The first statutory meeting of the shareholders of this Company was held on Friday at the offices, 102, Westborough, Scarborough, Lieut.-Colonel R. F. Steble presiding.

The CHAIRMAN said that the meeting was a formal one, being the statutory meeting they were obliged to hold within four months from the date of the registration of the Company, and he did not intend to do more than explain what had been already done in connection with the formation of the Company and the construction of the works. In the first instance the Corporation had the power to bring electric light into the town, but they came to the conclusion that it would be wiser to let a private company introduce it and supply it for a term of years, as they (the Corporation) would have the power to purchase at the expiration of that time. A concession was thereupon granted to Mr. Campbell Swinton, and he set about at once to form a Company to carry out the order he had obtained from the Board of Trade. The Company was formed with a nominal capital of £50,000, and the Directors then ascertained what the cost of starting the works would be. It was estimated that they would entail an expenditure of £20,000, and they then determined to make an issue of shares up to £20,000. They had not the slightest difficulty in realising that sum of money, and he was now going to make a suggestion, with which, he believed, the other Directors would agree, that they should increase the capital still further, not for the purpose of calling it up all at once, but in order to relieve those who had already subscribed, and to enable them to extend the works without going cap in hand for the money, and paying an enormous price for it. The Chairman then referred to the central station in course of erection, which could be extended to provide 100,000 lights, if necessary, and said that he looked with great hope on the prospects of the Company.

Mr. A. A. CAMPBELL SWINTON (the Managing Director and Consulting Engineer) reported that the generating plant that had been ordered would consist of two independent sets of engine and dynamo each set being of about 200 H.P., and capable of supplying 150 electrica units. The engines are of the Parsons steam turbine type, and drive the dynamos direct at a speed of about 5,000 revolutions per minute, or about 80 per second. Steam would be supplied to the engines at 120lb. steam-pressure by two Lancashire boilers, each 28ft. long by 7ft. 6in. in diameter The supply station would be furnished with the usual complement of subsidiary machinery, consisting of two feed-pumps, travelling over head crane, switching apparatus, measuring and regulating apparatus &c., all of a very complete description. The capacity of the machinery now arranged for and ordered is 300 units, or about 400 H.P. sufficient to supply about 7,000 lamps ; the buildings are, however, being built with a view to ultimate requirements. It was proposed, in the first instance, to lay down about 4½ miles of mains, which would cover the chief business and residential quarters of the town and thereafter extensions can be made as the demand arises. The mains will consist of highly-insulated cables drawn into cast-iron pipes, and laid under the footways, with junction boxes about every 50 yards. Referring to Newcastle-on-Tyne and Cambridge, where similar machinery, &c., are used as proposed at Scarborough, he pointed out that at the latter place the Company was making a good profit, and the former paid last year a 5 per cent. dividend, and this year 5½ per cent. The Company have power to charge 7d. per unit, which is equivalent to a farthing per hour for an 8-candle-power lamp. For large consumers, however, it is proposed to make a considerable rebate, amounting to 25 per cent. to those who have a large number of lamps and burn them for long hours.

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The retiring Directors, the ex-Mayor (Lieut.-Colonel Steble), Mr. J. W. Woodall, J.P., and the Mayor (Mr. John Dale) were re-elected, and Mr. C. E. Bradley was appointed auditor.

Mr. F. BRIGHT asked if there was any period specified when the works would be completed.

The CHAIRMAN stated that they expected the works would be completed early in July.

A vote of thanks having been passed to the Chairman, the meeting terminated.

Elmore's Patent Copper Depositing Company (Limited).

An extraordinary general meeting of this Company was held yesterday at the Cannon-street Hotel to consider the steps to be taken with a view to raising additional working capital for the purposes of the Company.

Mr. J. J. ATKINSON, who presided, said that he was pleased to state most positively that the Elmore process was perfectly successful as a manufacturing operation. In corroboration of that he could point to the French Elmore Company's undoubted industrial success, and they were informed that the expert who recently visited the French works on behalf of an influential body of their shareholders had reported to his principals most favourably in regard to the industrial position and prospects of that Company. It was the unanimous declaration of the Directors that the Elmore process was perfectly sound, and could be worked remuneratively. The present capacity of their works was for an output of from 15 to 20 tons per week, and they had a considerable number of orders in hand in course of execution, and would have no difficulty whatever in obtaining orders for steam pipes sufficient to occupy the whole of their plant. The one and only barrier to taking those orders and earning a dividend was the fact that they lacked the necessary working capital. They had experienced the want of an adequate supply of raw copper for many months, and that fact would account for the smallness of their output. The finished output, as taken from the actual working books at Leeds, from June 30, 1892, the date at which the last balance sheet was issued, up to February 25, was 102 tons. The actual manufacturing expenses of that output, exclusive of the administration charges and interest, were £3,396, an average cost of 3·57d. per lb. They had sold in the same period, 50 tons of stuff, 38 tons of which were tubes and ram work, and 12 tons scrap copper. The net invoice value to the customers from the 38 tons was 11·7d. per lb.; and as the gross cost of producing that was 8·5d. per lb., they were left with a profit of 3·2d. per lb. The trading liabilities of the Company were comparatively small and were more than set off by book debts and the raw and manufactured copper in stock. The Directors suggested that the 8,800 shares in hand should be issued as Six per Cent. Preference Shares. The Board also thought that the interests of the Company would be served by the appointment of a strong representative committee who should co-operate with the Board. They believed the £17,200 proposed to be raised by means of Preference Shares would supply all the money required to enable the business to be made a success.

In reply to Mr. Freeman,

Mr. WILLIAM ELMORE said that, although the Chairman of the Company and himself had at different times made various statements, they were prepared to prove the truth of their statements to the Committee of Investigation. The pan licence was still in existence, and would as soon as matters improved be carried out. It was perfectly untrue to say that his sons and himself had made large sums of money out of the Company.

A SHAREHOLDER suggested that a statement should be sent to the shareholders, showing the amount of capital originally subscribed, the amount since obtained on mortgage, and the manner in which those sums had been expended.

Mr. HAYS proposed the appointment of a Committee of seven shareholders to investigate the affairs of the Company and to report to a future meeting.

The motion was seconded and agreed to.

Elmore's Wire Manufacturing Company (Limited).

An extraordinary general meeting of this Company was held yesterday, at the Cannon-street Hotel, to consider the steps to be taken with a view to raising additional capital for the purposes of the Company.

Mr. J. J. ATKINSON presided, and said the shareholders were not asked to bolster up a defeated process, but to take advantage of a complete success. The Company owed £11,000 and interest to its bankers, and there were sundry creditors amounting to £9,000 in all. The subscriptions to the debenture issue had up to the present amounted to only £9,000, but he thought the Company would be able to obtain £20,000 from a financial institution by giving a first charge upon the property, provided the shareholders would subscribe a further £20,000 to be secured by a mortgage debenture ranking immediately after the first-mentioned debenture.

As in the case of the Elmore's Copper Company, it was thought necessary to appoint a Committee of Investigation.

In the course of the discussion which followed a committee was unanimously appointed.

Direct Spanish Telegraph Company (Limited).

The following is the report and accounts of the Directors of this Company for the half-year ended December 31st last, to be presented at the general meeting of shareholders, to be held on Friday, the 24th inst., at Winchester House, E.C., at 12 o'clock :—

The accounts show, after providing for debenture interest, a balance to the credit of profit and loss, of £5,438. 19s. 7d. The traffic receipts show an increase of £30. 14s. 7d. as compared with the corresponding period of 1891. The working expenses are £56. 9s. 9d. in excess of those for the corresponding period of last year.

The Company's cables, and the land-lines in connection with them, have continued in good working order throughout the half-year.

The Directors, with a view to strengthen the good relations existing between the Company and their staff, propose to follow the practice adopted by many companies, in assisting their *employés* to make provision for their old age, or for their representatives after death. Arrangements have been made for taking out endowment policies on which, under certain conditions, the Company pay one-half of the premiums. It is calculated that the amount which the Company can be called upon to contribute will not exceed £250 per annum.

After adding the usual sum of £2,500 to the reserve fund, the balance of profit and loss amounts to £2,938. 19s. 7d. Out of this amount the Directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the Preference shares, and a dividend at the rate of 4 per cent. per annum (free of income-tax) on the Ordinary shares. There will then remain a balance of £442, which will be transferred to the reserve fund in part repayment of the balance of £1,935. 9s. 4d. still remaining due to that fund for the repairs of the Falmouth-Bilbao cable in November, 1891. The reserve fund now amounts to £33,273. 15s. 2d.

Mr. E. Etlinger and Mr. J. Denison Pender are the Directors retiring by rotation, and offer themselves for re-election. The auditor, Mr. Herbert R. Duke, retires, and offers himself for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

AMERICAN RIVER ELECTRIC POWER SUPPLY COMPANY (LIMITED).—This Company was registered on February 28th with a capital of £25,000, in £1 shares, to carry into effect a certain agreement between the American River Syndicate (Limited), William Smith, and Henry Ward, of 6, Queen-street-place, London, E.C., to erect central stations for the generation, production, storage, and supply of electricity, electrical motive power, or similar agency, for lighting, heating, and motive purposes, in California and elsewhere; and to supply or use the same for the production, transmission, or use of power for lighting, heating, signalling, telegraphic, telephonic, and motive or other purposes; and to carry on the business of electricians, electrical, and mechanical engineers, suppliers of electricity and manufacturers of electrical and scientific apparatus. The first Directors are Viscount Grimston, Francis Retallack, Commander Oliver Young, R.N., John Taylor, M.Inst.C.E., and George C. Pearson.

ARIEL COMPANY (LIMITED).—This Company has been registered with a capital of £15,000, divided into 1,000 Preference and 2,000 Ordinary shares of £5 each, to acquire certain patents, patent rights, trade marks, &c., and to carry on the business of electricians, mechanical and electrical engineers, general contractors, manufacturers of engines, machinery, and apparatus, suppliers of electricity, and workers and dealers in electricity for the purposes of locomotion, light, and heat, and any business in which the application of electricity or other power is, or may be, useful, convenient, or ornamental. The subscribers include E. D. Purbright, civil engineer; H. F. Jackson, electrical engineer; F. C. Nunn, civil engineer; and G. Aken, electrician; all with one share each.

ELECTRIC ANTI-CORROSION COMPANY (LIMITED).—This Company has been registered with a capital of £6,000 in £10 shares, to purchase an invention for which a Provisional Protection has been granted, No. 6,105 (1892), a French patent, No. 223,664 (1892), and an Italian patent No. 472 (1892), or any improvements therein, and to enter into and carry into effect an agreement made between John Telfefsen, James Bennett, and Albert C. Woodford (as agent for the Company).

ELECTRIC SEMAPHORE SIGNAL SYNDICATE (LIMITED).—This Company was registered on March 9 with a capital of £3,000 in £1 shares, to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, and manufacturers of, and dealers in, all kinds of electrical and scientific apparatus.

ELECTROLYTIC SEPARATION SYNDICATE (LIMITED).—This Company was registered on the 11th inst. with a capital of £25,000, in £1 shares, to acquire the patent and other rights of Claude T. J. Vautin for and in respect of an invention for "improvements in the method of, and apparatus for, the electrolytical separation of the bases of salts and compounds of the same from saline solutions, and with a view thereto to adopt and carry into effect an agreement to be made between Claude T. J. Vautin of the one part, and James Thame (for the Company) of the other part."

THOMAS HOLT (LIMITED).—Registered with a capital of £10,000, in £5 shares, to carry on business as machinists, mechanical and electrical engineers, tool makers, iron and brass founders, fitters, machinists, &c.

ISLES (LIMITED).—Capital £20,000 in £10 shares, to carry on the business of brass and iron founders, mechanical and electrical engineers, crane makers, at Stanningley, Yorks.

JONES' PATENT STEEL COMPANY (LIMITED).—Capital £10,000 in £5 shares. Metal workers, metallurgists, brass and iron founders, smelters, mechanical and electrical engineers, &c.

R. A. LISTER AND CO. (LIMITED).—This Company was registered on the 13th inst., with a capital of £20,000 in £20 shares, to carry on the business of brass and iron founder and mechanical and electrical engineer, carried on by Robert A. Lister.

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HERCULITE MANUFACTURING COMPANY (LIMITED) (in Liquidation).—A meeting is to be held at 5, Crooked-lane, E.C., on March 27th, at 11, to receive an account of the winding-up.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to March 2nd, has been filed. The nominal capital of the Company is £350,000, divided into 50,000 ordinary, 10,000 First Preference, and 10,000 Second Preference Shares, all of £5 each; 15,000 Ordinary and 10,000 First Preference Shares have been taken up, and the full amount called. The calls paid amount to £100,000, while shares to the value of £25,000 have been issued as fully-paid.

KINGSTON-UPON-HULL ELECTRIC LIGHTING AND SUPPLY COMPANY (LIMITED).—This Company has been dissolved. The Company was registered in June, 1889, with a capital of £1,000 in £1 shares, to carry on the business of an electric light, heat, and power supply company. No capital was ever raised.

LEICESTER ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—This Company has been dissolved. The Company was registered in June, 1889, with a capital of £1,000, in £10 shares, to supply electricity in Leicester and neighbourhood.

MOUNTAIN'S WIRE MANUFACTURING COMPANY (LIMITED).—On the petition of Messrs. Leatham, Few and Co., Mr. Justice Vaughan Williams on Saturday ordered this Company to be wound up.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to February 27, 1893, has been filed. 3,535 shares out of a total capital of £50,000 in £10 shares have been taken up, and a call of £8 per share made. The calls paid amount to £28,040, leaving £240 in arrears.

UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED) (in Liquidation).—A meeting is to be held at A. S. Gedge's, 3, Great James-street, Bedford-row, on April 5th, at 12, to receive an account of the winding-up.

UNITED ELECTRIC SEWAGE AND CHEMICAL SYNDICATE (LIMITED).—The statutory return of this Company, made up to December 19, 1892, has been filed. Out of a capital of £5,000, in £1 shares, 4,757 shares have been taken up, of which 4,750 have been issued as fully paid, £7 being paid on the remaining shares.

WENHAM COMPANY (LIMITED).—The annual return of this Company, made up to December 30, 1892, has been filed. The Company was registered in May, 1888, with a capital of £250,000, in £1 shares, to carry on the business of mechanical, gas, and electrical engineers, &c. In 1889 the Company resolved to reduce its capital to £83,333. 6s. 8d., divided into 250,000 shares of 6s. 8d. each, which reduction was subsequently confirmed. At the time of making up 178,954 shares were taken up, of which 7 were taken by the signatories to the Memorandum of Association, the remainder being issued as fully paid.

WEYBRIDGE ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to January 12th, shows that only seven shares have been taken up out of a capital of £15,000 in £5 shares, no calls having been made.

WOLVERHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to February 15, 1893, discloses the fact that the 23 original signatories are the only shareholders. They took one share each, and have paid the full amount of £10 per share thereon. The nominal capital is £50,000, in £10 shares.

WOOLWICH DISTRICT ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to February 25th, has been filed. The nominal capital is £10,000, in £1 shares, and 3,435 of these shares have been taken up. 150 shares have been issued as fully paid, and upon 265 shares the full amounts have been called, upon 2,900 shares 7s. 6d. per share has been called, upon 25 shares 10s. per share has been called, upon 75 shares 5s. per share has been called, and upon the remaining 20 shares no calls have as yet been made. The calls paid amount to £1,383. 15s.

WREXHAM AND DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED).—The usual return made up to and filed on February 20, 1893, shows that this Company has made no progress since last return. The Company was incorporated in 1889, with a capital of £20,000, in £5 shares, and but 115 shares have been taken upon, no calls having been made. The gentlemen who signed the Memorandum of Association are the only shareholders.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended March 12th were £859, as against £876 for the corresponding period of last year, being a decrease of £17. The total receipts for half-year amount to £9,531 against £8,508 in the corresponding period of 1892, being an increase of £1,023.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—Notice is given that an extraordinary general meeting of the members of this Company will be held at Winchester House, E.C., on Tuesday, March 28th, at 12 o'clock, when the resolution passed at the last extraordinary general meeting on Thursday, the 9th instant, will be submitted for confirmation as a special resolution.

MEXICAN TRAMWAYS.—It is stated that an English syndicate is negotiating for the whole of the tramway companies in the city of Mexico.

ROCKHAMPTON (QUEENSLAND) GAS AND COKE COMPANY (LIMITED).—The Directors' report for the half-year ended December 31, 1892, presented at the meeting held on the 10th ult., after alluding to their being able to place a satisfactory report before the shareholders, dealt as follows with their electric-lighting scheme:—"The commencement of the electric-lighting operations was a step taken to protect the Company, and to retain the power conferred upon it by the special Act of Parliament. Owing to the want of additional capital the work of completing the private installations had to be suspended, and the electric-light station has consequently been placed under the great disadvantage of running to supply merely twelve consumers. No time will be lost in finishing the various business places which are waiting for the light. As they become gradually wired up and the full capacity of the machinery utilised, so will the revenue be sufficient for the payment of the working expenses and interest, and the Directors feel sanguine of the future maintenance of the usual dividend. No definite arrangement has yet been made with the Municipal Council for the lighting of the streets with the powerful arc-lamps. The Company submitted a price which is now under consideration. The loss sustained upon the electrical operations is £595. 3s. 1d., which includes £365. 14s. 5d. charged for interest upon the capital involved, together with legal expenses, printing, &c. As there are many things included in this loss inseparable from the starting of a new undertaking such as this, the Directors consider that at least a part of this should be borne by the reserve fund, and they have, therefore, decided to appropriate £250 of this fund towards the payment of the half-year's dividend, at the same time charging the whole loss to the profit and loss account for the past half-year." The Directors recommended the payment of a dividend at the rate of 10 per cent. per annum.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended March 10, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,484.

WOODHOUSE AND RAWSON UNITED (LIMITED).—On Saturday last the *Financial Times* contained the announcement that a receiver had been appointed in this matter, an occurence which was not altogether unexpected by those acquainted with the position of affairs. The following circular has been sent out by the Directors to the shareholders:—

"Woodhouse and Rawson United (Limited),

"88, Queen Victoria-street, London, E.C., March 9, 1893.

"Notice is hereby given that an extraordinary general meeting of the above Company will be held at the Cannon-street Hotel, in the City of London, at 12 o'clock noon, on Monday, the 20th day of March, 1893, for the purpose of considering and, if thought fit, of passing as an extraordinary resolution the following resolution—that is to say,

"'That it has been proved to the satisfaction of this meeting that the Company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the Company be wound up voluntarily, and that there be conferred on the liquidator or liquidators all the powers which, by virtue of the Companies' Acts, 1862 to 1890, can be conferred on Liquidators.'

"Should the resolution be passed a further resolution will be proposed at the same meeting for the appointment of a liquidator or liquidators for the purposes of such winding-up.

"Should these resolutions be passed, the Directors propose to submit to the meeting, at all events for preliminary discussion, the scheme for the future reconstruction of the Company."

Accompanying this circular was a letter, signed by the Assistant-Secretary, conveying the Directors' opinion that the constitution of the Company can only be modified by a scheme of reconstruction, and that the resolution to be proposed at the meeting for winding up is merely part of the legal machinery required for effecting what is desired. The Directors prepare the shareholders for the appointment of a receiver and manager on behalf of debenture-holders by stating that they are not prepared to oppose the appointment of such a person. We understand that the shareholders in this concern have also received copies of the report of the Investigation Committee with the Directors' observations marked against the various statements and comments of that Committee. The full report of the Investigation Committee appeared in the last issue of *The Electrician*, and in reference to the various clauses the Directors observe that they offered the Committee every facility for pursuing their inquiries. With regard to the £75,000 guarantee fund, concerning which, it will be remembered, the Committee of Investigation expressed themselves strongly, the Directors state that this fund was available for use in the Company's business, and on the date of the authorisation for its return was not represented by cash in hand, and, had no arrangement been made the whole of the £75,000 might have had to be paid in cash, involving a realisation of shares and securities at much sacrifice. The Directors demur to the opinion expressed by the Committee that the profits for the first year consisted of very doubtful items, and, taking the transactions with the Kensington Stores, the International Okonite Company, and Jensen's Bell, they consider these items were all of the full commercial value set against them in the balance-sheet, and, more particularly in reference to the Okonite Company's shares, the Directors claim that "a regular income of over £1,400 per annum is received." The £24,000 debentures in the Okonite Company are, in the Director's opinion, worth par. With regard to the large sum of £13,775 commission to the Managing Director, the Directors state that this gentleman never received any portion of this amount in cash, but took the amount in shares of the Company in order to enable it to obtain a quotation on the Stock Exchange. It will be seen that the Directors here contradict the statement made by the Committee that Mr. F. L. Rawson received £10,000 in cash out of this commission sum. The Directors state that the Company acquired a large interest in the Epstein patents, and are satisfied that the Epstein shares and advance will realise full value. The remainder of the Directors' observations is a general depreciation of the Committee's

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conclusions, the final comment being that the Preference and Ordinary shares in Woodhouse and Rawson United (Limited) held by the Chairman and the immediate members of his family (excluding the Managing Director) exceeds £6,000, the total called-up capital of the Company being over £6.0,000.

FOOTBALL.—On Saturday last the return match between teams from Messrs. Siemens' Bros. and Co. and Messrs. Johnson and Phillips was played at Charlton Park under Rugby rules, the game ending in a win for Messrs. Siemens' team by two tries (four points) to nil. The former match between these teams resulted in a draw.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Mar. 8.		Price Wednesday, Mar. 15.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 15.	
								£ s. d.		Highest	Lowest.
			TELEGRAPHS								
£1,247,720	Stock	17/6	Anglo-American	52	53	53	54	5 1 10	Jan., Apr., July, Oct	53⅜	52¼
£2,876,140	Stock	35/0	Do. Preferred	91⅛	92½	92	93	5 18 3	" "	93¼	91½
£2,876,140	Stock	5/0	Do. Deferred	13¼	13¾	13½	14	.. ..	" "	13¾	13 1/16
£250,000	100	4%	African Direct, Telegraph 4% Debentures	100	103	101	104	3 16 11	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	12	12¼	11⅞	12¼	5 6 1	Mar., June, Oct., Dec.	12⅛	12
£68,200	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	105	109	105	109	4 11 9	June and December	..	..
£7,716,000	$100	7/1	Commercial Cable Capital Stock	175	180	178	182	3 16 11	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11⅛	12¼	11⅛	12½	6 8 0	February and August	12¼	11¾
6,000	10	10%	Do. Preference 10%	17½	18½	18	19	5 5 3	" "	18⅜	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10%	9	10	9	10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅝	11¾	11⅝	11¾	5 17 8	Jan., Apr., July, Oct.	11⅝	..
100,000	10	2/6	Eastern	14⅞	15⅛	14⅜	15	4 6 8	" "	15⅛	14 13/16
70,000	10	6%	Do. 6 per Cent. Preference	15½	16	15⅜	16⅛	3 13 10	" "	16	15⅜
£1,194,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113	116	113	116	3 9 0	May and November	114⅜	114¼
1,105,900	100	5%	Do. 5 per Cent. Debentures 1899	107	110	107	110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15¼	15½	15¼	15½	4 10 4	Jan., Apr., July, Oct.	15 9/16	15 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	110	113	111	114	3 10 2	February & August	112½	112
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor Deb., 1900	102	105	102	105	4 15 3	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101	104	101	104	3 16 11	February & August	103	102¼
180,227	10	1/3	Globe Telegraph and Trust	9⅝	9⅞	9⅝	9⅞	5 1 4	Jan., Apr., July, Oct.	9¾	9 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15⅛	15⅝	15¼	15½	3 17 5	" "	15½	15⅜
150,000	10	5/0	Great Northern	19	19½	19	19⅝	4 7 8	Jan., April, and July	19 7/16	19 3/8
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	44	46	44	46	5 8 8	May and November	45½	..
38,348	10	4/0	London Platino-Brazilian	4	6	4	6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	106	109	5 10 1	March & September	..	..
10,802	8	4/0	Reuter's	7⅞	8½	7	8	..	April and October	..	..
3,381	£100 Cert.	30 0	Submarine Cables Trust 6%	118	123	118	123	4 17 7	" "	120½	119
15,609	10	5/0	West African Telegraph	6½	7½	6½	7½	5 6 8	January and July	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	102½	101
30,000	10	2/0	West Coast of America	2½	3½	2½	3½	..	January and July	..	..
£150,000	100	8%	Do. Debentures 8% 1902	105	109	105	109	7 6 10	June and December	..	..
88,321	10	6d.	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	" "	1⅛	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¾	11⅛	10⅜	11⅛	5 6 8	May and November	10⅜	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	" "	..	..
£50,000	100	5%	Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 10 11	June and December	..	..
64,242	15	3/0	Western and Brazilian	7⅜	8⅛	7⅜	8⅛	5 9 1	May and November	8⅛	7⅞
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5¾	6¼	5¾	6¼	6 0 1	" "	6 3/16	6 1/16
33,129	7½	4/6	Do. 5 per Cent. Deferred	2	2½	2	2½	..	" "	..	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105	108	105	108	5 11 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105	108	105	108	5 11 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120	125	120	125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	101	104	101	104	5 15 5	March & September	102½	102
			TELEPHONES.								
40,000	£5	10/0	Chili Telephone (fully paid) .....xd and rights	3	4	3	4	..	..	..	..
224,500	14/0	1½d.	Consolidated Telephone Const. & Maintenance	¼	⅜	¼	⅜	1 13 4	May and November	..	..
220,000	£1	4½d.	Oriental (11s. paid)	⅜	½	⅜	¼	7 18 2	Yearly	..	..
454,747	5	2/6	National	5½	5⅝	5⅝	5⅝	5 11 7	June and December	5⅝	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 6	" "	15¼	15 3/16
15,000	10	6%	Do 6% Cumulative 2nd Pref.	13¾	14½	13⅜	14½	4 4 3	" "	14½	14⅜
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref (£3 paid)	4⅜	4⅝	5⅜	5⅝	..	..	4 9/16	4⅜
726 477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	113	116	113	116	3 17 7	January and July	114¾	113½
43,060	£10	..	New Telephone, Limited (£4 paid)	..	..	..	..	..	..	..	..
58,000	5	1/0	United River Plate	2½	3	2½	3	..	January and July	2 9/16	2½
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
30,152	£10	..	City of London Electric Lighting (fully paid)	12½	13	12¼	12⅜		—	12½	..
20,000	£10	..	Do. 6 per Cent. Preference	8¼	8¾	10½	10¾	2 4 7	..	10⅜	8½
19,900	£5	..	Electricity Supply Co. of Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	—	—
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	—	—
8,332	£5	..	House to House Electric	..		1½	2¼	..	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully pd.) xd	..		5⅜	5⅝	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid) .... xd	..		6	6¼	..	January and July	..	..
30,000	£5	4½%	Liverpool Electric Supply (£3 10s. paid)	4½	4½	4⅛	4⅜	..	March	..	..
10,000	£5	4½% '91	Do. (fully paid)	5⅝	6	5⅝	5¾	..	March	..	..
111,000	5	..	London Electric Supply	1	1⅛	¾	1¼	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	5½	5⅝	6	6½	..	..	6⅜	5⅞
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102	105	102	105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5½	6½	5½	6½	..	—	..	..
18,680	£5	9½%	St. James' and Pall Mall	8	8½	8¼	8¾	..	—	8½	8½
7,900	£5	..	Do. 7% Preference	8	8½	8	8½	4 2 4	—	8¾	..
42,853	5	2/0	Westminster Electric Supply (fully paid) xd	5½	6	5½	6	4 3 4	—	5 15/16	5⅞
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	1/6	Brush Electrical Engineering xd new	3⅛	3⅝	3⅜	3⅝	..	—	3 5/16	3⅛
69,996	2	6%	Do. 6 per Cent. Preference xd new	2⅛	2⅜	2⅜	2⅝	5 1 1	—	2 5/16	2⅜
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	103	105	103	105	4 5 9	..	104⅛	104⅛
20,000	5	3/0	Crompton and Co., 7 per Cent. Pref. Shares	5	5½	6¼	5¾	6 1 9	January and July	5 7/16	5⅜
12,139	5	..	Edison and Swan United	..		..		..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	..	..
45,000	10	12/0	Electric Construction	3½	4	2¾	3¼	..	—	3⅜	2¾
70,000	2	10/0	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	—	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1½	2½	1½	2½	..	..	..	..
50,000	10	15/0	India Rubber, Gutta Percha & c., Works	22	23	22½	23¼	5 6 5	February & August	23 3/16	22⅞
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	104	106	104	106	4 4 11	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½	3½	2½	3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6	7	6	7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0	6/0	5/0	6/0	..	..	..	..
78,849	5	4 2/5	Swan United (£3. 10s. paid)	3	3½	3	3½	10 0 0	May and November	3	..
37,350	12	12.0	Telegraph Construction and Maintenance xd	35	38	35	38	4 14 8	March and July	36½	35½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	101	104	4 16 2	January and July	..	..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		..	—	..	..
..	£5	..	Do. Preference (fully paid)	..		¾	1¼	..	—	..	..
			RAILWAYS AND TRAMWAYS.								
63,000	£10	..	City and South London Railway	..		..		..	—	..	..
600,000	Stock	5%	Do. Stock	35	37	37	39	2 17 8	May and November	38¼	37

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And Albert Square, MANCHESTER.

LANCASHIRE AND YORKSHIRE RAILWAY

CONTRACTS FOR STORES.

The DIRECTORS are prepared to receive TENDERS for the SUPPLY of the Company's ordinary requirements of the following Articles during the twelve months ending 30th April, 1894:—

No.
1 Baskets.
2 Brass and Copper Tubing.
3 Brushes.
4 Cloth (Oil).
5 Colours
6 Copper Rivets and Washers.
7 Cordage.
8 Creosote.
9 Emery.
10 Fire Hose.
11 Gas and Water Fittings.
12 Glass (Sundry) and Lenses.
13 Hair and Hair Seating.
14 Harness Fittings.
15 Lead.
16 Leather.
17 Mats and Matting.
18 Naphtha.
19 Oil (Engine).
20 ,, (Gas).
21 Oil (Linseed).
22 ,, (Olive).
23 ,, (Paraffin).
24 ,, (Petroleum).
25 ,, (Rape).
26 Packing, for Engines.
27 Screws.
28 Signal and Telegraph Fittings.
29 Signal and Telegraph Wires.
30 Springs (Spiral).
31 Straw.
32 Tin (Sheet) and Zinc.
33 Tubes, Copper, for Boilers.
34 ,, Steel ,,
35 Wire.
36 Wire Rope.

Way Materials.

37 Crossing Timber.
38 Sleepers.

Further particulars and Forms of Tender may be obtained on application at the Stores Department, Osborne-street, Manchester, where parties are requested to call and examine the samples before tendering. The Sample Room will be open for this purpose from the 20th to the 30th March inclusive, between 10 a.m. and 4 p.m.; Saturday, 10 a.m. to 12 noon.

Tenders, properly endorsed and addressed to the Directors, must be lodged with the Secretary not later than Ten o'clock on the morning of MONDAY, the 3rd day of April next; any received after that date will not be considered.

Separate Forms of Tender will be provided for each Contract; parties applying are therefore requested to state the particular Contract for which they propose to submit Tenders.

The Directors do not bind themselves to accept the lowest or any Tender.

C. W. BAYLEY, Secretary.

Hunt's Bank, Manchester.
17th March, 1893.

COUNTY BOROUGH OF HUDDERSFIELD.

ELECTRIC LIGHTING, MARKET HALL.

The CORPORATION of HUDDERSFIELD invite TENDERS for the ELECTRIC WIRING and FITTINGS required for LIGHTING a portion of the MARKET HALL by ELECTRICITY.

Specification, plans, and form of tender, may be obtained from Mr. A. B. Mountain, Borough Electrical Engineer, Gasworks-street, Huddersfield, to whom tenders must be sent not later than Saturday, the 1st April, 1893, endorsed "Tender for Electric Lighting of Market Hall."

H. BARBER, Town Clerk.

Town Hall, Huddersfield, 9th March. 1893.

BOROUGH OF BRIGHTON.

ELECTRICITY WORKS.

NOTICE is Hereby Given, that the COUNCIL of the said Borough will receive TENDERS from such persons as may be willing to enter into a Contract for the SUPPLY and ERECTION of ELECTRIC ARC LAMPS, SWITCHES, and LAMP CANOPIES.

Specifications can be obtained on application at my Office at the Town Hall, Brighton.

Sealed Tenders, addressed to me and endorsed "Tender for Arc Lamps," must be left at my Office before Ten o'clock in the forenoon on TUESDAY, the 4th day of April, 1893.

A fee of One Guinea will be charged for the Specification, which will be refunded on the return of the Specification accompanied by a bona fide Tender on or before the above-mentioned date.

The Council do not bind themselves to accept the lowest or any Tender.

FRANCIS J. TILLSTONE, Town Clerk.

Town Hall, Brighton, 21st March, 1893.

TO CAPITALISTS, GENERAL AND ELECTRICAL ENGINEERS, AND OTHERS,

TENDERS are invited for the STOCK, PLANT, MACHINERY and EFFECTS of a going concern in the Electrical and General Engineering trade, together with its PATENTS, LICENCES and GOODWILL, and the trade name of the same. The business has been established in the West Riding of Yorkshire for over fifteen years.

The General Engineering Shops are fitted with the most modern tools for turning out high-class work.

The Dynamo, Electric Light and Construction Departments, are similarly laid out with every modern appliance.

The Telegraph, Telephone and Railway Signalling Departments are fitted up with the most modern automatic and other machinery for producing work in large quantities at a minimum cost.

Particulars and all information and permission to view may be obtained at the offices of Messrs. LAKEMAN and OLIVER, Prudential Buildings, Park Row, Leeds.

Tenders must be sent in to Messrs. Lakeman and Oliver not later than WEDNESDAY, the 12th April, 1893.

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TO BE SOLD OR LET.—Extensive FREEHOLD MILLS with warehouses, manager's house, cottages, and other buildings. Good water and steam power. Situate close to railway station midway between Gloucester and Bristol. Immediate possession.—Apply, CHANTER AND CO., Solicitors, Wotton-under-Edge.

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ELECTRIC & GENERAL CONTRACT CORPORATION, Limited.

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35, PARLIAMENT STREET, LONDON, S.W.

THE EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (Limited).

FIVE PER CENT. AUSTRALIAN GOVERNMENT SUBSIDY DEBENTURES.

NOTICE is Hereby Given that in terms of the TRUST DEED, dated 10th May, 1879, the TENTH DRAWING for payment of the above Debentures (353 IN NUMBER) will take place in the presence of a Notary Public of the City of London, on Thursday, the 6th day of April next at 11:30 o'clock, at the Offices of the Company, Winchester House, 50, Old Broad-street, in the City of London.

By order of the Board,

F. E. HESSE, Secretary.

Winchester House, 50, Old Broad-street, E.C.,
22nd March, 1893.

CHEAP PREPAID ADVERTISEMENTS *relating to* **SITUATIONS VACANT AND WANTED, MISCELLANEOUS PLANT WANTED, FOR SALE, AND FOR EXCHANGE,** *are inserted in* "THE ELECTRICIAN" *at the following low rates:*

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Nine Words to the Line.

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WANTED, a capable ELECTRICAL ENGINEER, with fair connection, and about £2,000 capital, to join a well-established business in London. Principals only.—Apply, "A. L.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

ELECTRICAL ENGINEER (21) desires ENGAGEMENT, good theoretical training, experience in Drawing and Engineers' offices of large Contractors. Had charge of construction and maintenance at central station, and laying of mains. Good tester. Excellent references.—Address, 1207, *Electrician* Office, Salisbury-court, Fleet street, E.C.

ELECTRICAL ENGINEER, 7 years' experience, mechanical and electrical, good draughtsman, theoretical knowledge, just finishing engagement installing central station, seeks RE-ENGAGEMENT, home or abroad. Excellent testimonials.—Address 1208, *Electrician* Office, Salisbury-court, Fleet-street, E.C.

SCIENTIFIC, Electrical and Optical Instrument Lathe Hand, requires SITUATION. Good references. Long experience.—MATHEWS, care of *The Electrician* Office, Salisbury-court, Fleet-street, E.C.

YOUNG MAN wishes to LEARN the ELECTRIC LIGHT, would not mind paying a small premium.—E. RICHARDSON, Woburn, Bedfordshire.

WANTED, SITUATION as IMPROVER. Good experience in lighting and bench work.—Apply, 85, Sefton-street, Southport.

A GENTLEMAN of business habits, with opportunity of introducing considerable installation work, seeks practical PARTNER with capital.—Apply, 1211, *Electrician* Office, Salisbury-court, Fleet-street, London, E.C.

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Miscellaneous Advertisements, Plant Wanted and for Sale, &c., &c., continued on next page.

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Makers of High-class ELECTRICAL INSTRUMENTS of every description.

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J. WEEKS AND CO., King's-road, Chelsea, S.W., supply all kinds of Boilers, their improved and other Valves, tested Hot-water Pipes, Castings, Connections and Fittings at lowest retail prices.

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A SMOKING CONCERT will be held on FRIDAY, April 7th, 1893, at the ST. JAMES'S HALL RESTAURANT (Banquet Room), Regent-street, W., at Eight o'Clock.
Artistes.—Messrs. Lester, Albert James, Arthur Thompson, and Franklin Clive. Solo Violin, Mr. T. E. Gatehouse; Solo Pianist and Accompanist, Mr. Alfred E. Izard; Humorous Recitals, Mr. Fred. Frampton; Ventriloquist, Mr. Frederic Russell; Humorous Sketches, Mr. George Cronin.
Musical Directors.—Mr. T. E. Gatehouse and Mr. Alfred E. Izard.

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PENYWERN HOUSE
2, Penywern Road, EARL'S COURT, S.W.
Principal: G. W. de TUNZELMANN, B.Sc., M.I.E.E.

The Complete Courses qualify Students for entry into Electrical and other Engineering Work.
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ELECTRICAL RULES & TABLES
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For the use of Electricians and Engineers.
By JOHN MUNRO, C.E., & Prof. A. JAMIESON, F.R.S.E., M.I.C.E., M.I.E.E.
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ELECTRIC CIGAR LIGHTER.

Size 6½in. by 6½in.
Price (packed in box, post free) 21s.
Is absolutely safe. Machine complete in itself.
Generates its own Electricity.
So simple a child can work it.
Lights instantaneously on pressing knob.
3,000 lights at the cost of 6d.
Lasts a lifetime.
SHOULD BE IN EVERY SMOKING-ROOM.
These Electric Lighters are made of the best quality nickel-plate, and are of first-class workmanship.
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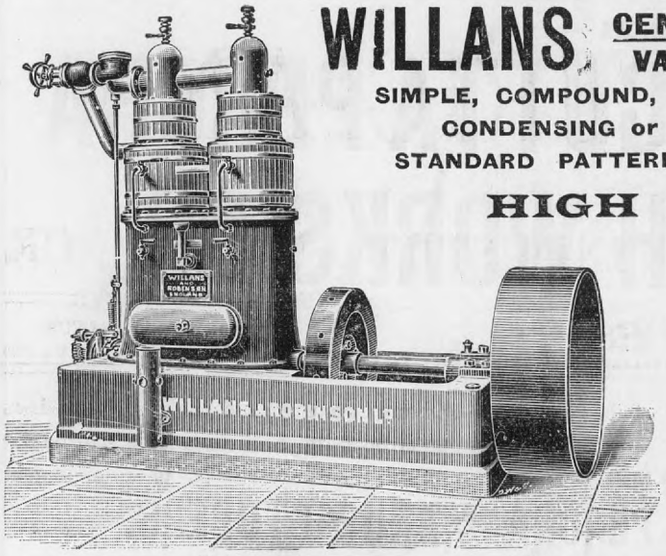

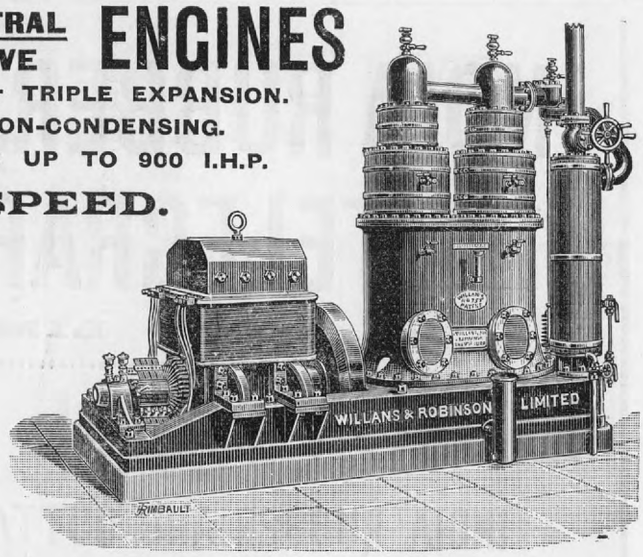

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OVER 60,000 H.P. IN USE OR ON ORDER.

WILLANS & ROBINSON, Ltd., THAMES DITTON, SURREY.

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MAKERS OF A GREAT VARIETY OF STEAM ENGINES & BOILERS.

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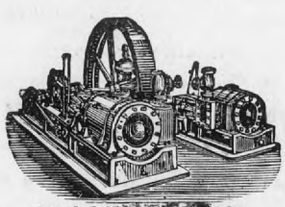
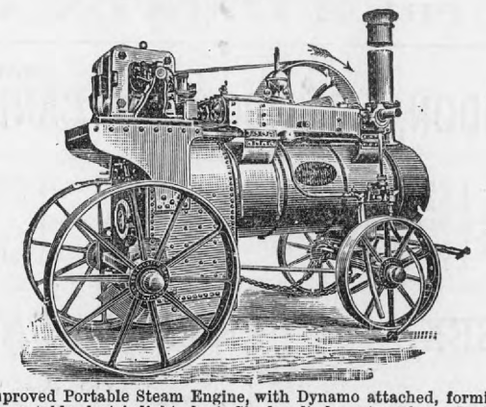
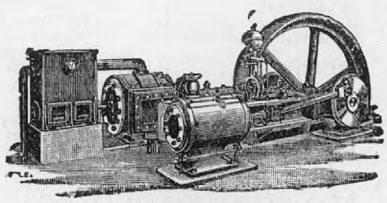


Coupled Horizontal Engine, 40 to 1,000 H.P.



Improved Portable Steam Engine, with Dynamo attached, forming a portable electric light plant. Single cylinder, 4 to 12 h.-p.; double cylinder, 8 to 25 h.-p.; compound, 8 to 30 h.-p. nominal.



Horizontal High Pressure Coupled Compound Engine. 12 to 1,000 H.P.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED URNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 775.—Vol. XXX. FRIDAY, MARCH 24, 1893. PRICE SIXPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

Challenges are not uncommon in the engineering world, but competitive tests rarely take place. At least two such challenges have been made in connection with electrical engineering, but both of them have fallen flat. Mr. Dowson has recently offered to back his gas-generating plant and a 100-H.P. gas-engine against any steam-engine, for fuel consumption on an ordinary electric-lighting load factor. He proposed to place the complete gas producer on a weighing machine, and to connect it with the engine by a hydraulic joint. Stand by losses and working consumption would be continuously recorded. Unfortunately, his challenge was too wide; it was anybody's business to take it up, and therefore nobody has done so. But, unlike other less enthusiastic inventors, Mr. Dowson has not contented himself with winning a victory "by default." He has completed arrangements for a thorough trial, probably at the end of next month, and it is only necessary to say that he has engaged the services of Prof. Kennedy, to satisfy everybody that it will indeed be thorough. A 100-H.P. (effective) Crossley engine will run two Crompton dynamos, the whole load will be absorbed by resistances, and the output will be varied to imitate, as far as possible, the actual requirements of a central station. There is every reason to expect that Mr. Dowson will beat record on this occasion, if, indeed, there is anything that has yet been arrived at by sufficiently careful measurement to be called a record.

The withdrawal of the tramway clauses in the Salford Corporation Improvement Bill shows in a very striking manner the inevitable result of the insistance by the National Telephone Company of the insertion in all tramway Bills of the obnoxious Birkenhead clause or its equivalent. If the overhead trolley and earth return are, by their very nature, unacclimatisable in this country, electrical engineers must, of course, endeavour to do without them. But until this is proved it is a grave tactical error to allow the National Telephone Company to perpetuate the anachronism of single-wire telephone circuits, and to quietly snuff out electric traction into the bargain. The National Telephone Company is, of course, quite right, from its own point of view, in securing the insertion of protective clauses wherever it can, and the electric-tractionists would do well to imitate their antagonist's aggressive action. Fortunately, in this particular instance, as at Leeds, all existing tramways can be worked by electricity without the leave of the National Telephone Company, and the only immediate result of its action, as far as Salford is concerned, is to render the *extension* of the tramway system difficult, if not impossible.

It has been courteously pointed out by a contemporary that in an editorial note appearing in our issue of March 10th, we did some injustice to the House-to-House Company by inadvertently omitting to include the item "salaries" in the total "sheer-cost" of production of the Kensington and Knightsbridge Company for 1892, thus making the latter Company's figure of merit compare more favourably than it should with that of the House-to-House Company. To make matters clear, we append the component items just as they are given in the two Companies' accounts, which we may remark are drawn up on different lines:—

Kensington and Knightsbridge Company.

	£	s.	d.
To manufacturing electricity, coal, oil, water, waste, wages, and sundries	3,746	11	4
To salaries	975	12	6
	£4,722	3	10

House-to-House Company.

	£	s.	d.
1. To coals or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	2,803	12	5
2. To oil, waste, water, and engine-room stores	791	5	1
3. To *proportion* of salaries of engineers, superintendents, and officers	620	6	2
4. To wages and gratuities at generating station	1,383	15	1
	£5,603	18	9

Our contemporary volunteers the estimate of £314 as the *proportion* of salaries chargeable to the "sheer-cost" of the Kensington and Knightsbridge Company. Adopting this, its total is then £4,060. 11s. 4d., instead of the £3,746 originally figured out, as compared with £5,603. 18s. 9d. of the House-to-House Company.

In connection with the remarkable experiment described in another column by Prof. Elihu Thomson, it is of interest to read the views of Oliver Heaviside concerning the action of conductors on magnetic fields, which are fortunately printed in the present issue. The change of the force acting on the copper disc from a repulsive to an attractive force, is no doubt in some way due to the improvement in the magnetic circuit as the copper disc is brought nearer the core of the electromagnet, but even so a fuller explanation seems needed. The importance of eddy currents in shifting the lines of force has been prominently brought out by Prof. J. J. Thomson,

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who has shown that even in transformers where the iron core is well laminated, the altered distribution is of noticeable value. With large discs of low-resistance copper placed just over the core the effect must be very marked indeed, and, when looked at from this point of view, it is not surprising to find the effect described by Prof. Elihu Thomson. When the disc is at a moderate distance from the core, the distribution of the lines of force is probably not much affected, but when it is brought quite close to the core the lines are shifted so as to avoid going through the copper.

Probably experiments of this kind will remain to a great extent unexplained until some simple way is discovered for plotting the lines of force due to alternating currents. We have already suggested the use of copper filings for this purpose, but apparently this method is not sufficiently sensitive, the currents induced in the filings not being sufficiently strong to give them a set. A suspended disc of copper might be tried, or possibly a test coil connected with a delicate alternate-current voltmeter. There is little doubt that any method of plotting the lines of force generated by alternate currents would be of great value in investigating alternate-current phenomena.

Until some actual tests are published with regard to the working of non-synchronous alternate-current motors, there seems little to be gained from the consideration of their theory, especially as the most striking property of the machines is their inability to start. Mr. Kingdon's views, which we publish in another column, possess, however, some interest, since, if they are correct, the phenomenon of hysteresis, usually only a source of waste, may possibly in the future be turned to useful account.

We have already opposed the view that the rotation in a Tesla or Brown motor is due to hysteresis in the iron; and can hardly support Mr. Kingdon's attacks on what he calls the self-induction theory, though, no doubt, much useless mathematical work has been written about self-induction, and this word has often been used to cloak ignorance or vague knowledge. The term is not a good one, but the quantity it refers to is important, since it is closely connected with the magnetising or "idle" currents, the consideration of which is highly necessary in alternate-current work. The need of distinguishing these "idle" currents, which are in quadrature with the volts, from the "working," or load, currents is now generally acknowledged, although Mr. Kingdon does not appear to think so, since he refers to what he calls the usual view that "secondary currents are in quadrature with the inducing primary currents." This view may have been usual some years ago when the distinction we have alluded to was but little understood, but it is now quite exploded. Mr. Kingdon has little difficulty in disproving it, and arrives at the well-known result that in a transformer the primary and secondary currents are in opposite phase. But this conclusion, however true for transformers, the magnetic circuits of which are fixed, is not necessarily true for motors, which are really transformers, the iron circuit of which is in motion. All that Mr. Kingdon has shown is that hysteresis in the iron would produce an effect of the kind described. The magnitude of the effect caused in this way would, we believe, be excessively small.

Some interesting information on "indirect lighting," that is, illumination by diffused reflectors, will be found in another column, in an article from the German. A loss of over 50 per cent. seems a heavy price to pay for the uniformity of illumination and absence of glare, but since such a system will allow arc lamps to be used where they would not have been tolerated before, and when the 15 to 30 per cent. absorption by ground or opal globes is set against it, the system is worthy of careful consideration. We cannot approve of opal glass as an upper reflector for indirect lighting. For a lower reflector, partly reflecting and partly transmitting, it may be useful, but the upper reflector should be solid white, and probably nothing could excel good enamelled iron or copper.

An occasional contributor has sent us more than one communication on the Physics of Thought-reading, and claims that such enquiries should not be shirked. He suggests, as Prof. Houston has done, that ether vibrations may explain thought-transference. As soon as this or any other class of phenomena really comes within the domain of physical science we will try to find space for its discussion. One criterion of its inclusion should be a capability of measurement. Hertz's researches were nothing if not quantitative. When the wave-length of thought-transference can be even guessed at by the observation of stationary thought-nodes, or if, like gravitation, the action is found to be a definite function of the distance, the subject shall claim our attention. If thought be a form of radiant energy, it should obey the laws of optics. Reflection of thought is to be found in the phenomena of plagiarism, but how are we to measure the angles of incidence? Interference phenomena are abundant in the House of Commons, and if distortion or perversion of thought be a form of refraction, accompanied sometimes by chromatic effects, it is indeed too prevalent; though the refractive index, or, as it has been called, the coefficient of mendacity, may be difficult to determine. An elegant form of such refraction is known as hyperbole, but what is the focal length of a gross exaggeration, or the negative focus of a disparaging remark? Thought-reading may have its scientific aspects, but it does not at present come within those branches of physical science which are discussed in our columns.

Bridgend.—The Board of Trade has granted the Electric Lighting Provisional Order to the Local Board.

Birkdale Electric Lighting Order.—The Board of Trade have revoked the Birkdale Electric Lighting Order, 1883.

Bromley.—An inquiry has recently been held by a Local Government Inspector, as to the borrowing of £3,175 for the purchase of an electric-lighting station site at Bromley (Kent).

Cable Interruptions—

Gibraltar-Tangier	February 18th.
Para-Maranham	March 20th.

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Obituary.—The death is announced of M. J. P. Hofstede, the head of the Department of Posts and Telegraphs at the Hague. The deceased represented the Netherlands at the International Telegraph Conferences held in Berlin and Paris, and was a perfect master of all detail in connection with his department. His large figure and genial manners will be long remembered by those brought into contact with him.

The Late Mr. E. T. Mercer.—The secretary of the Hastings and St. Leonards-on-Sea Electric Light Company informs us that a fund is being raised by subscription for the widow and family of the late Mr. Mercer, who met with a fatal accident on the 9th inst. whilst returning to Hastings in the London express. Contributions to the fund should be sent to Mr. F. E. Burton, the Secretary of the Hastings Company.

Royal Institution.—The following are some of the lecture arrangements after Easter :—Prof. Dewar, five lectures on "The Atmosphere"; Mr. James Swinburne, three lectures on "Some Applications of Electricity to Chemistry" (the Tyndall Lectures). The Friday evening meetings will be resumed on April 14th. Discourses will probably be given by Prof. A. B. W. Kennedy, Mr. Shelford Bidwell, Lord Kelvin, Prof. Osborne Reynolds, and Prof. T. E. Thorpe.

The Manufacture of Cored Carbons.—Messsrs. Mahla and Braun, of Nuremberg, instead of introducing the cores of their arc light carbons in a state of paste into the previously finished hollow rod, complete the core first. The core is then placed in a mandrel contained in a press, in such a manner that as the mass of carbon paste is pushed along under the action of the plunger, it carries the core, which projects slightly beyond the mandrel into the carbon paste, along with it. In this process it is only necessary to guide the core into the mandrel, and the work then goes on automatically.

The London Telephone Service.—A statement, for which we have been unable to obtain official conformation, has been going the round of the Press to the effect that the National Telephone Company proposes "almost immediately" to reduce the prices of private-house telephones in London, giving communication over the whole Metropolitan area, from £20 a year to £10 a year, subject to the condition that they are taken upon a five years' contract. The price of business telephones will remain as at present, but the National Company promises immediately to adopt the twin-wire system.

Yarmouth.—At the monthly meeting of the Town Council last week, the subject of the electric lighting of the borough, at an estimated cost of £15,000, was under discussion. Resolutions adopted at public meetings, protesting against the scheme, were submitted. The Chairman of the Electric Lighting Committee moved the adoption of the Committee's report, which recommended that the scheme for lighting the town by electricity should be carried out without loss of time. When the question was submitted to the vote it was found that the opponents to the scheme were in a decided minority.

Municipal Electric Lighting at Hackney.—At the last meeting of the Hackney Vestry a discussion arose upon a report of the Parliamentary Committee upon the subject of the Pitfield-street Iron Works site, now in the market, which the Committee recommended as most suitable for the combined purposes of electric-lighting station, and baths and washhouses. They suggested that the Vestry should offer the owners the sum of £33,000 for the whole of the site, which consisted of about 1½ acres of houses, shops, and vacant land, subject to a good title being adduced, and to each party paying their own law costs. An amendment that the Vestry should offer £28,000 was carried.

Forthcoming Books.—Messrs. Whittaker and Co. will issue in their Specialists' Series a work on "The Dynamo," by C. C. Hawkins and F. Wallis, and a new edition of Sir David Salomons' work on "The Management of Accumulators." They have also in preparation in the Library of Popular Science an introductory work on "Electricity and Magnetism," by S. Bottone. Mr. Perren Maycock has completed the second part of his work on "Electric Lighting and Power Distribution," and it will be issued in a few days. Messrs. Griffin and Co. announce "Griffin's Electrical Price-Book," edited by Mr. H. J. Dowsing, and the tenth annual issue of the "Year-Book of Learned and Scientific Societies."

Albert Medal.—The Council of the Society of Arts will proceed to consider the award of the Albert Medal for 1893 early in May next, and they therefore invite members of the Society to forward to the Secretary, on or before April 15th, the name of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit for promoting arts, manufactures, or commerce," and has been awarded in previous years to Michael Faraday (1866), Sir W. Fothergill Cooke and Sir Charles Wheatstone (1867), Sir William Siemens (1874), Sir George B. Airy (1876), Sir William Thomson (1879), James Prescott Joule (1880), Prof. Helmholtz (1888), Thomas Alva Edison (1892).

The Electric Light at the Mansion House.—At the meeting of the Common Council last week the General Purposes Committee asked for authority to pay the accounts of the City of London Electric Light Company for current supplied to the Mansion House for the quarter to Christmas last (£306 11s. 4d.). Mr. Salmon said the total cost of lighting the Mansion House by electricity was about £700 per annum—about double that of gas. The Committee had made no arrangement with the Company in question, and it was not improbable that at some future time they would generate their own electricity. The Court, having approved of the payment of these accounts, agreed also to a report from the same Committee, recommending that the two large windows in the Egyptian Hall should be lighted by gas instead of electricity.

The Electric Traction Question at Coventry.—Last week there was a lengthy and heated discussion at the Town Council meeting over the tramways question. The Council has already consented to Mr. Graff Baker, the owner, equipping the line electrically, but owing to the conditions imposed by the General Works Committee there was some danger of the negotiations falling through and Mr. Baker resorting to steam. When the correspondence was laid before the Council, it was proposed that the matter should be at once dealt with by the larger body, and taken out of the Committee's hands. As Mr. Baker had conceded some of the Committee's points, a compromise was finally come to, some fresh letters which had been received being referred to the Committee, on the understanding that no time was lost in completing the agreement between the Council and Mr. Baker.

Electrical Communication with Lighthouses.—In the House of Commons on Tuesday, the President of the Board of Trade was asked whether, inasmuch as the recommendations unanimously endorsed by the Commissioners as a means of saving life at sea involved a very small estimated cost, the Government intended without any further delay to carry out the recommendations of the Royal Commission upon Electrical Communication with Lighthouses and Lightships made in December last. Mr. Mundella stated in reply that a Committee had been appointed to consider and report on the best means of carrying out the recommendations of the Royal Commission. He was advised that they had now the whole matter under consideration, and would report soon after Easter. He could assure the right hon. gentleman that no unnecessary delay would take place.

Edinburgh.—The Edinburgh Town Council have now had the subject of electric lighting more or less under discussion for over three years. A few months back a Committee made the customary provincial tour of inspection, and after much labour issued a voluminous report, which required the professional assistance of Prof. A. B. W. Kennedy to elucidate it. Prof. Kennedy supplemented the Committee's vague generalities by a few particulars regarding probable first cost, annual cost, and annual income of a 40,000-light system supplying the northern half of Edinburgh. A meeting of the Lord Provost's Committee was held last week for the purpose of considering this report of Prof. Kennedy. The Committee discussed the question for two hours. The point which gave rise to the greatest difference of opinion was with regard to who was to have the working of the scheme. Some of the members of the Committee were strongly averse to the Corporation having any-

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thing to do with it. The meeting finally broke up without coming to any resolution.

The Earth's Magnetism.—In the course of a lecture, entitled "The Ether and its Functions, or Demon Worship in Science," delivered last week in the theatre of the Royal Dublin Society, Prof. Thomas Preston remarked that an interesting point arose concerning the magnetism of the earth. Why should the earth be magnetised on the whole in the direction of its axis rather than in some other direction, and why magnetised at all? The ether theory seemed to point to the magnetic polarity of the earth as a natural consequence rather than as a surprising fact. For if they went back to the time when the earth was a fluid mass rotating about its axis, they should expect to find that on account of that rotation the atoms would set their axis parallel to the axis of rotation, that was, with their faces towards the poles, and they would have an arrangement which would give the earth the magnetic properties it actually possessed; and that arrangement they should also expect to be ever and anon disturbed and partially destroyed by the internal movements and crust motions, and such mass motions might account for the changes and disturbances which were still in operation in the earth's magnetism.

The City Lighting.—At Wednesday's meeting of the Commissioners of Sewers, the Finance and Improvement Committee brought up a report relative to an application of the City of London Electric Lighting Company for the Commission's assent to their introduction of a Bill for amending Section 8 of the Electric Lighting Order. The object of the proposed Bill would be to abrogate the provisions for setting aside 7½ per cent. on the capital expended, for depreciation. The Committee were unable to recommend compliance with the application. Mr. W. H. Pannell said he thought the report should be reconsidered, and his suggestion was accepted by the Committee.——The *City Press* of Wednesday delivers itself of the following :—

"The conduct of the City Electric Lighting Company deserves to be looked into. Not only is the Company putting its work forward at its leisure, so that it will probably be opening our streets for the next twelve-months, not only is it laying down extra tubes so as to transmit power as well as light, but the light sent is intermittent and unreliable, and the price charged is much greater than other companies are asking. The Lord Mayor told the Court on Thursday that the light at the Mansion House sometimes went out, and while the City Company is charging 7d. per unit, I find that the Westminster Company is only charging 5d. for a strong, bright, unflickering light. Unfortunately the City contract gives a maximum of 8d., so that I fear there will be a great many misunderstandings before things are reduced to working order."

Efficiency of Schuckert Dynamos with a Small Load.—The official certificates of the dynamos from 350 to 500 H.P., supplied by Schuckert and Co. to the Municipal Central Stations of Düsseldorf and Hanover, give the following results.

Düsseldorf Central Station.

Output in kilowatts.	Efficiency of steam engine.	Efficiency of dynamo.	Total commercial efficiency.	Watts per I.H.P.*
20·75	86·00 per cent.	91·6 per cent.	78·8 per cent.	588
24·60	85·26 ,,	92·4 ,,	78·8 ,,	588
26·99	87·30 ,,	92·4 ,,	80·7 ,,	602
36·16	87·94 ,,	92·7 ,,	81·52 ,,	608

* English horse-power of 746 watts.

At Hanover the efficiency of dynamo and steam engine are not given separately, but the total efficiency, instead of being 76·5 per cent., has been proved to be 81·8 per cent., which, after comparison with the above-mentioned figures, is equivalent to an efficiency of 88 per cent. for the steam engine and 93 per cent. for the dynamo. For a smaller load, viz, two-thirds the maximum output, the efficiency is only 1 per cent. less. As the machines work in combination with secondary batteries, they need never be worked with a smaller load than two-thirds the maximum, so that high efficiency is practically attained with the average output of the central station. These figures have been obtained from tests made by Prof. Kittler, of Düsseldorf, and Prof. Kohlrausch, of Hanover.

The Green and Field Electric Traction Patents.—As the Green electric traction patents have recently been purchased by the General Electric Company of America, it may be presumed that they are supposed to be of some legal value, and their chief claims may not, therefore, be without interest. Green's first patent (No. 465,407) was applied for on September 15, 1879, and was granted December 15th, 1891. Its third claim runs as follows :—"The combination, substantially as set forth, of a railway track, one or more stationary means of electric supply, electrical conductors extending from said means of electric supply along the lines of said track, and consisting wholly or in part of the rails thereof, vehicles movable along said track, electrodynamic motors fixed upon said vehicles for imparting motion thereto, and wheels supporting said vehicles upon the track, and also serving to maintain continuous electrical connection between said means of electric supply and said motors, substantially as described." Green's second patent (No. 465,432) was applied for on May 15, 1886, and granted on the same date as the first. Its first claim is as follows :—"The combination of one or more stationary sources of electric current, conducting circuit formed wholly or in part of an insulated line of rails of a railway track, a wheeled vehicle movable upon or along said line of rails, one or more rotating electric dynamic motors mounted upon said vehicle for propelling the same and included in said circuit of conductors, and a circuit-controller placed on said vehicle and also included in said line of conductors, substantially as described." Another so-called master patent is that of Mr. Stephen D. Field (No. 407,188) applied for March 10, 1880, and granted July 16, 1889. The first claim reads as follows :—"The combination, substantially as herein before set forth, of a stationary dynamo-electric generator driven by a suitable motor, a circuit of conductors composed in part of an insulated or detached section of the line of rails of a railway track, a wheeled vehicle movable upon or along said insulated section of track, an electro-magnetic motor mounted upon said vehicle for propelling the same, and included in said circuit of conductors, and a circuit-controlling device placed upon said vehicle."

Cardiff.—A local Government Board inquiry was held at Cardiff on Wednesday last week into an application made by the Town Council for sanction to borrow £32,500 for purposes of electric lighting. The borough engineer said that for some years previously to 1890, the Brush Company had supplied electric light to a large number of customers, but in that year many of their overhead wires had become decayed, and the Board of Trade insisted upon the wires being placed underground. As a result the Company closed their station in October, 1890. The present application was to enable the Corporation to carry on the electric lighting. The site adopted was at a distance of about one mile from the area of supply, but it had the great advantage of being alongside the Great Western Railway, and at a depth of seven or eight feet below the surface an abundant supply of water could be obtained for condensing purposes. Mr. W. H. Massey said that although he had for many years, and of his own choice, not acted for local authorities in other districts, he readily undertook the duties of consulting electrical engineer in this case, believing that Cardiff was one of the few places in the kingdom where electric lighting might be carried on at a profit, and where the whole of the work connected with the establishment and maintenance of the necessary works could be placed under the control of the borough engineer and his staff, thus avoiding the complications which had arisen in other towns, where an electrical engineer had been specially appointed to take permanent charge of such works. He produced an approximate estimate of expenditure. Mr. Sydney F. Walker desired to point out to the Inspector the fact that there were coming into Cardiff four million gallons of water per diem, and they came in at a considerable pressure, and he asked what objection there was to water power being used. The borough engineer said that with a life-long experience of waterworks he knew they could not possibly rely upon the regularity of the supply. After further discussion, Mr. Walker expressed himself as satisfied. He then went on to say that part of the Corporation scheme was to light the streets with arc lamps. He desired to call attention to the rapid headway made by the large incandescent lamp. The inquiry then closed.

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ERNST WERNER VON SIEMENS.

Dr. Ernst Werner von Siemens was borne at Lenthe, in the Electorate of Hanover, in 1816. He was the eldest of seven brothers, all of whom have attained distinction in the pursuit of science, while William—the best known of the family in this country—Carl, and Frederick displayed a genius almost equal to that of Werner. The parents of this family of scientists were Christian Ferdinand Siemens, a man possessed of considerable means and engaged in the occupations of farming and forestry, and Eleonore Deichmann. In the virtue of perseverance particularly, Werner has testified to the benefits of his father's example and encouragement.

Werner's early life was spent, first in acquiring an excellent education at the Gymnasium of Lubeck, and afterwards in the study of military practice and theory. At the age of 28 he was appointed Superintendent of Artillery Workshops' and devoted his attention to the applications of mechanical, electrical and chemical science to the defences of his country. Among his more practical military researches may be mentioned the application of electricity to the firing of submarine explosive mines, and the accurate measurement of the velocity of projectiles. The first of these became useful at Kiel, at which place Siemens was stationed when that military port was attacked by the Danish fleet, in 1848. The apparatus for the second of these inventions consisted of a polished steel cylinder, set rotating at a high and uniform speed, which was finely marked by the spark from a Leyden jar when the moving projectile completed the discharging circuit. The inventor claimed for this machine a sensitiveness sufficient to enable 1-10,000th of a second of time, or 1-100th of a foot of motion to be recorded. About this time, Werner Siemens proposed the use of subterranean instead of overhead telegraph lines, and invented a machine for serving the conductor with seamless guttapercha.

The history of gutta-percha is, indeed, a most striking instance of the way in which we moderns are rapidly and wastefully exhausting the bountiful supplies of Nature. Introduced into Europe for the first time as an article of commerce exactly half a century ago, the electrical industry is already threatened not merely with a famine but with the complete exhaustion of the supply of gutta-percha. In a modestly and clearly written little pamphlet, published in 1851, Werner Siemens gave a graphic and interesting account of the many difficulties encountered by himself and his colleagues of the Commission zur Vorbereitung der Telegraphenanlagen in Preussen, when in the spring of 1848 they sought to make use of gutta-percha as an insulator for the underground wires which were hastily ordered to be laid between Berlin and Frankfort-on-the-Main and Aix-la-Chapelle in view of the then menacing civil disturbances. Vulcanisation was attempted, but the excess of sulphur, the overheating and the absence of anything in the nature of a "separator" between the copper conductors and the over sulphured gutta-percha, together with the crude character of the machinery employed, resulted in troubles of all kinds. The adulteration of gutta-percha which has now attained the proportions of a fine art was, it is worth noting, even in 1848 a source of annoyance and the cause of many a breakdown.

Shortly after this Werner Siemens retired from the army, and commenced to devote his whole energies to investigations in theoretical and applied science. To describe all the inventions and discoveries which resulted from this work, would require a large volume; we must here be content with briefly enumerating only the more important of them. When quite a young student, Werner had succeeded in electro-gilding a surface of metal, and, better than this, had succeeded in selling his patent for a sum of money which enabled him to further prosecute his research into electro-chemistry. In the year following his retirement from the army he published a note on the electrolytic separation of nickel and cobalt. His other achievements in practical electricity include dial and printing telegraphs, the duplex telegraph circuit, apparatus for localising faults in electric cables, and the "Siemens' unit" or standard of electrical resistance, which has now given place to the *ohm*. Later than these came the polarised relay, an electrical range-finder, and the crowning inventions of the self-exciting dynamo and of the method of armature winding known by his name. Mining operations have been aided by the practical magnetic ore separator and the electric hammer which he invented, the latter being the precursor of the electric rock-drill. The first electric railway ever constructed was put up by Messrs. Siemens and Halske, of Berlin, at the Trades Exhibition in that city in 1879; and one of the earliest forms of self-regulating arc lamps is to be attributed to this prolific inventor. Among the numerous non-electrical inventions, we may notice the pneumatic dispatch—a method of transmitting small parcels—which is largely employed on the continent and in the Post Office in this country, a pneumatically-controlled torpedo, which was inspired by the outbreak of the Franco-Prussian war in 1870, and an alcoholometer which indicates the percentage of absolute alcohol in any spirit passed through it.

For his researches in pure science Werner Siemens received from the University of Berlin, in 1860, the degree of Doctor of Philosophy, *honoris causâ*, while a patent of nobility was conferred upon him by the late Emperor Frederick III. Besides these distinctions, Dr. Siemens could claim the highest scientific order of his country, that of the Prussian order "Pour le Mérite," and the honorary membership of several engineering societies. His scientific research, however, was directed towards the solution of definite practical problems rather than towards the advancement of pure or abstract science. It comprised investigations on the electrical resistance of alloys, on the heating of a dielectric during electrical discharge, on the effects of light and electricity on selenium, and on the "Electrostatic Induction and Retardation in the Cores of Cables"—this last being the title of an important paper read by him in 1857.

The scientist who knew how to explore nature, the inventor who understood how to apply to practical ends the fruits of his explorations, and the shrewd man of business who saw in the theories of science and in the inventions which he had made a means to reap a harvest for himself and his firm, was also the philanthropist and the man of heart, who knew how to scatter among the less favoured the good things he had so well earned for himself. In 1886, Dr. Siemens presented 500,000 marks to the German nation for the foundation of a national scientific and technical institution; and thus conferred a lasting boon on the civilised world. In earlier years, when the introduction of the telegraph by Siemens and Halske bid fair to ruin the business of those who had worked under the older postal system, a young lady came to Werner Siemens and told him, with tears in her eyes, that he was about to utterly ruin the business of her husband, a pigeon-post man. Dr. Siemens strongly advised the young couple to roast their pigeons, and promised his assistance if they went to London and started a news agency. The husband of that young lady was Herr Reuter, who subsequently became a baron and a very rich man. It is said that for years it was the first daily duty of Dr. Siemens to read the large number of requests for assistance which came to him from every quarter. These he would mark with the amount of money to be sent in each case; and it was very rarely indeed that his assistance was refused.

On December 6, 1892, and within one week of his 76th birthday, Dr. Siemens' life of usefulness and activity ended. He had been twice married, and left three sons and three daughters. The former of these will continue the business of the world-famed firm, from which Herr Halske, who died in March, 1890, retired in 1867, but in which Dr. Werner von Siemens took an active interest up till the few days before his death when the influenza attacked him. Not in sand, but ineffaceably in granite, has Werner von Siemens left footprints which will be seen and utilised by the generations to come.

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ELECTROMAGNETIC THEORY.—XLVI.

BY OLIVER HEAVISIDE

(*Continued from page 536.*)

§ **191.** The theory of the effect of a finite degree of conductivity in the medium on electromagnetic waves is far more difficult and complicated than that of the effect of infinite conductivity. Nevertheless, we may gain a general idea of the nature of the effect by means of the substitution of simple problems for the real ones that present themselves, and also in this way obtain a knowledge of very important properties concerned. There are two ways in which we may regard the question of conductivity. First, starting from the theory of perfect conductors surrounded by perfect dielectric non conductors, we may examine the effect of introducing a slight amount of resistivity, to be then increased more and more until at last we come to conductors of high resistivity, or infinite, when we have dielectrics merely. The other way is to start with electromagnetic waves in a perfect dielectric, and examine the effect produced upon them of introducing first a small amount of conductivity, then more and more, until we come to perfect conductors again. Both ways are instructive—none the less because they give very different views of the same matter.

In the first place, it may be readily conceived that if a conductor have only a slight amount of resistivity it may behave approximately the same as if it had none, and may obstruct waves nearly perfectly internally, and likewise reflect and conduct them superficially nearly perfectly. This is true, but the element of time has to be taken into account, as it becomes of great importance when there is some resistivity, however little, instead of quite none. Suppose, for example, we have an initially steady magnetic field, and bring a conductor into it very quickly from a distance, and keep it there. If this be done quickly enough, the first effect is nearly the same as if the conductor were perfect. That is, the induction of the field will be driven out of the space it previously occupied, which is now occupied by the conductor, and pass round it tangentially, as if the conductor were of zero inductivity. It will, therefore, be mechanically acted upon by the stress in the field in a manner resembling the action upon a perfect diamagnetic body—that is, there will be a force tending to drive it from stronger to weaker parts of the field. In another form, we may say that there is a resisting force to be overcome to bring the conductor into the field and to hold it there. But this state of things will not continue. The magnetic force, which is at first only skin deep, will penetrate into the interior in time, according to a law resembling that of the diffusion of heat. Given time enough, it will assume the same distribution as if there were no conductivity, although our assumption is that there is nearly no resistivity—that is, in the ultimate state tended to, it is merely the inductivity that settles how the magnetic induction will distribute itself. Initially, there is a skin current, its total being measured by the difference in the magnetic force just outside and a little way inside the conductor, in the bulk of which there is practically no magnetic force or electric current. As in the case of a perfect conductor, Ohm's law is fully obeyed. There is no internal current, because there is no internal electric or magnetic force. They simply have not had time to get in, on account of the obstructive action of the high conductivity. It is as useless and misleading to say that one electric force is cancelled by another, as it is to ascribe the absence of magnetic force to the counteracting magnetic force of the skin current. As the magnetic force spreads into the conductor, so does the electric current, which is the curl of the former. In the end, when the magnetic force has got steady, the current ceases. There may now still be moving force on the conductor, but not of the same kind as before, it being simply the ordinary paramagnetic attraction or diamagnetic repulsion according as the value of the inductivity of the body exceeds or is less than that of the external medium.

It will be very much the same thing if we start with the conductor at rest in a neutral state in a neutral field, and then establish a steady magnetic field by some external cause. There will still be the same internal obstruction offered by the conductor, and consequent delay in the assumption of the steady state throughout it. In both cases, too, there is a necessary waste of energy involved in the process, according to Joule's law of the generation of heat by the existence of electric current in conducting matter. Thus two things happen when the degree of conductivity is not infinite. First, the reflection is imperfect at the boundary of the conductor, a portion of an incident disturbance being transmitted into it. Next, in the act of transmission and the attenuation involved, there is a loss of energy from the electromagnetic field. We shall see later more precisely the nature of the attenuating process. At present we may note that if the external field be not steady or do not tend to a steady state, so that the conductor is exposed to fluctuating forces, then the internal part of the conductor need never acquire any sensible magnetic force. Thus, if the external field be the sum of a balanced alternating, and of a field which would be steady in the absence of the conductor, only the latter part will penetrate fully into it. The former alternating part will penetrate imperfectly, the more so the greater the conductivity, and, as before said, not at all when the conductivity is perfect. With rapid alternations the region of sensible penetration is only skin-deep, consisting of layers of opposite kinds (as regards direction of the magnetic force, which is nearly tangential), with, however, so very rapid an attenuation of intensity in going inward that practically only one wave need be considered (except for short waves, like light). Of course, the heat generation is now confined to the skin. What goes in further does so by ordinary heat diffusion.

The time-constant of retardation of a conductor varies as the conductivity, as the inductivity, and as the square of the linear dimensions. This refers to the intervals of time required to establish a definite proportion of the steady state under the action of steady forces—in bodies of different size, conductivity, and inductivity, but geometrically similar. Here the two properties, conductivity and inductivity, act conjointly, so that, for example, iron is far more obstructive than copper, although its conductivity is much inferior. It is different with the heat-generation. There the inductivity and conductivity act in opposite senses, for, with the same electric force, the waste varies as the conductivity, or, with the same current-density, as the resistivity. It results that in cases of skin-conduction of rapidly alternating currents, the resistance per unit area of surface varies directly as the square root of the product of the resistivity (not conductivity), inductivity, and frequency. Thus, whilst we may increase the resistance by increasing the frequency, with a given material, and also by increasing the inductivity, we decrease it by increasing the conductivity, in spite of the fact that the internal obstruction varies as the conductivity and inductivity conjointly. The point to be attended to here is that mere internal obstruction is no necessary bar to effective skin conduction, although, of course, in a given case the resistance is greater than if the conduction were more widespread. It depends upon how it is brought about, whether by conductivity or inductivity. This is how it comes about that with the complete internal obstruction of a perfect conductor, with the effective skin reduced to nothing, there is still no resistance, and the slip of electromagnetic waves along them is perfect. But it is different when we obtain the internal obstruction by increasing the inductivity, preserving the conductivity constant. Perfect internal obstruction then means infinite resistance, and no proper slipping of waves at all. If the obstruction be not complete, it will be accompanied by very rapid attenuation of waves running along the surface when the obstruction arises from high inductivity, and by relatively very slight attenuation when it arises from high conductivity.

The repulsive force which was referred to in the case of a perfect conductor brought into a magnetic field, or when a magnetic field is created outside the perfect conductor, arises from its obstructive action, combined with the fact that it is only the lateral pressure of the magnetic stress that acts on the conductor, owing to the tangentiality of the magnetic force. This repulsive force is naturally also operative, though in a less marked form, when the conductivity is not perfect. In fact, it is operative to some extent whenever there is a sufficiently rapid alternation of the field to cause a sensible departure from full

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penetration of the magnetic force, and is, therefore, strongly operative with ordinary metallic conductors with quite moderate frequency of vibration. The remarkable experiments of Prof. Elihu Thomson on this "electromagnetic repulsion" will be remembered. The phenomenon has nothing specially to do with electromagnetic waves. It is magnetic repulsion, rather than electromagnetic, using the word "magnetic" in its general sense, apart from the special fact of magnetisation when the inductivity of the conductor is not the same as that of the ether.

When a conductor is brought into an electric instead of a magnetic field, the case is somewhat different. There is in any case merely skin conduction, for there is an actual destruction of the flux displacement by conductivity. The final result therefore, is that the ultimate permanent state in the conductor is a state of perfect neutrality, just as if the conductivity were perfect. Electric conductivity destroys displacement, but it cannot destroy induction. Similarly, magnetic conductivity would destroy induction, but would be unable to destroy displacement. Thus, a magnetic conductor brought into an electric field would, in time, permit its full penetration, but if brought into a magnetic field the final result would be a state of internal neutrality, however low the conductivity. If, however, it be very low, then, whether it be of the electric or the magnetic kind, there will be an initial nearly complete penetration (owing to the removal of the obstruction), followed by subsidence to zero of the flux appropriate to the conductivity, electric or magnetic respectively. The persistence of magnetic induction, in spite of the presence of electric conductivity, is a very important and significant fact, of which I shall give a simple proof in a later Section, in amplification of my proof of 1887-8. The present method of passing from perfect to finite conductivity is unsuitable for the purpose, because in good conductors the dielectric permittivity is altogether swamped, and is therefore ignored; whilst, on the other hand, in very bad conductors the permittivity is a factor of the greatest importance. Now we can pass continuously from a non-conducting dielectric to a conducting one, up to perfect conduction, but we cannot pass the other way without having the permittivity in view all the time, which makes the matter difficult.

§ 192. As people's memories are very short, and there is some discussion on the subject, I may repeat here that the so-frequently-used word inductivity is not intended for use as a mere synonym for permeability. The latter is the ratio of the inductivity of a medium to that of ether, and is therefore a mere numeric. On the other hand, inductivity has a wider meaning, namely, such that $\frac{1}{2}\mu H^2$ is the density of the magnetic energy, irrespective of dimensions. We can only make it a numeric by assumption. Even then, it has only a fictitious identity with permeability—a forced numerical identity. Similar remarks apply to some other quantities, but they are particularly necessary in the case of inductivity, on account of the obscure and misleading manner in which the connections between induction, magnetic force, and magnetisation were formerly commonly presented (and still are sometimes), together with the misleading connection between the susceptibility and the permeability. We should write

$$p = 1 + \kappa,$$

if p is the permeability and κ the susceptibility, instead of

$$p_i = 1 + 4\pi\kappa_i,$$

where the suffix letter refers to the common irrational reckoning. The 4π is, as usual, simply nonsense, unworthy of scientific men near the end of the nineteenth century. Now introduce Maxwell's ether theory, and make $p = \mu/\mu_0$, where μ_0 is the inductivity of ether, and μ that of some other substance (with the usual reservations), then

$$\mu = \mu_0(1 + \kappa)$$

takes the place of the common

$$\mu_i = 1 + 4\pi\kappa_i,$$

which is misleading in two respects, first as regards the obstreperous 4π, and next in making μ and κ be quantities of the same kind. But κ is always and essentially a numeric, whilst μ is not. We see that the use of inductivity rather than permeability is necessary in electromagnetic theory, as a matter of logical common sense as well as for the purpose of scientific clearness. But this need not interfere with the use of permeability in its above-described sense of a ratio. If, on the other hand, one of the two words should be abolished, there can, I think, be little doubt as to which should go.

In the case of purely elastic magnetisation (without intrinsic), we have

$$\mathbf{B} = \mu\mathbf{F} = \mu_0(1 + \kappa)\,\mathbf{F},$$

where $\mathbf{B}$ is the induction and $\mathbf{F}$ the magnetic force. Here $\mu_0\mathbf{F}$ is what the induction would be in ether, so that the additional part $\mu_0\kappa\mathbf{F}$ expresses the effect of the matter present, which becomes magnetised. The ratio κ, therefore, naturally expresses the susceptibility for magnetisation of the matter. Perhaps, in passing, it might be thought that $\mu_0\kappa$ should express the susceptibility. But this will not do, because magnetisation and induction are similar. The induced magnetisation is $\mu_0\kappa\mathbf{F}$. In strictness it should not be called the intensity of magnetisation, but rather the density, if we properly carry out Maxwell's principles about forces and fluxes, or intensities and densities. $\mathbf{B}$ is a flux, therefore so is $\mu_0\kappa\mathbf{F}$, to be measured per unit area. Now, the common form is

$$\mathbf{B}_i = \mu\mathbf{F}_i = (1 + 4\pi\kappa_i)\mathbf{F}_i,$$

or

$$\mathbf{B}_i = \mathbf{F}_i + 4\pi\mathbf{I}_i,$$

if $\mathbf{I}_i = \kappa_i\mathbf{F}_i$. Here we have, apart from the 4π absurdity, an irrationality of a different kind, viz., that induction and magnetisation are made identical in kind with magnetic force, since we have the difference of two flux densities expressed by an "intensity," which is referred to unit length. Now, this may matter very little in practical calculations, but it is more than mischievous in theory. Suppose, for example, we are working with a kind of mathematics that takes explicitly into account the two ways of measuring vector magnitudes, with reference to length and to area respectively, according as they are regarded as "flux" densities or "force" intensities. Then, if we do not recognise and take account of the radical difference between $\mathbf{B}_i$ and $\mathbf{F}_i$ in the last equation, we may expect to be led to singular and unaccountable anomalies. This is, I think, what has happened in Mr. MacAulay's recent paper on the theory of electromagnetism. The remedy is easy. There should be no special limitations imposed upon the quantities concerned such as occur when permeability and inductivity are made the same.

It is also highly desirable, for the same purpose of obtaining scientific clearness and freedom from distressing anomalies, that the distinction between "induced" and intrinsic magnetisation should be clearly recognised and admitted in the formula. In the above there has been no intrinsic magnetisation. Let this now be $\mathbf{I}_0$. An equivalent form is $\mu\mathbf{h}_0$, where $\mathbf{h}_0$ is the corresponding intrinsic magnetic force. This $\mathbf{I}_0$ is of the same nature as $\mathbf{B}$. The complete induction becomes

$$\mathbf{B} = \mu(\mathbf{F} + \mathbf{h}) = \mu\mathbf{H},$$

where $\mathbf{H}$ is the complete force of the flux $\mathbf{B}$. This is the best way of exhibiting the induction. If $\mathbf{H}$ be split at all, let it be into the part involving the intrinsic force $\mathbf{h}$ and the rest. Or,

$$\mathbf{B} = \mathbf{I}_0 + \mu\mathbf{F}.$$

The other separation, namely, of $\mu\mathbf{F}$ into the ether induction $\mu_0\mathbf{F}$ and the additional part due to matter, is less useful. If done, then

$$\mathbf{B} = \mathbf{I}_0 + \mathbf{I} + \mu_0\mathbf{F}.$$

If we now amalgamate $\mathbf{I}_0$ and $\mathbf{I}$, to make, say, $\mathbf{I}_1$, the total magnetisation, intrinsic and induced, we have

$$\mathbf{B} = \mathbf{I}_1 + \mu_0\mathbf{F},$$

which, translated into irrational units, makes

$$\mathbf{B}_i = 4\pi\mathbf{I}_{1i} + \mu_0\mathbf{F}_i;$$

and lastly, omitting the μ_0 by assuming it to be unity, we obtain the common

$$\mathbf{B}_i = \mathbf{F}_i + 4\pi\mathbf{I}_{1i},$$

containing three faults, the arbitrary 4π, the equalising of an intensity and a flux, and the unnatural union of physically distinct magnetisations.

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"Different men have different opinions—some like apples, some like inions." But can anyone possibly really like the roundabout and misleading way of presenting the magnetic flux relations which I have above criticised? There is no excuse for it, except that it was employed by great men when they were engaged in *making* magnetic theory, before they had assimilated its consequences thoroughly. When the rough work of construction is over, then it is desirable to go over it again, and put it in a better and more practical form. We should copy the virtues of great men, if we can, but not their faults.

Men who are engaged in practical work can hardly be expected to fully appreciate the importance of these things, because their applications are of so highly specialised a nature, in the details of which they may become wholly absorbed. They may even go so far as to say that the paper theory of magnetic induction is not of the least moment, because they are concerned with iron, and although there may be a certain small range of application of the theory even in iron, yet they are scarcely concerned with it, and, therefore, it is of no consequence. There could not be a greater mistake. A complete theory of magnetic induction, including hysteresis, must necessarily be so constructed as to harmonise with the limited theory that has already been elaborated, which is understandable when exhibited in a purified form, freed from 4π's and other anomalies. First of all, we have the ether, in which $\mathbf{B}=\mu_0\mathbf{F}$ or $\mathbf{B}=\mu_0\mathbf{H}$, because of the absence of intrinsic magnetisation. Next we come to elastically magnetised bodies in which the relation between flux and force is linear. Then $\mathbf{B}=\mu\mathbf{H}$, where μ differs from μ_0, being either greater or smaller, and is either a constant scalar, or else (with eolotropy) a linear operator. If there is no intrinsic magnetisation, $\mathbf{F}$ and $\mathbf{H}$ are still the same, and the curl of either is the current density. But should there be intrinsic magnetisation, then $\mathbf{H}=\mathbf{h}_0+\mathbf{F}$, whilst $\mathbf{B}=\mu\mathbf{H}$ still, and it is the curl of $\mathbf{F}$ that is the current density. Or, $\mathbf{B}=\mathbf{I}_0+\mu\mathbf{F}$. The next step is to make $\mu\mathbf{F}$ be not a linear, but some other function of $\mathbf{F}$, to be experimentally determined, if it be possible to express $\mathbf{B}-\mathbf{I}_0$, which is the free induction, as a function of $\mathbf{F}$. Of course, it can be done approximately. Then comes the difficult question of hysteresis. This involves the variation of $\mathbf{I}_0$ with $\mathbf{F}$, with consequent waste of energy. If this little matter be satisfactorily determined, we may expect to have a sound mathematical theory of magnetic induction in an extended form which shall properly harmonise with the rational form of the elementary theory. The divergence of $\mathbf{B}$ is zero all through. The experimental justification of this generalisation is the fact that no unipolar magnets have yet been discovered.

(*To be continued.*)

A NOVEL ELECTROSCOPE.

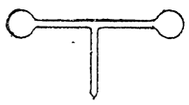
BY E. C. RIMINGTON.

In a Paper entitled "Experiments in Electric and Magnetic Fields," read by the writer in conjunction with Mr. Wythe Smith before the Physical Society last November (reproduced in this paper December 9th, 1892), an experiment was given of the illumination of an electrodeless vacuum tube rotated in a constant electric field between two charged plates.

The writer has since found that this experiment can be much more simply shown by bringing a rubbed ebonite or glass rod near to the rotating tube, when the set of double fan-shaped images of the tube will be developed nearly as brilliantly as when charged plates are employed.

The fan, however, will not be quite as symmetrical as in the case of the plates, on account of the electric field being much less uniform, since the lines of induction, will, many of them, pass to the spindle of the motor or apparatus used to rotate the tube, unless, of course, the tube be fastened to the end of a long rod of some insulating substance. When the rod is moved away from the tube, the number of images in the fan diminishes, as the electric field in which the tube is rotating is weakened.

An ebonite rod excited by being drawn once through a piece of dry flannel, will produce one image when held at a distance of over one foot from the tube, thus forming an exceedingly novel kind of electroscope. The best form of tube to employ is that given in the figure; the straight portion between the bulbs is about the bore of a spirit thermometer, the length about 5in., the T-piece is where it was connected to the pump,



and serves as a means of connecting the tube to the motor. It is not, however, even necessary to employ a motor, as twiddling the tube between the finger and thumb by the T-piece when holding it near the excited rod enables the effect to be obtained, though, needless to say, it is not so good as when the tube is rotated at a uniform speed.

This experiment is an interesting one from the fact that the extra power (infinitesimally small) required to rotate the tube, when in the electric field, is practically converted directly into light.

THE AMERICAN PROPOSALS WITH REGARD TO ELECTRICAL UNITS.

We have great pleasure in publishing the following letter from M. Guillaume, and a translation of the official report of his remarks at the recent meeting of the Société Internationale des Électriciens:—

"Dear Sir: The slight astonishment I felt on seeing my suggestions characterised as 'rather too nice' in the last issue of *The Electrician* was dissipated so soon as I was able to assure myself that they had been misunderstood. As a matter of fact, in all my remarks relating to terminology I only repeated—rigorously defining them—terms already employed for some little time in England in a very precise manner, some of which, if I mistake not, first saw light in your excellent journal. It is very fortunate that these words, created by English electricians, have an absolutely French root and termination [for instance, *reluctance* comes, no one can doubt it, from the French word *lutter*, formerly *lucter*], and we may hope that their form will, therefore, act as their passport, at any rate as much as it has done to words like *meeting* (pronounced *métingue*) and *square* (pronounced *skar*), with which our language has made the mistake of enriching itself.

"I send you, moreover, the text of my remarks, and I think that after you have looked at them, my proposals will seem 'rather reasonable' to you.—I am, Sir, yours truly,

"Ch. Ed. Guillaume.

"Bureau Internationale des Poids et des Mésures,
Paris, March 17, 1893."

[Translation.]

M. Guillaume: The American proposals may be divided into two categories. (1.) Definitions of new units and terms, and a unification of the vocabulary and notation. (2.) Sanction of the values of the legal standards. The first are within the competence of a Congress, the latter belongs to an official Conference. As regards the first, a Congress may come to a decision, as regards the latter, it can only express its wishes, of which, no doubt, a Conference or a diplomatic assembly would take cognisance, though only to the extent it deemed convenient. It will not be without advantage if we clarify our ideas on this question, either at the Congress, or, better still, by preliminary discussions.

The first thing to be done is to adopt a fixed rule for the termination of words denoting the same category of physical properties. For instance, *conductibility*, *malleability*, and *permeability*, are incontestably properties of certain substances, and are independent of the shape or amount. *Resistance* is a property of a conductor depending on its substance and shape. Speaking generally, the English have already adopted the words *conductance* and *permeance* the form of which is absobutely French, so that they will be neologisms for our language and not barbarisms like *self-induction*, *shunt*, *spot*, which have nevertheless been only too widely adopted in France. We should then have the following table:—

Properties of matter.		Values depending on the shape of a body.	
Resistibility.....	$[\alpha]$	Resistance ...	$[R]=[\alpha L^{-1}]$
Conductibility.....	$[\gamma]$	Conductance..	$[T]=[\gamma L]$
Permeability	$[\mu]$	Permeance ...	$[P]=[\mu L]$
Reluctibility	$[\rho]$	Reluctance ...	$[R]=[\rho L^{-1}]$

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In the same way *inductibility** and *inductance*, though it would be convenient to define the meaning of the term induction, which is employed in very different senses. Two meanings would be suppressed by reserving the term *flux of force* for *total induction*, whilst *magnetic induction*, as generally understood, would logically mean *density of flux*, a term already employed. The word *conductance*, to which many electricians find it difficult to get accustomed, would simplify matters considerably; we should enunciate the well-known theorems, in fact, in the following way :—"The total resistance of a series circuit is equal to the sum of the resistances of the circuit." "The total conductance of a parallel circuit is equal to the sum of the conductances of the parallel circuit." The unit of conductance exists, it is the *mho*. Resistance will always have its *raison d'être* in science, but in commerce it is conductance which will become, in the case of distributing networks, the important magnitude; mhos, not ohms, will be spoken of one day in connection with distribution networks. The mhos of a circuit indicate its efficacy. A circuit of n mhos will allow n amperes per volt.

The American Institute has proposed a unit of magnetic field, the *gauss* $=10^8$ C.-G.-S. and a unit of flux of force the *weber* $=10^8$ C.-G.-S. These two units, unrealisable up to the present, only have their *raison d'être* because they form part of the coherent system already adopted. Such, indeed, was the reason for the adoption of the farad. The *weber per second* is a *volt*. But then there is no cause for adopting as the unit of magneto-motive force anything else than 10^8 C.-G.-S. units; since the magneto-motive force is equal to the field multiplied by a length, the unit of force should be the gauss centimetre, and not one-tenth C.-G.-S. If we sacrifice the C.-G.-S. system it should be in favour of the coherent system; another intermediary system would only confuse our ideas.

As regards material standards, I will call attention first of all to a misunderstanding in our Bulletin (p. 100). It is not a question of bringing the mass of silver deposited in the voltameter into relation with the gramme-weight, we can effectively compare by means of a balance the weight of the deposit with the standard weight, but it is a question of deducing the mass of the deposit, the value of g eliminating itself and the corrections for pressure, &c., being easily carried out. In fact, we obtain the mass without any correction by balancing the platinum cup with platinum, and weighing the deposit with silver weights (gilded or platinised).

Without wishing to discuss matters which are, as I have said, beyond the competence of the Congress, I may observe that after the Conference of 1884 the English retained the B.A.U., the Germans the Siemens Unit, and that in France we were divided between the legal ohm and the B.A.U. To-day the English give up the B.A.U., not merely as unit, but even as standard. The first proposal was, indeed, to define the new ohm as $\frac{1}{0{\cdot}9866}$ B.A.U. But after the Edinburgh Congress, to which foreigners were invited, the English unreservedly withdrew their standard, and now define the ohm as the resistance of a column of mercury of 106·3cm., &c. The German Bill just published contains the same proposal, and it is much to be desired that France should also adopt the new ohm. It is so approximately equal to the theoretical ohm, that instead of the B.A.U., the S.E. (Siemens'sche Einheit), the legal ohm and the true ohm, which are at present in existence, we shall only have for a long time to come a single ohm, at the same time true and legal—the 106·3 ohm. Later on, perhaps, there will be grounds for departing from this value, but only very special cases. The reform will be effected without anyone noticing it, since resistance-box makers have taken time by the forelock. The majority of the german-silver standards constructed of late years have been equal to or more than the 106·3. The adoption of the new ohm will be an excellent occasion to restandardise them.†

PARLIAMENTARY INTELLIGENCE.

HOUSE OF COMMONS—THURSDAY, MARCH 16TH.

Clapham Junction and Paddington Railway.

This Bill came before Sir John Kennaway's Committee of the House of Commons last week, when Mr. Pember, Q.C., and Mr. Freeman appeared as counsel for the promoters; Mr. Bidder, Q.C., and Mr. Courthope Monro for the Metropolitan District Railway Company; Mr. Littler, C.B., Q.C., and Mr. Wors ey Taylor, Q.C., for the Metropolitan Railway Company; Mr. Worsley Taylor, Q.C., and Mr. Claude Baggallay for the Commissioners of the Exhibition of 1851; Mr. Fletcher Moulton, Q.C., and the Hon. Sydney Holland for the Commissioners of Her Majesty's Works and Public Buildings; and Mr. Saunders, Q.C., and Mr. Lush Wilson for the City and Guilds of London Institute. There were also petitions against the Bill by the London County Council, the Corporation of the Hall of Arts and Sciences, the London and South-Western Railway Company, the Vestries of Chelsea, Paddington, and St. Margaret and St. John, Westminster, but no counsel appeared in support of the petitions.

Mr. PEMBER, Q.C. in opening the case for the Bill, explained that it would be an electric underground line from Clapham Junction, northward by Battersea Park across the Thames, through Chelsea and under Kensington Gardens to Paddington Station of the Great Western Railway, with a subway to the Albert Hall from the South Kensington Station. The capital of the Company would be £1,050,000, with £350,000 borrowing powers. The line would be made at a great depth below ground on the Greathead shield system, and the motive power would be electricity or cable, or any other means that the Board of Trade might sanction other than steam locomotive. Dealing with the petitions against the Bill he referred to that of the Commissioners of Her Majesty's Public Works and Buildings which alleged that the Royal College of Science included physical laboratories, astronomical observatories and other places for scientific research, and they were advised that if the railway was constructed and worked by electricity as projected, the work carried on at the College for public purposes and for the advancement of science would be seriously prejudiced. Serious disturbance would be caused to scientific instruments and appliances, to the detriment of the public service and the students, while the micrometer and photographic records made by astronomical telescopes, as well as observational astronomical work would be affected, and measurements of precision would be impossible. Commenting upon these allegations, Mr. Pember said if they were true he could only say that the life of London could not stand still even for astronomical and other scientific observations of a group of gentlemen who happened to live in the middle of it, and it would simply show that London was becoming unfit to carry on these delicate observations, and they must be carried on elsewhere. As a matter of fact, however, there was a complete answer to the whole case. After having referred to other potitions and to the probability of the financial success of the line, he called first

Mr. P. M. THORNTON, M.P. for Clapham, who spoke as to the inhabitants of that district desiring the line; Sir W. H. FLOWER, K.C.B., who, on behalf of the Natural History Museum, thought it would meet a public necessity; and Mr. H. A. HUNT, surveyor of Lord Cadogan, who also approved of it.

Mr. J. H. GREATHEAD, the engineer to the Company, then stated the objects of the Bill, and the course it proposed to take, stating that they proposed to have a generating station at Clapham, but the proposed generating station at South Kensington had been given up. The system employed would be the direct-current system. On the City and South London the pressure was 500 volts, but with an overhead conductor he thought the pressure might be increased; in fact, Lord Kelvin, who was one of the members of the Joint Committee of the two Houses who considered this question last year, recommended that by placing the conductor overhead instead of between the rails economy might be obtained by working with a higher potential. They proposed to insulate the currents completely, so that serious disturbance might be entirely avoided. He believed the speed would be 25 per cent. better than on the Inner Circle line, and that there would be ample traffic to make the line a financial success. In cross-examination he said that he did not know what was done within the walls of the College of Science and the City and Guilds Institute, but he did not think the vibrations from the tunnel would affect a microphone. He did not know of any electric railway in England working with the return conductor insulated, but he fancied there was a tramway at Buda-Pesth worked in that way. He was told there would be no difficulty in working with 1,000 volts, but he did not think they would attempt 2,000 volts; he admitted that the greater the potential the greater the danger of leakage. On the City and South London the leakage from the conductors amounted to something like half an ampere for the 6½ miles with 500 volts.

Lord CHARLES BRUCE, Chairman of the Royal College of Music, having given evidence that the accommodation which the line would give to the institution, was favouably regarded by the Committee of that institution,

Mr. CLARK SCOTTER, of the London and South-Western Railway, gave evidence in favour of the Bill, and spoke as to the traffic which his Company would be able to put upon the line.

H.R.H. the Duke of EDINBURGH, on behalf of the Exhibition Commissioners of 1851, expressed his opinion that the line was not only unobjectionable but was one of great importance, bringing the public from two great outlying railway centres, besides the advantage that it would be to the estate of the Exhibition Commissioners and to the Albert Hall. In cross-examination by Mr. Saunders, he said a lease had been granted to the City and Guilds of London Institute, and he would regard anything that prevented scientific education being given to the greatest possible advantage as a detriment to the people, in whom he was interested; but the question was one so simply professional and technical that he did not feel himself capable of dealing with it. From the mode of construction, and the depth at which it would be placed, he did not think it would be likely to cause any damage to the South Kensington institutions.

Mr. ALLEN SARLE, on behalf of the London, Brighton, and South Coast Railway, and Mr. HENRY LAMBERT, of the Great Western Company, having stated that the line was favourably regarded by their companies,

Prof. J. A. EWING, F.R.S., said that he had made a special study of electricity and its applications, as well as of earth tremors, for investigating which he had devised instruments. In conjunction with Mr. Preece he had made special experiments to test the amount and character of the disturbances caused by the South London line, with a view to determine how far they were due to preventible causes. Mechanical vibration would occur whether the train were worked by electricity or not, but magnetic disturbance would occur if the train were worked by electricity, while a third cause of disturbance would be that which proceeded from the electric currents used in the working of the line. In the case of an electric railway with a completely insulated system of going and returning conductors, the last cause of disturbance would not exist at all.

* The Report proposes to adopt the term *inductivity* as a synonym for permeability; one of the two would then play two parts. The latter, very convenient in practice, has, perhaps, the defect of recalling too exclusively a certain theory of magnetism.

† I should even see no disadvantage in keeping the name *legal ohm* for the new ohm, if for a year or two the figures 1893, or perhaps 106·3, are added in parenthesis. In this way we should avoid all confusion, and should not burden ourselves for the future with a new and useless word. On the other hand, the name *true ohm* could be retained for the *theoretical ohm*

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Mr. PEMBER: As a matter of fact, with an earth current, if it is a question of a very delicate hyper-sensitive instrument being disturbed by a railway which passed along, say, within 100 yards or feet of it, it would not be free if the railroad passed within a quarter of a mile.

The WITNESS: It would not be entirely free. The disturbances which the City and South London gives rise to from this cause are felt even for miles through the passage of the current through the earth. The disturbance from earth currents was, however, quite preventible by the use of insulated return conductors, and would not be detectible by the most sensitive test that could be applied.

In cross-examination by Mr. MOULTON, the witness stated that one of the conductors on the City and South London line was insulated, and if the other were equally well insulated there would be no leakage into the ground of a kind to affect sensitive instruments.

A MEMBER of the COMMITTEE: If you had the other conductor insulated could you use the electricity again when it got back to the station?

The WITNESS: No, the energy is expended; it simply goes round in a closed system.

Does it return again? if so, that would look like perpetual motion.—It is rather difficult to give a categorical answer to that question on account of the fact that the circulation of electricity in the conducting system is different in its nature from the circulation of water in a tube. If the current has gone out on one of the conductors and done its work, and comes back along another, it has lost its energy.

But has it sufficient energy to go into the ground and cause disturbance?—That is coming back. It passes into the dynamo again.

Mr. MOULTON: Do you know that it was proved that in America there was not a single railway working with an insulated return?—I am not aware that there are in America any railways of the same kind as that which it is now proposed to construct. An insulated return becomes extremely easy in a tunnel railway. Continuing, he said that with regard to tramways, the practical difficulty in completing the metallic circuit was very great, but there was no practical difficulty in the use of a completely insulated system in a tunnel railway. The magnetic disturbance of delicate instruments was preventible partly by the proper arrangement of the motors upon the locomotives, and finally, if necessary, by the use of a compensating magnet.

Supposing these motors were put in improperly, or there were no proper compensating magnets, would not the Royal College of Science be interfered with?—I think the disturbance which I observed was of such a character that one reasonably could not complain of it as an interference, but if ever it were adjudged to be an interference it could be prevented by the device I have suggested. The simplest way to prevent disturbance by the current working the trains would be to have three conductors instead of two. If the positive conductor were arranged in a central position, and two conductors were arranged alongside of it, parallel to it as return conductors, those two sharing the work of returning the current between them, then there would be no effect outside the tunnel. As to the vibrations, he believed they might be felt in the Royal College of Science if means were taken by instruments of great delicacy to search for them; but he did not believe they would prejudice the work that was carried on in the College.

Mr. MOULTON: With regard to insulation, the return path of the electricity is made an easier one if you do not insulate the return, is it not; and, therefore, you would get more work out of your electricity if you let your insulation get out of order?

The WITNESS said to a small extent it would be so, but the question was too generally put. Inasmuch as any destruction of the insulation on the one conductor would probably also take place upon the other, there would be a cross leakage which would prevent them from getting so much work out of the electricity. The advantage which would be gained by the destruction of insulation would certainly not be enough to form a motive for deliberately destroying the insulation.

Before the Witness's cross-examination was concluded, by special permission of the Committee it was agreed that the evidence of

Mr. W. H. PREECE, F.R.S., President of the Institution of Electrical Engineers, should be interposed. He said that if the contention of the opponents were true that the disturbance must be felt and could not be remedied, it would negative any electric railway being carried out anywhere near London. The Central London Railway, which had been sanctioned, passed within three-quarters of a mile of the Royal College of Science, and that being passed without any protection the College was already subject to the danger apprehended from this railway—if it existed. He agreed that a return metallic circuit inside the tube would remedy any possible danger, and confirmed Prof. Ewing's views on that point. He could not say what the extra cost would be, but the intrinsic value of a second conductor could not be much more than probably £200 a mile.

Mr. SAUNDERS: With regard to the system of insulation, I suppose it could only be effected by the conductors being supported upon porcelain or china bearers.—Yes.

You cannot insulate the rail which is used for electric traction by means of encasing it in gutta-percha or anything of that sort?—Yes; I think the rails could rest on vulcanite.

But the conductor itself cannot be surrounded by that because it has to be touched by the brush and brought into physical contact, has it not?—It does not require to be surrounded, it only requires to be kept from the tube or from the earth.

A very slight accident, even with the best intentions on the part of the Company, might prevent it being effectual by carrying the current to the earth, might it not?—Carelessness, of course, might prevent its working, as would also dust or wet to a slight extent. He was not aware of any case where it had been tried and found to be successful.

In reply to the Hon. SYDNEY HOLLAND, the witness stated that a magnetic screen would prevent the magnetic disturbances from affecting the instruments at the Royal College of Science. The iron tubing of which the tunnel would be formed would of itself act as a screen to prevent the magnetic disturbance caused by the passing of the train from disturbing the instruments at the College of Science. He had not calculated the thickness of which the screen should be made.

Prof. EWING, in reply to the cross examination of Mr. Saunders, gave further evidence as to the results of his investigations into the disturbances caused by the City and South London line, but said that in the present case, if the precautions suggested were carried out, there would be no disturbance save of the most trifling mathematical character.

The Committee then adjourned till Friday.

FRIDAY, MARCH 17TH.

On the Commitee resuming, Mr. WILLIAM TROTTER, of the firm of Messrs. Capel and Trotter, stockbrokers, gave evidence as to the probabilities of raising the capital for the line; Lord SUDELEY, one of the promoters, spoke as to the probable remunerative character of the undertaking, and the large sources of traffic; Mr. ROBERT VIGERS, surveyor, gave estimates of the cost of land and property to be acquired; and Mr. C. S. PEACH, architect, who had devoted special attention to the subject of vibration, stated the results of his observations in connection with the City and South London line were that the ordinary road traffic produced more vibration than the underground electric railway.

Mr. PEMBER said the promoters were ready to submit to a clause which ought to meet all reasonable requirements in the following terms:—"In the event of the railway being worked by electricity, the following provisions shall have effect:—The Company shall use an insulated system of conductors for the conveyance of the electric current to and from the trains throughout the whole of their railway, and shall not permit the current, or any material part of the current, to be conveyed by the earth; the Company shall further construct and maintain their conductors and rolling stock in the way best calculated to avoid producing magnetic disturbance in the laboratories of the Royal College of Science and of the City and Guilds of London Institute; in the event of such disturbance occurring, it shall be open to the trustees (or managers) of these institutions to complain to the Board of Trade, and the Board of Trade may, after due inquiry into the character and extent of the disturbance, require the Company to take such additional precautions to mitigate the disturbance as the Board may deem expedient." He did not for a moment believe he would be able to satisfy the enthusiastic professors on the other side, and therefore he did not offer the clause to them, but to the Committee.

The CHAIRMAN: You put yourself entirely under the Board of Trade..

Mr. PEMBER: Yes, that is my offer to you, sir.

This concluded the case for the promoters, and

Mr. SAUNDERS addressed the Committee in support of the petition of the City and Guilds Institute and the Royal College of Science, stating that the whole existence of those institutions for all useful purposes depended upon the mode in which this matter was settled. As representing a scientific institution, and having to call before the Committee a professor of that institution (Prof. Ayrton), who had specially given himself up to the question of electrical technology, he did not propose to say a single word against electricity as a means of locomotion. He believed that electricity as a means of traction had a great future before it, and that the secret of the improvement of the means of communication in London was very much mixed up with electricity. But if electricity was to be used in connection with this railway the promoters had chosen the very worst possible route by bringing it in such close proximity to institutions where the most delicate electrical experiments were made with the most delicate instruments, which would have the effect of very materially interfering not only with the facility with which they were used, or the advantage with which they were used, but even with the use of them altogether. The case which he should present to the Committee was that there would be three distinct causes of disturbance anticipated from the construction of the railway, viz., the magnetic disturbance arising from the currents in the conductors, and from the leakage, which was the main disturbance, and mechanical vibration and the effect of the moving train.

Lord KELVIN was then examined by Mr. MOULTON, and said for many years he had given great attention to electricity and magnetism, and especially to electric screening. If the proposed railway had uninsulated conductors it would be absolutely ruinous to magnetic work in the City and Guilds Institute and the Royal College of Science, but the effect would be much less with perfectly insulated conductors.

Mr. MOULTON: Prof. Ewing has suggested that there should be one conductor outwards and two returns. Would you tell the Committee your opinion, as a practical man, of that device.

Lord KELVIN: If it were possible to maintain the insulation of all three conductors perfect, and to maintain the practical conductance through the two side conductors absolutely equal, then the disturbance due to the current through the line would be very much diminished indeed by the arrangement proposed by Prof. Ewing. He believed, however, that it would be almost impossible to maintain such a delicate balance. As to the iron tube of the line acting as a magnetic screen, it would do so very effectively if it were 7ft., or even 4ft. thick to a large extent, but it would not annul the disturbance. The effect of a 2in. thickness of tube as a magnetic screen would be practically *nil*. The arrangement of compensating magnets on the motors for the prevention of disturbance, in his opinion, could not be carried out. On the question of vibration, the witness described experiments which he had carried out, and said that he believed in a horizontal component of almost every vibration that they could have from disturbance, and that vibration would prevent the accurate reading of the electrical and magnetic instruments in use at South Kensington

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In cross-examination by Mr. Freeman, Lord KELVIN said that at the various exhibitions at South Kensington there was considerable horse-power employed with various mechanical instruments, and also electrical generation, but he did not know if the electrical generation at all affected the conduct of the College of Science. The disturbance by electric currents, and by the effect of the electro-magnet of the motor, did not require any experiments to tell him that it would be very serious. As to vibrations, they could only be established by special experiments. It would be a very costly kind of experiment to place the railway there and then to find out that it did produce serious disturbance. He did not see any practical way whatever of annulling, or of seriously diminishing, the magnetic effects of the motors by counteracting magnets placed on the car, nor would an iron casing round the motors have sufficient effect to be f practical use.

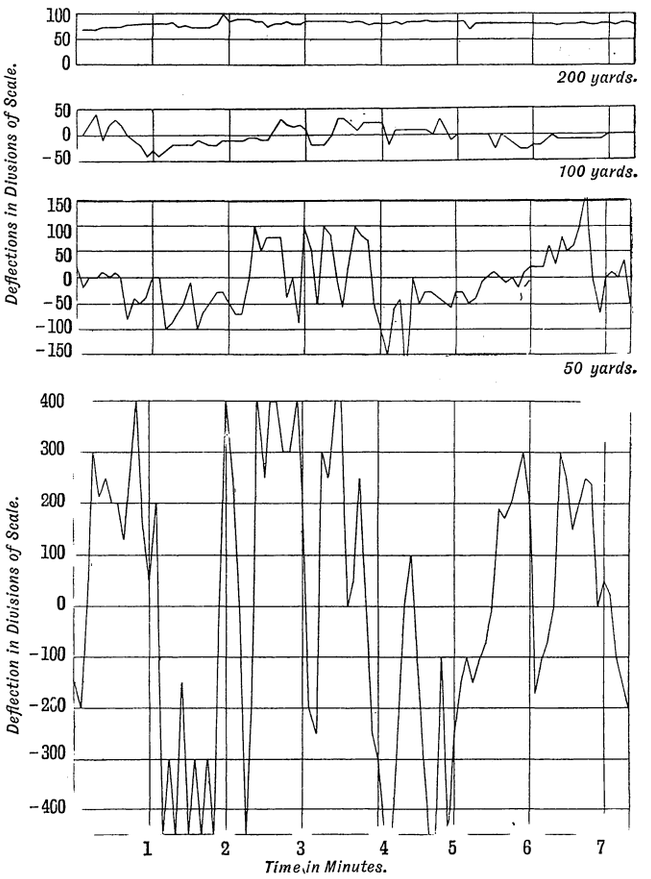
Re-examined by Mr. Moulton, Lord KELVIN, speaking of Prof. Ewing's suggestion of having two return conductors, said that if a bit of paper, or anything of the kind got between the brush and the conductor it would for the time destroy the balance. He did not say that it would be impossible to keep the balance by proper arrangements, but it would be necessary that the conductance of the two should be very exactly equal, and should be always equal and perpetually kept equal

Sir WM. PRIDEAUX, Clerk to the Goldsmiths' Company, who for some years acted as hon. sec. to the City Guilds, produced the Articles of Association of the Institute, showing the educational and technological character of the institution, and gave evidence as to the expenditure which had been made upon it. When the South Kensington and Paddington Subway was first proposed, Lord Sudeley and the promoters met the Council, when it was agreed that a clause should be introduced into the Bill stating that electric traction was only to be resorted to and used with the approval of the Council and of Her Majesty's First Commissioner of Works for the time being, both being unanimous. The Council never conceded that the proposed railway should be worked by electrical traction. That scheme was abandoned.

Prof. W. E. AYRTON said that for the last 25 years he had been profes sionally engaged in connection with the industrial application of electricity. In the early days of electric traction eight or nine years ago, he devoted a good deal of time specially to the development of overhead electric traction, and was in entire agreement with the application of electricity as a means of locomotion. He was, therefore, very sorry to have to oppose this Bill, but at the same time, if passed, it would certainly damage two very important teaching institutions in London, so he felt that he had no alternative but in the interests of science to oppose this particular application. The researches at the Central Institution were not conducted for the entertainment of the professors, but for the instruction of students. He was personally engaged in training men to become electrical engineers, but there were also students being trained to become mechanical engineers, civil engineers and chemical engineers. In all those branches the students were taught the mode of using electrical instruments, so that they might have a fair working knowledge of the commercial uses of electricity. The foundations for the delicate instruments in use were put 6ft. below the floor of the basement, or 16ft. or 17ft. below the street level, in order to avoid disturbances from the street traffic. The foundations, therefore, would not be far from the level of the proposed railway and it was difficult to say whether under those circumstances the railway might not mechanically disturb them. Had they known they were to have the disturbance of burrowing underneath, they would not have gone down to avoid the street traffic disturbances. The mechanical evil, however, would not be nearly as serious as the magnetic disturbance. He produced illustrations (*see* curves) of the disturbance caused in the neighbourhood of the City and South London line, taken by the employment of a portable magnetometer. At 200 yards distance they would get a little disturbance, but at 300 yards for the students' ordinary work (not speaking of the most delicate research), he did not think they would object to the railway. The use of a single insulated return on the line as at present laid out would not protect them from disburbance. Prof. Ewing's suggestion for two insulated returns was a very pretty one, but rather crude. He had himself thought of many suggestions that could he devised for screening magnetic disturbance produced by an electric railway, which were as pretty as that of Prof. Ewing's on paper, and about as unpractical. Any one of those conductors must carry a large current. The current going out of the City and South London, for instance, was about 900 amperes, and any one of the conductors alone would produce enormous disturbance. Now, the promoters proposed to put six conductors so mathematically exact in the tunnels, and they were going to send the current through those conductors so exactly and to regulate the currents and the resistance of the conductors so exactly, that no disturbance would be produced! He had made calculations that if five per cent. of the current preferred to come back by one of the return conductors instead of by the other, with the railway forty feet distant from the laboratory, they would have a disturbance of about thirty-seven deflections. If Prof. Ewing would consent to spend the rest of his life forty-five feet below the Exhibition-road, always regulating the conductors and the current flowing along them, he might attain success; but it was absolutely certain that the ordinary man who looked after an electric railway would never be able to attain success.

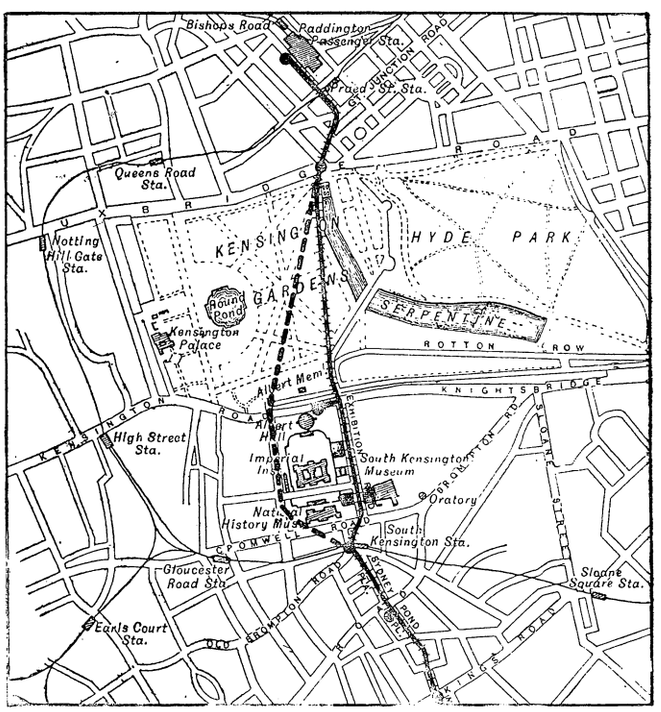
Mr. SAUNDERS: In fact, Prof. Ewing's suggestion is theoretically correct, but practically impossible.

The WITNESS: It is theoretically perfect, but practically impossible. He agreed with Lord Kelvin that it was necessary to have perfect insulation, but, what was much more difficult, they must have the same resistance for each of the return conductors. If one got a little hotter than the other, or wore more than the other, if the brushes of the passing trains made worse contact with one conductor than with the other, then the balance would be destroyed. It was the practice on all electric railways or tramways that he was connected with to use simply the rails and the earth as the returns. Though it was said there was a case at Buda-Pesth where a single insulated conductor had been tried, he did not know it, but to use six insulated conductors, and to make those experiments while the railway was running, at the expense of the laboratories of the City and Guilds Institute and the Royal College of Science, seemed to him to be very



Taken in Prince's-square, 25 yards from centre of Kennington-park-road March 3, 1893. Magnetometer, E. and W. Period = 10 seconds.

[The magnetometer appears, therefore, to have been placed at an angle of about 60° with the line of the railway. We have no information as to the value of the deflections.—Ed. *E.*]



——— Projected route of Railway, according to plan issued by the promoters in January, 1893.

- - - - - - - - - - - - - - Deviation proposed by Prof. Ayrton.

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serious. As far as economy was concerned, it would be to the interest of the railway to let the return current go to earth in as many places as possible. They would want to keep the going conductor well insulated and the others as badly insulated as possible, in order to diminish the total resistance of the circuit. As regards the clause suggested by Mr. Pember, it would be an impossibility for the Board of Trade to enforce precautions. He had made experiments as to the magnetic screening of an iron tube, and while he thought a tube 15 inches thick would have some screening effect, with one of two inches there would be practically no screening whatever. When the Inventions Exhibition was held, the generating plant was some hundred feet from the laboratories, but the main reason for their getting no disturbing effect was that they did not commence their work at the Institution practically till after the reign of the Exhibition. As to Mr. Peach's experiments with regard to vibration, they were most unsatisfactory, as the instrument which he used would not record any horizontal vibration at all, and he did not think it would be very sensitive to vertical vibration.

In cross-examination by Mr. FREEMAN, the witness stated that if the railway was 300 yards away (*see* Map), in the interests of applied electricity he should not think it desirable to oppose it, but even if they did not use an insulated return there it would not be nearly as serious as a line under the Exhibition-road. A line with two conductors perfectly insulated would do far more harm at 25 yards distance than an ordinary uninsulated return at 300 yards distance. Asked if he had ever made experiments in the process of insulating three conductors as suggested by Prof. Ewing, the witness stated that he knew a case where three conductors were used, not in connection with an electric railway, but for the transmission of power at Frankfort. It was proved mathematically that the current going by one conductor divided itself between the other two, and therefore at some distance from the three conductors, it would be apparently impossible to detect the magnetic disturbance. However, some of the German Government officials and himself, believing that it existed, went to find it, and they did find it, showing that it was very difficult to attain such a condition of absolute non-magnetic disturbance with three conductors at a considerable distance —at a far greater distance than there would be between the proposed railway and the Central Institution. The disturbance arising from the inequality of the current upon the return conductors and of the rubbing contact might be diminished, no doubt, by frequent crossing sections.

The Committee then adjourned till Monday.

MONDAY, MARCH 20TH.

Prof. W. E. AYRTON was recalled and gave further evidence in regard to the vibration caused by the trains on the City and South London line which he had observed since his examination on Friday. He said that, standing on the platform, the vibration could be distinctly felt with the feet or with a walking-stick, and putting his hand upon the signal-box, the firm wooden supports, and, indeed, the whole box, could be felt to shake, and the windows were made to rattle even, by the moving of the train in the other tunnel. Therefore, it would not require any delicate instruments to convince him that the vibration would have a serious effect upon the galvanometers and other instruments used at South Kensington. The engines and dynamos which were in use at the College were at the extreme end, away from the delicate instruments, and were ridiculously small compared with what would be used on the railway. The railway would have two machines, one at Clapham Junction, which would convert the mechanical power into electrical power, which would be sent by the insulated conductors ; and there would be a similar machine on the locomotives of the trains, which would convert back again the electric power into mechanical power, so that the moving train would bring within 40ft. of them large powerful electro-motors, which he felt sure would produce very serious disturbance.

The WITNESS was cross examined by Mr. PEMBER as to whether the vibration of the signal-box and the rattling of the windows was not caused by the rush of air through the tunnel. With regard to the use of triple conductors for the avoidance of magnetic disturbance, the witness stated that it was more a question of practice than of theory, but there was one theoretical question which ought not to be forgotten, namely, that they could not arrange three conductors to produce no magnetic disturbance anywhere, but could only arrange the carrying of definite currents so as to produce no magnetic disturbance at a particular place. So that even if it were possible to carry out the conditions of placing three conductors in a tube carrying different currents, and there were absolutely no magnetic disturbance at one place, at other parts of the same building there would be magnetic disturbance.

Mr. PEMBER : Have you calculated at the nearest point of your laboratory what the effect of 5 per cent. of inequality on the part of the return conductors would be, comparing it with the ordinary magnetic action of the earth. I am told it would be only one seven-thousandth part of the earth's magnetic force at the nearest point, and that at most parts of the laboratory it would be less than one twenty-thousandth part.

The WITNESS : Supposing it is one seven-thousandth, that may be a large quantity, because there are certain experiments where the earth's field would interfere with us very much, and therefore a fraction of the earth's field may interfere with us. A changing field equal to the earth's field would interfere with us, but a stationary field like the earth would not interfere with us. If only one train per day will run I should not mind, but they will be running every two or three minutes.

In reply to the CHAIRMAN, the witness reiterated his conviction that neither cross connections, triple-insulated conductors, nor compensating magnets would entirely remedy the disturbance, while the tubing of the tunnel would have to be extremely thick for it to act as a magnetic screen. To have an outer and inner tube with the space between packed even with iron would not be so effectual as a solid iron tube of less thickness.

Prof. NORMAN LOCKYER was then examined by Mr. Moulton on behalf of the Royal College of Science, and described the scientific work carried on at that institution which he regarded as of national importance. Some millions of money had been spent in connection with the College, and the Governors had recently invested another £100,000 for the purpose of increased laboratories, and for the housing of the delicate apparatus which was used for instruction of the students and in connection with their practical work. It would be quite impossible to carry on their work if the railway were to come there.

Prof. A. W. RÜCKER, Professor of Physics at the Royal College of Science, gave similar evidence. Even accepting the proposition that 5 per cent. of inequality in the work of the return conductors would be equal to one seven-thousandth or one twenty-thousandth of the general magnetic force of the earth, he would regard that as serious, though the effect might be largely diminished by the use of cross connection.

Mr. PEMBER : Are not the natural variations from day to day in terrestrial magnetism greater than that difference of one seven-thousandth or one twenty-thousandth ?—Yes, they are during the whole day.

And a professor tells me that you may take them as being fifty times as great ?—I am not able off-hand to say what the maximum is.

In re-examination by Mr. MOULTON, he said the average diurnal variation in the terrestrial magnetism was spread slowly over the whole twenty-four hours, and would affect no individual reading. It was not at all comparable with the disturbances which would be caused by the electric railway.

Mr. C. V. BOYS, Assistant Professor of Physics at the Royal College of Science, speaking with reference to the suggested double return conductors, said that while it certainly seemed on paper a most excellent scheme, and one which, if the enormous counter effects exactly balanced one another, would be an advantageous scheme, yet as a scientific man and not an engineer, he would expect such a suggestion if he had made it to be received by a practical engineer with ridicule. Engineers always found difficulties that the professors could not foresee. If it succeeded the Company would benefit by it, but if it failed the college would suffer. As to compensating magnets or dynamos he did not consider it a practical suggestion. As to shielding the car and motors by a screen, dealing with the car first, if they attempted to put an iron shield outside it, it would be made so much bigger, and in consequence so much worse. To shield the motor would increase the weight of the whole thing very greatly indeed, and they could not by a compensating magnet shield the magnetism of the motor.

In cross-examination by Mr. FREEMAN, he said that insulation alone, even of the most perfect character, would not obviate the evils which he feared of interference with the instruments. A large effect might depend upon there being a going and returning current at a distance from one another, in which there is no leakage at all. If Prof. Ewing's scheme were successfully carried out, and a balance were successfully obtained (a point on which he would not like to offer an opinion), then all magnetic disturbance due to the mains, the mere conductors going and returning, would be obviated for the particular distance at which the balance was complete ; there would be no disturbance there, but there would be disturbance at other places. In the physical laboratories they were more afraid of the magnetic disturbance than of the mechanical disturbance. There were large engines at work at South Kensington Museum, but they did not cause any serious disturbance.

Mr. MOULTON stated that Prof. Huxley would have given evidence, but was too unwell to attend, and Sir Henry Roscoe could also speak to the importance of the work at the Royal College of Science.

The CHAIRMAN said they need not trouble to call Sir Henry Roscoe.

Mr. WILFRED AIRY, C.E., who had had large experience in matters of vibration, spoke as to the vibration experienced in connection with the City and South London line, and said that he did not think the spring machine used by the promoters' witnesses for testing the vibration was a reliable instrument.

This being the whole of the evidence, Mr. Moulton addressed the Committee for the Royal College of Science, Mr. Littler for the Metropolitan Railway Company, Mr. Bidder for the Metropolitan District Company, and Mr. Pember was then heard in reply.

The Committee then consulted for a short time in private, and upon the re-admission of the counsel and parties

The CHAIRMAN stated that the Committee were of opinion that the preamble of the Bill was not proved, and the Bill was therefore rejected.

The promoters of the Clapham Junction and Paddington Railway did not apply yesterday, as announced, to the Select Committee who rejected the scheme on Monday last for their consent to a motion being made in the House for the re-committal of the Bill to the same Committee with a view to placing before them a proposal intended to satisfy the opposition of the City Guilds Institute and the Royal College of Science. The proposal was that the use of electricity should be restricted to within a certain distance of these buildings—that is to say, that the trains when passing these institutions shall be propelled by some mechanical contrivance other than electricity. The non-application for re-committal of the Bill does not mean that one may not be made after Easter. We were informed yesterday that the differences of the promoters with the authorities of the College of Science have been practically settled.

The National Telephone Company and the Salford Tramways.

The Salford Improvement Bill, which came before a Committee of the House of Lords on Thursday last week, the Earl Cadogan presiding, contained a clause to double the tramway along the Eccles road, and was opposed by the National Telephone Company, who alleged that the electrical working of the lines would derange their system. Mr. Balfour Browne appeared for the Corporation, and Mr. Pember for the Telephone Company.

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Mr. BALFOUR BROWNE characterised the petition of the Telephone Company as an impertinent one, and urged that they had no more right to the earth as a conductor than other people; but to save expense they trusted to earth returns for their telephonic communication. At the present time, with the single line, the Corporation had power to use electricity without the Telephone Company having any protective clause against them, and all that they proposed to do was to double the line for the benefit of the public.

Mr. CORBETT, the borough engineer, was called, and proved the necessity for widening the line, and was cross-examined by Mr. Pember as to clauses which the Telephone Company had obtained in the case of other electrical tramway Bills, but the witness admitted his ignorance on that subject.

Mr. PEMBER then addressed the Committee, stating that in the case of the Birmingham Central Tramways case in 1891, the Duke of Westminster's Committee gave the Company a clause with which he would be content in the present case. At Birmingham the Tramway Company had powers to work by electricity all along, and when they came for a small extension the Committee gave the Telephone Company protection in respect of the whole system of tramways. The clause which he proposed should be inserted in the Bill was as follows:—

"For the protection of the National Telephone Company (Limited), its successors and assigns (in this section called the Telephone Company), the following provisions shall have effect in the event of any tramways of the Company being worked by electricity, otherwise than by electrical power carried along with the carriages, that is to say—

(1.) The Company shall so construct their electric circuits and other works of all descriptions, and shall so work their tramway in all respects as to prevent any injurious interference by induction or otherwise with the electric circuits from time to time used or intended to be used by the Telephone Company for the purpose of telephonic communication, or with the currents in such circuits, provided that, as regards electric circuits erected or laid down by the Telephone Company after the construction of the works of the Company, this sub-section shall only apply if reasonable and proper precautions have been taken in the erection or laying down of such circuits, and if they have not been erected or laid down in unreasonably close proximity to the lines or works of the Company.

(2.) Seven days before commencing to lay down any electric line, or to supply electricity through any line, in any manner whereby the work of telephonic communication through any wires or lines belonging to the Telephone Company and lawfully laid down or placed in any position by them may be injuriously affected, the Company shall, unless otherwise agreed with the Telephone Company, give to that Company notice in writing specifying the course, nature, and gauge of such electric line, and the amount and nature of the current intended to be sent along the same, and the Company shall conform with such reasonable requirements as may from time to time be made by the Telephone Company for the purpose of preventing the communication through such wires or lines from being injuriously affected as aforesaid.

(3.) If any difference arises between the Company and the Telephone Company with respect to anything in this section contained, such difference shall be determined by the Board of Trade, whose decision shall be final, and sections 30 to 32, both inclusive, of the Regulations of Railways Act 1868, shall apply in like manner, as if the Company and the Telephone Company were companies within the meaning of that Act.

(4.) Nothing in this section shall apply to repairs or renewals of any electric line so long as the course, nature, and gauge of such electric line, and the amount and nature of the current sent along the same, are not altered.

Mr. WINTERBOTHAM, solicitor to the Company, stated that a protective clause had been obtained in about 50 cases, and the Birmingham clause was even more stringent than that now proposed, but they had only been fought in 10 cases out of the 50.

Lord KELVIN gave evidence as to the disturbance caused to the telephone lines by the working of electric tramways, and said that the twin wire would greatly increase the cost of the Telephone Company. The telephone electric currents going to earth would not act detrimentally to electric tramways or electric-lighting companies.

Mr. BALFOUR BROWNE addressed the Committee, asking them to give the powers asked for, without the protective clause to the Telephone Company, but after a private consultation,

The CHAIRMAN announced that the portion of the preamble of the Bill relating to tramways was proved; but they required that a clause should be inserted for the protection of the Telephone Company, and in reply to Mr. Balfour Browne, said that it was intended to apply to the whole of the tramways.

Mr. BALFOUR BROWNE urged that the clause ought not to apply retrospectively. If the Telephone Company wanted such protection they should themselves introduce a Bill for the purpose. The Corporation of Salford rather than have a clause of that nature put upon them, would withdraw the tramway powers from the Bill, for it would put them under a serious obligation involving, he believed, thousands and thousands of pounds expenditure.

That part of the Bill relating to tramways was, therefore, withdrawn.

Edgware Road and Victoria Railway.

Owing to the pressure on our space, we are compelled to hold over our report of the proceedings in Committee in connection with this Railway Bill until our next issue.

Waterloo and City Railway.

On Tuesday last the Bill for the construction of an electric railway between Waterloo and the Mansion House, which was brought in last Session, was proceeded with before Sir Charles Dalrymple's Committee.

Mr. Pember, Q.C., Mr. Bidder, Q.C., and Mr. Ackworth appeared as counsel for the promoters, and the only opponents were those who desired protective clauses, among them being the London County Council and Mr. Walter, proprietor of *The Times*.

Mr. PEMBER, in opening the case for the Bill, said that it was practically opposed on preamble, the time which had elapsed having given them opportunities to make arrangements with the opposition. The scheme was a very simple one, being to construct a line 1½ mile long at an estimated cost of £610,000, starting from Waterloo Station, passing along Stamford-street, crossing beneath the Thames at Blackfriars, and thence, by way of Queen Victoria-street, to the Mansion House, at depths varying from 15½ft. to 96ft. below the surface of the streets. It was not intended that there should be any stations *en route*, but merely the terminal stations at Waterloo and the Mansion House, the object principally being to afford passengers to Waterloo an access to the City.

Mr. GREATHEAD, the engineer to the line, gave a description of its character and the method of construction, and Mr. SCOTTER, general manager of the London and South-Western Company, gave evidence of the convenience which it would be to passengers travelling by that line desiring to reach the City, and said the proposal was so favourably regarded by his Company that they would be willing to enter into a working agreement with the proposed new Company.

The Committee then formally declared the preamble of the Bill proved, and proceeded to adjust its clauses, and finally ordered the Bill to be reported to the House for third reading.

Baker-street and Waterloo Railway.

On Thursday last week this Bill came up in the House of Commons for consideration of the Lords' amendments, which were agreed to.

Barry Electric Railway.

The Barry Railway Bill, which empowers the Company to construct new dock, railways and tramways to be worked by electricity, and to raise £480,000 further capital, with £160,000 borrowing powers, came before Mr. Mellor's Committee on Wednesday last as an unopposed measure, and was ordered to be reported for third reading.

Brighton and Rottingdean Seashore Railway.

In the House of Commons on Tuesday last, the Brighton and Rottingdean Seashore Electric Railway Bill was read a second time.

BOOKS, &c., RECEIVED.

"Vörschläge zu gesetzlichen Bestimmungen über elektrische Maasseinheiten." By Dr. E. Dorn. (Berlin: Julius Springer.) 90 pp., 4to.

"Bulletin de l'Association des Ingénieurs Electriciens." (Paris: Gauthier Villars et Fils.)

"Polyphased Alternating Currents." By E. Hospitalier. (London: Alabaster, Gatehouse & Co.) 85 pp., 8vo, illustrated.

"Johnston's American Electrical and Street Railway Directory." (*Electrical World* Office, New York. Price $5.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 24th.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "On the Differential Equation of Electric Flow," by T. H. Blakesley, M.A.; (2) "Experiments on the Viscosity of Liquids," by Prof. Perry, J. Graham, and L. W. Heath.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Some Points in the Regulation of Direct-Current Motors," by Francis G. Baily, B.A.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Interference Bands and their Applications," by Lord Rayleigh, F.R.S.

SATURDAY, March 25th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Sound and Vibrations," by Lord Rayleigh, F.R.S.

MONDAY, March 27th.

CHEMICAL SOCIETY.

8 p.m. Annual Meeting. Presidential Address. Election of Officers.

TUESDAY, March 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion: "The Pier Foundations of the Tower Bridge," by G. E. W. Cruttwell, M.Inst.C.E.

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The Electrician.

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All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as evidence of good faith. No notice whatever will be taken of anonymous communications.*

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SPECIAL NOTICE.

With this issue of "THE ELECTRICIAN" is published (Gratis to Subscribers) a fine Steel-Plate Portrait of the late Dr. WERNER VON SIEMENS.

Complaints of non-receipt should be at once sent to "The Publisher."

GOOD-FRIDAY WEEK.

"THE ELECTRICIAN" will be published on THURSDAY in Good Friday week instead of Friday. Communications intended for this issue must reach us not later than Wednesday Morning's post.

Alterations to existing Advertisements and copy for new Advertisements should reach the Publisher on Tuesday, but in any case not later than Wednesday mid day.

ELECTRIC RAILWAYS AND ELECTRICAL DISTURBANCES.

Well may the promoters of the Clapham Junction and Paddington Railway exclaim that they have been wounded in the house of their friends. After three days' costly combat in Committee it was decided, mainly at the instance of Prof. AYRTON, that the preamble of the Bill was not proved. From an electrical-engineering point of view this defeat is to be regretted; we were promised 1000-volt and insulated-return working, both interesting departures from ordinary practice. From the investing and travelling public point of view the deferment of the line for at least another twelve months is also perhaps a matter of regret. On the other hand it is impossible not to sympathise with those in charge of the scientific institutions threatened with earth-currents, magnetic-storms, and anything but harmonic mechanical vibrations. For our own part, we are inclined to believe that the resources of electrical and mechanical engineering would not have been unduly strained in the endeavour to obviate all cause of professorial complaint; but, of course, an ounce of actual experiment is worth a pound of pious belief in matters like this, and it was only natural that Prof. AYRTON and his colleagues should dislike the experiment being made at their expense. Under the circumstances, the promoters would have been well advised if they had consented betimes to a reasonable deviation of trace as well as to the clause rendering them liable for any disturbance which might arise from the operation of the line. Two courses are open to the promoters; the one to sacrifice the present Bill and to introduce another next year, taking the route shown in the map which will be found in another column the other to work the whole or part of the line by cable. It appears

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that Prof. AYRTON would not object to a line constructed *with as little care for leakage* as the City and South London line, if only it went up Queen's Gate. We are inclined to doubt the policy of such a concession. In any case, the South Kensington Laboratories seem to have gained a victory, though at the expense of a good deal of personal feeling and contradictory evidence.

We may now turn our attention to the much wider, and in many respects graver, question of the probable effect of the more important electric railways which have been projected, and which were fully described in our issue of January 13th. And not only to these, but to the working of the Metropolitan and District railways of London by electricity—the solution of which problem every electrical engineer looks forward to as a crowning achievement of the expiring century.

Mr. PREECE recently remarked that the earth currents generated by the City and South London Railway had so disturbed the telegraph instruments on the Continental cable circuits at North Walsham, 130 miles from London, that the passage of every train between the City and Clapham could be checked. But this would only mean that a difference of potential was set up at the London end of the circuit, and, similarly, a waistcoat-pocket battery could cause "serious disturbances" at the other end of an Atlantic cable. Prof. AYRTON does not appear to have been alarmed by earth currents, because he has no long wires by which these might be picked up, and disregarding the earth-current question, he considered magnetic disturbances only. It seems, however, very probable that the greater part, if not practically the whole, of the disturbances recorded by him, were due to the magnetic effect of these very earth currents, which, as the City and South London line is at present constructed, are far more serious than is generally supposed. A railway of this kind with a single conductor is, like a telephone service with one wire, only half built; there can be no excuse beyond that of expense, for using a single conductor and an earth return. The practice is likely to cause a very serious nuisance, on the one hand to the Telephone Company, on whom no sympathy need be wasted, and on the other, to every householder in the district, whether he is in the habit of using magnetometers or no.

On Wednesday last we paid a visit to No. 156, Clapham-road, where a Mr. GLEW carries on the business of chemist and druggist close by the electric railway. Some two years ago Mr. GLEW, who takes great interest in electrical matters, tested his gas and water pipes, and found evidence of strong earth currents. He has for some time past exhibited in his window a simple galvanometer which is strongly deflected, and is always in motion while the trains are running. An ordinary electric bell rings distinctly when connected in the same manner between the gas and the water pipes. The difference of potential has been measured, and is found to be about $\frac{1}{3}$ volt. The effect is less in wet weather than in dry. Even Mr. HARNESS is well aware, when he humanely sells belts without connections, that where there is current there must be corrosion, and as the current in a single house in Clapham-road far exceeds anything that could be generated by a cart-load of belts, the corrosion that must be going on must eventually do more harm than it has done to the whole of Mr. HARNESS's deluded patients. The remedy is so obvious that this part of the subject may be dismissed. But Mr. GLEW has experimented also with an ingenious little reflecting magnetometer, and he finds that when the needle is set by a control magnet (the shop scissors) so that it is approximately at right angles to the railway, hardly any disturbance is observed; when, set parallel to it, however, considerable deflections are observed. This experiment has been repeated with more elaborate appliances by Prof. EWING, and points to the currents and not to the stray field of the motors or to moving masses of iron as the disturbing cause. The iron tunnel, in fact, seems to have no screening effect at all, but is merely a huge uninsulated conductor. The effect of a pair of fairly-insulated conductors leaking only an ampere or so to the mile, and enclosed in and insulated from, and screened by, an iron tunnel, has yet to be tried. It is greatly to be regretted that the City and South London Railway Company were not better advised in this respect from the first. Meanwhile, no experiments and evidence about the behaviour of an iron tunnel, which itself vainly attempts to conduct the return current, are of much use in settling the real question of the disturbances which might be set up by a properly-fitted line. We understand that some attempt has been made to mend matters by a good metallic connection between the sections of the tunnel which are broken at each station; but this is a trifling matter compared with the reasonable precaution of an insulated return. The *raison d'être* of an insulated return is, we may remark in passing, rather difficult to make clear to the uninitiated, but it is a severe strain upon the gravity of a witness to be asked whether its advantage does not consist in the fact that it renders "the electricity" available for further use—after the manner of the oil-circulating arrangements now so common in our central stations. We can almost imagine one well-known electrical joker gravely replying that the insulated return is in a way a disadvantage, inasmuch as "the electricity" is *filtered* by its return through the earth to the generator.

Turning now to the probable nature of the dreaded disturbances other than those due to earth currents, we suppose they are of three kinds—mechanical vibrations, the movement of stray fields of motors, and the variation of the magnetic field due to the permanent conductors. The mechanical vibrations, together with the noise inside the tunnel which is a rather objectionable feature of the South London line, could be greatly reduced by suitable modifications of the permanent way, as on certain portions of the Metropolitan line. The stray field of the motors is of two kinds, the one passive, due merely to the movement of masses of iron. An iron tube is the best possible shield in such cases, but the thickness necessary to quench the effect is difficult to determine. Disturbances of this kind were noticed, it is true, during the original experiments for the determination of the ohm at King's College in 1863, and were due to the passing of iron steamers in the Thames, but in those days the Embankment was not built, and as a matter of fact, the experiments were conducted in a basement room overlooking the river, steamers passing within a few feet of the apparatus. We understand that not only is no such disturbance felt in the present laboratories, either from ships or from the trains on the Metropolitan Railway, but the vibrations caused by the latter are insignificant compared with the tremors due to the street traffic in the Strand. A far more serious, but perhaps more easily cured, disturbance is that due to the stray fields of the motors. Much misplaced ingenuity has been spent in the design of "ironclad" dynamos, in the belief that a stray field means stray energy and low efficiency. An ironclad machine saves a very few ampere-turns, generally at the cost of ventilation and accessibility. Without, then, disparaging the design of the motors used on the City and South London line, we have no hesitation in expressing the opinion that their stray field at some little distance is probably greater than that of any other type. If it were worth while, this stray field could be reduced to a very small amount.

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Messrs. Edser and Stansfield measured the stray fields of a number of machines last year, and by far the greatest effect was produced by an Elwell-Parker dynamotor; and yet such a machine, weighing over seven tons and fixed about sixty feet away from the Millard Laboratory at Oxford, is effectually and completely screened by a layer of nine inches of scrap iron between a brick wall seven feet high, and an inner wall of one-inch boards. The field due to the current in the permanent conductors could be neutralised in several ways. One, a double return, was suggested in evidence before the Committee. Another way would be to wind a few back turns of wire round the unhappy laboratory itself in a plane at right angles to the intruding lines of force. This winding should be connected with the offending conductors, and whatever current they might carry, and in whatever direction, the stray field would thus be automatically cancelled.

REVIEWS.

Transformers: Their Theory, Construction, and Application, Simplified. By Caryl D. Haskins. (Bubier Publishing Company, Lynn, Mass; and E. and F. N. Spon, London, 1892.)

This is a praiseworthy effort to produce a semi-technical yet semi-popular book on the subject of the alternate-current transformer. There is much in it that is good, clear, and even suggestive, marred, indeed, by occasional faults of style or of abstract science, but still useful to the general electrical reader or to the engineer who wants to know something about transformers. Beginning with the notion of the magnetic field surrounding an electric current, and of its propagation outward from the wire, the author at once introduces the notions of Faraday about induction of electromotive forces in conductors in varying fields, and explains in very simple language the fundamental ideas about alternate-currents. The attempt to explain popularly (on page 39) the choking action of self-induction is bold rather than successful. The second chapter winds up with some general ideas about eddy-currents, hysteresis, and magnetic leakage. The third chapter gives the theory in the Hopkinson form. The fourth professes to deal with the evolution of the transformer, but omits all mention of Joseph Henry, of Bachhofner, of Ritchie, and of Sturgeon; and jumps from Faraday to Ruhmkorff, and thence to Jablochkoff and Gaulard. The fifth chapter is on construction, and contains some useful notes respecting American practice, concluding with practical hints. In the sixth chapter, on the transformer in service, there are also some useful hints; but the descriptions of modes of arranging transformers, including an incorrect three-wire plan, which the author rightly condemns, are not all true descriptions of the practice as found in England. Chapter seven describes a number of commercial forms. The seven short appendices relate to high voltages, the welding machine, constant-current transformers, and other topics.

As to the points that seem to us faulty, they can easily be amended in a second edition. We were not aware that the Greeks christened the effect of friction on amber "electron," or that the effect of friction had anything to do with the Greek name of the substance. We were under the impression that the term "Converter" for transformer was invented by Mr. Westinghouse, and that the use of that term was almost exclusively confined to America. The author, however, tells us that it is called converter, "especially in Europe." There is nothing like going abroad for information about ourselves. The old untruth that electricity always takes "the path of least resistance" is trotted out to prove that magnetic lines always do the same thing. If they did do so why should there ever be any magnetic leakage into by-paths of greater resistance? If spelling with capitals is any clue to meaning, one would suspect the author to be in doubt whether parasitic induced currents were discovered by Prof. Foucault or by Prof. Eddy. Of course he knows better himself. He omits to mention on page 51 how complete a remedy against eddy-current losses in the copper is afforded by stranding the conductor. An author who states that "in Europe it is the general practice to install them (the transformers) *within* the building whose lighting service they are to maintain" must beware of the wrath of Mr. Musgrave Heaphy and of all the fire-insurance offices. His recommendation on page 103, that the transformers should be placed "when out of doors, either on the side of the building, or still better, *upon a pole* when available" is not explicit enough. He ought really to say whether a north pole or a south pole is the more suitable; otherwise we poor Londoners who have no other sort of pole "available," might be in doubt. Perhaps, like Mr. Crompton in the fervid words of the newspaper reporter, we might prefer to erect the apparatus upon the horizontal component of the earth's magnetism. If Mr. Haskins will acquaint himself with European practice as it is, and not write of it as it is only supposed to be, he will make his book of more use to English readers. The very success of those parts which describe American practice leads us to think him capable of yet higher efforts; and we welcome him into the field of electrical literature.

The Practical Management of Dynamos and Motors. By F. B. Crocker and S. S. Wheeler, D.Sc. (London: E. and F. N. Spon.)

The contents of this little book appeared as a series of articles in the *Electrical Engineer* of New York, between September, 1891, and May, 1892. Its object is to give simple directions for the practical use and management of dynamos and motors, both during runs and at breakdowns. Admittedly incomplete, this work forms but the skeleton of a larger and more elaborate treatise on the subject. The first three chapters are introductory, and are designed to teach those who do not know what a dynamo is. The remark that "fine finish" on a machine causes it to receive much better treatment than if of good but "unfinished" construction, is worthy of consideration. Well finished fittings on a machine cost something, but one is satisfied if their inspiring presence guards the machine from rough treatment and reduces the cost of repairs. Chapter III. gives directions for setting up a machine. It is rather vague information to be told that the thickness of a belt is "somewhat a matter of taste"; especially when no directions for proportioning the width and thickness according to the diameter of the pulley are given. And it is "putting the cart before the horse" to say that the belt should be half-an-inch less wide than the pulley face. A useful chapter on the coupling of all sorts and conditions of dynamos in parallel and series follows this. The diagrams, which are given in almost every case, are very clear, and the descriptions may easily be followed by inexperienced persons. One regrets that no diagram is given for coupling alternators in parallel, and that this case forms the only exception to the explicit information. If there is any case where a novice is likely to require careful direction, aided by diagrams, it is this case. Only those who "know all about it," as it were, could follow the account given of how to get alternators into step. The directions for testing machines are crowded into a small space and suffer in consequence; but the table of tests may prove useful, and the directions for brake tests are fairly explicit. An appendix, dealing with the "localisation and remedy of troubles," sets out, after the fashion of a "family doctor," the cause, symptom, and remedy for an immense number of dynamo diseases.

Electric Lighting and Power Distribution. Part I. By W. Perren Maycock, M.I.E.E. (London: Whittaker and Co.)

On taking up a small book, provided with flimsy paper covers after the fashion of a cheap catalogue, and looking at its preface, we find that it is designed as an elementary manual for students preparing for certain examinations. Before passing on to review the contents of this work, we may stay to express the opinion that in the hands of an average elementary student this manual would be in fragments before it could steer him to the desired haven of the examination hall. Above all things, elementary text-books require to be well-bound, even though the price must be three-and-sixpence instead of half-a-crown. The reader of this work is expected to have some acquaintance with the fundamental principles of the science of electricity, though a brief recapitulation of the

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elements is given in the earliest three chapters. Almost the whole of page 14 is filled by a list of "good conductors," the list including such items as "telephonic silicium bronze" and "telegraphic silicium bronze"—a fine distinction indeed; but the list, as it stands, is covered by one word—*metals*. Why should an elementary student be troubled with the doubtful distinction between the terms *conductance* and *conductivity*, or *resistance* and *resistivity*? It will be time enough to use these terms in an elementary class when they are recognised outside a small class of abstract mathematicians whose accurate work demands such niceties, or among scientific pedants. On page 24 there is a technical error, where it is said that in every circuit there is both E.M.F. and P.D. (potential difference). There are important cases where a current is set up in a circuit by the former without the existence of the latter, as, for example, when there is a change of uniform magnetic induction through a closed circular ring. The multiplicity of "screw rules," "clock-face rules," and "hand rules" for finding the direction of a current or of a magnetic field, which we find in Chapters III. and IV., is apt to confuse the beginner, who would do better if given one good rule, or better still if compelled to use his theoretical knowledge alone. Specially confusing to some students is the author's "hand rule" which makes the current flow in the direction of the thumb. A far better known rule makes the current flow in the direction of the fingers of the right hand, while a magnetic needle moves like the thumb. Rules such as these may well be placed in an electrician's pocket-book for ready use by a practical man whose college days are over and whose theoretical notions are getting rusty, but they are likely to be abused if introduced into the college curriculum. Rules like these should never replace theory—which they are prone to do if taught at too early a stage in the course—and the less an elementary student knows of them the more likely is he to seek to master the theory on which they are based. The *pièce de résistance* is evidently Chapter V., which deals with electrical measurement. By far the longest chapter in the book, this covers the ground of electric testing and testing instruments, and deals with the subjects in a manner to be easily understood by a beginner. In one of the many illustrations forming part of this chapter there appears to be a slight mistake. The twisted strip voltmeter shown on page 100 would not work if constructed according to the drawing; for it is essential that the upper half of the strip should be twisted in the *reverse* direction to the lower half. Chapter VI., which concludes this part of the work, deals with the principles and construction of modern dynamos, a subject which is to be continued in Part II. At the end of each chapter a list of questions, to be answered by the student, is to be found; and a few blank pages have been bound in at the end of the book—details which materially enhance the value of the work as a class-room text-book.

Hulfsbuch für die Ausfuhrung elektrischer Messungen. By Dr. Ad. Heydweiler.

This is an excellent reference book for laboratory use, containing, as it does, a description of almost every possible method of making the various electrical measurements necessary in everyday work. A glance at the table of contents will show the completeness of the compilation. Beginning with the usual description of the electrical system of units, the author goes on to describe mirror methods of measurement and treats of period of needles and damping, of suspensions and magnetic control, and measurement of the field at a needle. The second chapter treats of measurement of current, including both constant, intermittent, and momentary flow. Chapter III. deals with resistance, and gives every conceivable method of measurement. Chapter IV. treats of the measurement of pressure and of energy. Chapter V. includes measurement and calculation of the various constants of a circuit or coil, self-induction, &c. Chapter VI. deals with capacity and properties of dielectrics; while Chapter VII. gives methods of determining "v" and the ohm.

A series of excellent tables closes a book of reference which may be confidently recommended to all whose work lies in the direction of accurate electrical measurements. Unfortunately, the book is, as is usual in Germany, very badly bound.

A CURIOUS ACTION OF ATTRACTION BY ALTERNATING CURRENTS.

BY ELIHU THOMSON.

A curious case of apparent attraction of closed circuits in the neighbourhood of an alternating magnetic pole, which was found in experimenting on the repulsive effects, is worth recording.

Let P (*see* Fig. 1) be an alternating magnetic pole, produced by a bundle of iron wires surrounded by a coil through which alternating currents are passed, and C a copper disc considerable smaller than the pole end P. As the disc C is approached to P it will, of course, be found that it is repelled, or that a certain force has to be overcome in bringing it nearer and nearer. It will be found, however, that instead of increasing as nears the pole after a certain position has been

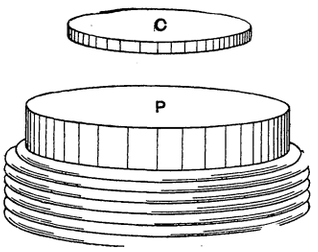

Fig. 1.

passed, the repulsion diminishes, then disappears, and is at last replaced by an attractive force of considerable amount, which increases down to the position of actual contact with the pole. It is assumed that the disc C be kept parallel to, and central with, the pole face P

The explanation of this apparent anomaly is, I think, simple. The attraction appears to be due to the nearness of the disc C to the iron core. Currents are induced in C which, owing to the small diameter, relatively, do not suffer as great lag as when induced in rings or discs which encircle the pole. These currents exert an attraction for the iron of the core which at last becomes superior to the effort of the repulsion, which is feeble. The induced currents in C, in seeking a better magnetic circuit for their induction, cause the disc C to approach the core. The strongest attraction will, of course, exist when the current which energises the pole P is passing its zero value. At this time the attraction will be understood by a glance at Fig. 2, where the magnetic effects of currents in C now have free action on the pole P.

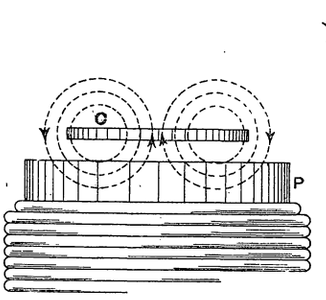

Fig. 2.

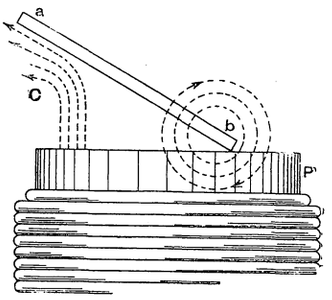

Fig. 3.

A pretty modification of the experiment, and one in which both attraction and repulsion take part, is indicated in Fig. 3. The disc may be set in the position inclined, as shown, and attraction at b may keep it from being thrown off the pole, while repulsion at a sustains something less than one-half the weight of the disc in the inclined position shown. If the alternating pole be presented in a horizontal direction, it will also be found that the disc will adhere to the pole and slip down to a position below the centre. If it slips too far down, the attraction is at once replaced by a quick repulsion which casts the disc away from the pole quite suddenly. With the pole completely inverted or facing outward, the attraction will be sufficient, in some cases, to hold the full weight of the disc against the pole.

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A HYSTERESIS THEORY OF BROWN'S ALTERNATING CURRENT MOTOR.

BY J. A. KINGDON.

The single-phase motor of Mr. C. E. L. Brown which is the latest attempt to solve the alternating-current motor problem, has been fully described in *The Electrician* of January 27th, and has no doubt attracted a considerable amount of attention on account of its undoubted novelty and its extreme simplicity. No attempt has been made to explain, or even to indicate, the nature of the actions which produce the motion, but as a clear idea of what takes place in the motor may lead to further developments, it is proposed to investigate the matter in a common-sense fashion, and without recourse to the abstruse mathematical expressions which are so prominent a feature of our *fin de siècle* electricity.

It is usual to commence an attack on alternating-current problems of this nature, with the statement that "secondary currents are in quadrature with the inducing primary currents." The meaning of this expression is, that the induced secondary currents are zero when the primary currents have their maximum values, and are at their maximum values when the primary currents are zero. As the reaction between currents in quadrature is nil, so that no atttaction or repulsion could be set up by them, it is then usual to call in the assistance of *self-induction*, which produces according to this theory a lag of the secondray current and sets up a repulsive action between the primary and secondary currents.

Now, in the first place, secondary currents are *not* in quadrature with the inducing primary currents. Setting aside the initial magnetising current, the behaviour of which has already received consideration in these pages, secondary currents are very nearly cophasal with, but opposite in direction to, primary currents. That is to say, primary and secondary currrents attain the maximum values and zero values at almost identical moments of time. The truth of this statement has been proved experimentally, but it may be pointed out that the mere fact of the "parallel regulation of transformers" proves it conclusively without further experimenting. The reasoning is as follows:—

If the primary of a transformer be connected with a supply of alternating current at a fixed pressure, the pressure at the secondary terminals (allowing for a slight drop at full load) will remain constant for all values of the secondary current from zero to full load. It follows from this that the maximum induction reached in the iron of the core is constant for all loads. But as the secondary current increases from zero to its maximum value, the primary current increases from the initial value of the magnetising current of the transformer on open circuit to 50 or 60 times (in a good transformer) this value at full load. If the secondary current were in quadrature to the primary current, that is, if its value were zero when the primary is at a maximum, the magnetic induction of the core would increase very considerably and the pressures would rise. As a matter of fact, the constancy of pressure shows that the magnetising effect of the induced secondary current is equal and opposite, putting out of the question the initial magnetising current, to the magnetising effect of the primary current. *The secondary current is, therefore, identical in phase and opposite in direction to the primary current.*

Next, as to self-induction. Self-induction is like charity. "Charity covereth the multitude of sins." Self-induction explaineth the multitude of obscure phenomena.

As the writer mistrusts this constant use of self-induction in a vague and inaccurate sense, he will proceed to the investigation of the Brown motor without further reference to it.

The first point that strikes the eye in the diagrams of the various types of motor is that, with one exception, the air-gap between the fixed and moving iron is absolutely uniform, although in the inducing part there are well defined through constantly changing magnet-poles, and not a pair of rotating poles as in the two-phase Tesla-Ferraris motors. If the motor is at rest no movement is set up when the current is switched on, although considerable secondary currents are induced in the windings. If we suppose that a North and South pole are momentarily set up at N and S in the primary magnet of Fig. 1, it follows that the secondary currents tend to magnetise the secondary magnet *n* and *s* with magnetism tending to counteract the magnetism of the primary current, but the latter, having the dominant magnetism, masks that of the secondary current. This is an instantaneous condition of the apparatus when at rest.

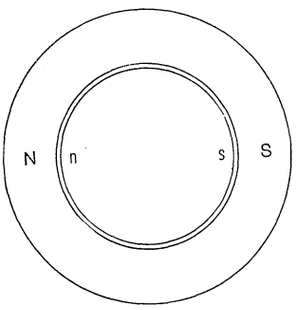

FIG. 1.

If, however, by some device, mechanical or electrical, the motor is once started, the effect of hysteresis comes into play, and different conditions result. The effect of hysteresis or magnetic viscosity is as follows:—A piece of soft iron magnetised by a current retains a good deal of its magnetism even if the magnetising current falls to zero. If instead of reducing the current the magnetic resistance is increased, for example by increasing the air-gap, the same effect takes place. In the Brown

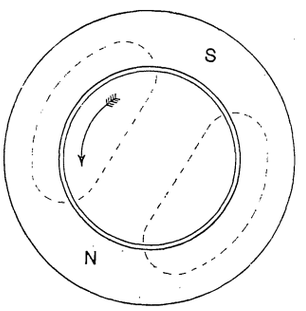

FIG. 2.

Motor the air-gap being uniform, the effects of hysteresis will be particularly marked, the result being that if the interior magnet is moved in the direction of the arrow in Fig. 2, the hysteresis of the iron distorts the magnetic field in the manner indicated in the figure.

Now, the phase of the secondary currents is identical with that of the primary current, but their direction depends upon the position of the resultant magnetic field as distorted by the motion of the inner magnet owing to the hysteresis of the iron.

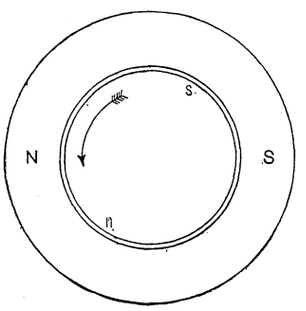

FIG. 3.

The result is, that the polarity set up by the secondary currents is no longer in the line N S of the poles of the primary magnet, but is distorted through an angle as shown at *n* and *s* in Fig. 3.

It will be noticed that the secondary poles in Fig. 1 are of such a sign as to be repelled by the primary poles, but, being in a symmetrical position in relation to them, there is no rotation in either direction, although the rotating part of the motor

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is in unstable equilibrium. As soon as the polar symmetry of the arrangement is destroyed by the rotating part of the motor receiving motion in one direction or the other, the repulsion between the primary currents and the secondary currents is no longer balanced, but has a resultant in the direction of the arrow in Fig, 3, which is in the same direction as the motion in Fig. 2. It must, however, be remembered that, even if the rotating part of the motor is in motion, the secondary poles would still remain opposite the poles of the primary current, were it not for the effect of hysteresis in distorting the resultant magnetic field of the two parts of the motor. Perhaps it is advisable to point out that the primary current tends to prevent the distortion of the field by the motion of the rotating part, and no doubt does so to a great extent, as long as the value of the primary current is considerable.

The secondary currents, generated as they have been by the previous magnetic wave, and having the polarity of Fig. 3, while they tend to accelerate the motion, also tend to reduce the distortion produced by hysteresis, and, in fact, to distort the field in the opposite direction. Hence there is not much actual distortion of the magnetic field until the primary and secondary currents decrease almost to zero, which, as has already been pointed out, they do nearly simultaneously, and it is near the time of their zero values that the combined hysteresis of the iron and the rotation of the motor produce the distortion of Fig. 2. The effect is, that the next wave of secondary currents are set up with an unsymmetrical polarity, by which, as Mr. Brown points out, "a turning moment is produced."

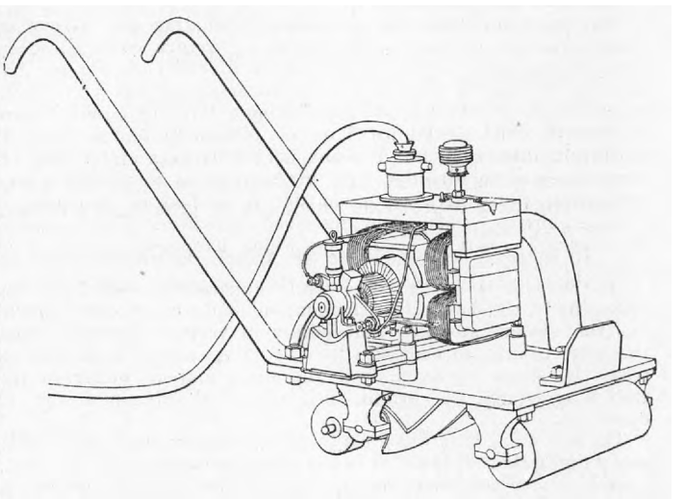
The foregoing explanation may be termed "the hysteresis theory of alternate current repulsions," as distinguished from the "self-induction theory" already alluded to. Experiments are, no doubt, needed to ascertain the exact effect of hysteresis under the conditions of lengthening the magnetic circuit, or rotating part of the iron which composes it, as well as under the conditions of varying the exciting current, and it is hoped that the attention of those who are able to undertake such experiments may be drawn to the matter.

When the cores of the fixed and rotating parts are both smooth and without slots or recesses for the wire, there is no considerable resistance, except that of hysteresis, to the shifting round of the magnetic poles, so that, even if the speed is synchronous, there is no great tendency to keep it so. If, however, the rotating core is deeply slotted, as in Figs. 3 and 4, p. 359, well-defined poles would be set up in the rotating part which would tend strongly to synchronise with the alternations of the current, and every time the poles shifted past a slot the lines of force would cut the thick copper conductors, and set up strong secondary currents which would have a synchronising action.

If the foregoing explanation of Brown's motor is correct, it is likely that hysteresis, which has hitherto been regarded merely as a vexatious and wasteful phenomenon, may turn out to be a property of great value to the electrical engineer.

A NEW ELECTRIC TOOL.

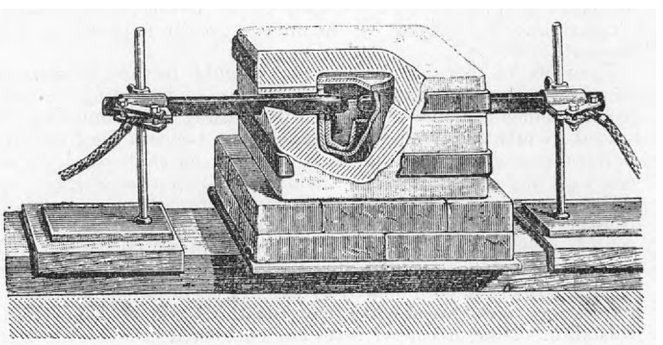
The use of electricity for transmitting power has been steadily increasing during the last few years. Not only is it often found better than mechanical transmission, but in many cases it enables mechanical power to be applied to work where, without electricity, it would be quite impracticable to use anything but hand power. One of the latest machines of the latter kind, our illustration shows, is an electric deck-planer, invented and patented by Mr. Malcolm Sutherland, electrical engineer to Messrs. Wm. Denny and Brothers, the well-known shipbuilders of Dumbarton. It is used for planing the decks of the ships, and is so simple in construction that very little explanation is necessary. The tool resembles a lawn mower in form, and is handled in the same way, and with as much ease. A steel base plate is mounted on rollers, and on the underside of this the revolving cutter is fixed. The electric motor is geared to the cutter by means of toothed wheels. One of Rawlin's spiral cutters is used, and revolves at a speed of 3,000 revolutions per minute, the motor having a speed of 2,000 per minute. The rollers which follow are fitted with eccentric journals, so that by moving a lever they can be raised or lowered and the depth of cut nicely adjusted. The machine does very good work, is faster than hand planing, and relieves the men of a very dis-



agreeable job, as the planing of decks by hand involves kneeling, or sitting in a very uncomfortable position. Current is supplied to the motor by means of a twin flexible lead, and the whole machine is of a very compact and portable nature.

THE MOISSAN-VIOLLE ELECTRIC FURNACE.

At a recent meeting of the Académie des Sciences MM. Moissan and Violle exhibited one of their electric furnaces made by M. Nion, head of the Physical Laboratory Workshop at the École Normale. The essential feature of the furnace is a closed cylindrical carbon vessel, having a diameter equal to its height, the material being an agglomerate of tar and powdered retort carbon. This vessel consists of a carbon tube resting on a slab of carbon, and having another slab of carbon resting on it at the top. Inside this cylinder a carbon crucible is placed, as shown in the figure. The whole is enclosed in a block



of limestone, similar to those employed by Deville and Debray, in their platinum-melting experiments. The carbon vessel does not touch the walls of the limestone block, but is separated from it by a 5mm. air-gap, the bottom resting on magnesia supports. The dimensions of these furnaces depend, of course, on the purpose for which they are intended. When currents of between 300 and 500 amperes are to be used, MM. Moissan and Violle employ a carbon cylinder 6·5cm. in diameter, carbon electrodes 3 to 3·5cm. in diameter, and a block of limestone 20cm. high, 2·5cm. broad and 30cm. long, the lid having a thickness of 4 to 5 cm. The carbons are held in iron sockets carried on movable uprights.

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GROUND PLATES VERSUS A CONTINUOUS COPPER RETURN.*

A very unusual and singular occurrence took place on an extensive electric railway system in the north-west last month, during a spell of unusually cold weather, which has attracted considerable attention in the electrical field.

The question of the proper method of bonding the rails of an electric railway, or otherwise providing a "return circuit," seems from current practice to admit of a great diversity of opinion; but latterly this part of electric railway construction has been given more attention, with a view to providing a "return circuit" more consistent with the known laws of electricity and economical operation of the system. The unusual occurrences on the road referred to bear so directly upon this subject as to present a very favourable illustrative argument for a method of providing a "return circuit," such as is described hereafter. The essential features of the various occurrences which happened on this road were as follows:—

In the middle of the day, while apparently everything was operating to the best of satisfaction, suddenly every car throughout the system stopped, and horses in various localities about the city, coming in contact with the rails, were knocked down from the shock received, and the main ampere meter in the station registered no current, although all the dynamos were in operation.

The first thing that was done to try to remedy the trouble after ascertaining that all fuses, switches, dynamo connections, &c., &c., were in proper condition, was to run from the negative line bar in the station a cable into an adjacent river bed, thus providing an excellent ground for the dynamos. But this did not obviate the difficulty; the ampere meters still registered no current, and cars refused to move; this proved conclusively that it was not lack of dynamo grounds that caused the trouble. Attention was next directed to the track feeders, which were buried in the ground and connected the track with the negative sides of the dynamos. They, upon inspection, were found with their soldered connections melted, the wire itself very hot and burned for a length of two feet. A new cable was immediately provided in place of the burned one, and the road then started up in as good order as before.

That the earth was in a condition offering great resistance to the flow of electricity through its surface, either on account of its being in a dry frozen condition or for some other peculiar local condition, or that the rails themselves were practically insulated from the earth, which, when it is considered that ice is a very good insulator, it can easily be imagined possible to occur in cold weather, is very evident from the fact that the soldered connections in the track feeders were melted. This melting of the connections would only have occurred by reason of excessive current passing through them, which being the fact, occurred because the rails alone were conducting approximately the entire amount of current necessary to operate the system back to the station. This could only occur when the earth was in a condition offering great resistance, as compared with the rails, or when the rails wore insulated from the earth, for usually under normal conditions the "return circuit" offered by the rails is greatly supplemented by the earth itself.

The facts of this case being thus brought to view, present in themselves a strong argument in favour of providing suitable grounds along the line of an electric railway, by connecting the rails at frequent intervals to the moist earth beneath the frost line. Besides preventing such mishaps occuring as shutting down an entire railway system, it would furthermore prove a valuable adjunct in the economical operation of a railway, for it would very materially decrease the total resistance of the circuit. In this manner dry earth is a very poor conductor. The earth in actual contact with the rails is dry during the greater part of the year, particularly in summer; thus the path offered by the dry earth for the current to find its way to the moist earth underneath is one of considerable resistance. Now, if copper wires are connected between the rails and the moist earth an easy path of very little resistance is immediately provided, and as it is desirable to have as much current return through the moist earth as possible, as being a medium offering the least resistance, infinitely less than the rails, the advantages of this method of construction are very apparent. These grounds should be provided at least every tenth of a mile, or as much oftener as circumstances will admit. The wire should be as large as No. 0 B. and S., and connected to both rails if a single track, and to all four rails if a double track road.

If without these track grounds there is any advantage in running a copper return wire the whole length of a railway, a method of construction the economy of which is very much to be doubted, with these track grounds it is only a useless expense, for in providing a conductor of no resistance for "the return," as is a case in using the moist earth, why supplement this by another one of infinitely greater resistance, as would be the case in a copper return wire? Another difficulty overcome by providing these track grounds is the complaints made by telephone companies, where they themselves use the ground as a return, that at a certain period adjacent electric railways cause all their annuciators to drop in the central office. This is due to the railway not having efficient track grounds, in which case the current seeking to "return" through the dry surface of the earth, runs across a grounded telephone wire. This offering a path of less resistance than the dry earth, it immediately chooses this wire upon which to return. Thus, passing through the telephone central office, it drops all their annunciators. This fault can be obviated by providing efficient track grounds in manner as above described.

* From the *Street Railway Review* of Chicag›

INDIRECT LIGHTING.*

Our Viennese contemporary, *Der Gastechniker*, in its issues, Vol. XVIII., Nos. 6, 7, 8 and 9, gives a series of Papers by Dr. Franz Menning, which originally appeared in *Der Gesundheits-Ingenieur* (the *Sanitary Engineer*), on the subject of indirect lighting. The Papers are based on experiments made by Dr. Menning in the Hygienic Institute of the University of Halle. He remarks that short-sightedness in school children is often due to insufficient lighting, which makes them bring their eyes too close to their work, and thus makes them squint, and damages the accommodation of the eye. In many instances this is the case even with daylight, as, for example, in buildings in narrow streets and so on; but artificial light is usually in a still worse case. It is only recently that we have been able, since the introduction of Weber's photometer, to measure the actual illumination in such circumstances. Another serious cause of injury to the eyes is the fact that in many schoolrooms, lecture-rooms, and the like, there are many lamps or burners used, and that these, or some of them, are in sight, and worry the eye. The lamps are also often overhead, and cast a strong shadow of the writing hand, or of the head, or of the upper part of the body; and this strains the eye. Farther, the distribution of the illumination tends to be very unequal; in a lecture-room in the University, the illumination of the six seats on one bench was found to be 8·4, 12·7, 45·8, 74·9, 16·9, and 11·0 candle-metres;† the reason for this extreme inequality being that an argand lamp was suspended above the middle of the bench, and fitted with a polished reflector. Another evil is, that reflectors send down radiant heat; and this makes it necessary to put the lamps higher up, with the result that less benefit is derived from them as illuminants. Daylight does not present these disadvantages, at any rate to a corresponding degree, and it appears desirable to assimilate our artificial lighting to daylight, so far as may be.

Daylight is diffused light; lamplight is direct light. The problem accordingly is to transform direct light into diffused light. In order to accomplish this, the device has been hit upon of placing white reflectors under the flame, and throwing the whole light upwards on the ceiling, the flames themselves not being then visible. This seems to have been first done with arc-lamps, in the Paris Electrical Exhibition of 1881, and in the Vienna Anatomical School, and also the Industrial Museum. It was also done in two engineering drawing-rooms in Leipzig; metallic reflectors, white varnished internally, were used under bare arc lamps; the ceiling was the brightest part of the room, and the lower part looked as if it were dark, but for working purposes was found not to be so, even for fine drawing work. Prof. Erismann, of Moscow, first introduced this method of illumination into schoolrooms in 1888. The lamps used were petroleum lamps. He illustrated the method in the Moscow Exhibition of that year. The visitors were unanimous in their approval; there was nowhere any trace of shadow; it was equally easy to read at all points in the room, and also easy to do all sewing, except stitching in black. The contrast between the shadows under the hand by direct lighting and their absence under the new method was very striking. There are, however, no data as to what was the loss of lighting power as compared with the older method; and it seemed desirable to ascertain this.

Through Prof. Renk's favour, Dr. Menning has had the opportunity of doing this in the University of Halle. The lecture-hall of the Hygienic Institute is fitted up with four Butzke regenerative lamps, placed so near the ceiling that their products of combustion escape at once through openings in it. The flames themselves are about 9ft. 4in. above the desks. Above the lamps are milk-glass reflectors. The four lamps form a rectangle of 11 square metres area, while the area of the floor is 28 square metres. The illumination had been previously ascertained to be over 10 candle-metres on the average, and was therefore considered sufficient. These lamps are now fitted, for the new method, with

* From th *G World.*

† 1 cand.e-metre = approx. one tenth of a candle foot (·089).

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removable mirrors below them, and the downward reflectors temporarily removed. The mirrors placed below entirely hide the flames, and they are segments of spheres, with a diameter of 24in., and corresponding to an angle of 120deg. ; they are painted white inside and then varnished. The effect seems to astound all who come in. The hall seems divided into two zones, the upper bright and the lower dark ; but both reading and writing are found to be easy when a seat is taken at any one of the desks. There is no shadow, no reflection from the walls ; the flames are out of sight, and the lighting does not cause radiant heat to strike upon the head. The subjective impression is pleasant, as the members of the German Association of Science found during their Halle meeting ; the only defect is the comparative darkness of the lower part of the room. But these are not measurements ; and actual measurement brought out less satisfactory results. Using a Weber photometer at the desk-level and at the demonstration table, it was soon found that it was not necessary to take measuremements at every point, and that it was enough to do so at the corners and the middle of the hall. The main result was that with the same consumption of gas, the illumination in the brightest place was 26·15 candle-metres with direct and 8·59 with indirect lighting ; that in the darkest it was 16·58 and 6·74 respectively ; and that the average values were 21·33 and 7·64 respectively. Now this shows that the average is seriously reduced ; there is an average loss of no less than 64·2 per cent. ; and in order to maintain the former standard of brightness three times as much lighting power would have to be employed. Besides, the light was not really sufficient ; no illumination less than 10-candle-metres* is so. On the other hand, the absence of shadow, the great uniformity of the illumination, the absence of wall-glare, and the invisibility of the flames, seemed to offer encouragement to go forward, and try to overcome the defect of the indirect method.

The next thing then was, since the walls of the room were dark in their lower portions, to paint everything pure white. The effect was that in the brightest place the illumination was 33·29 candle-metres by direct, and 10·20 by indirect lighting ; in the darkest 18·20 and 8·43 respectively ; and, on the average, 24·01 and 9·11. The illumination by both methods had thus been improved ; but the indirect showed a loss of 62·5 per cent. It was now found that the glass lids of the lamps were not air-tight. This was put right. The averages then were 27·05 for the direct, and 10·76 for the indirect lighting ; but still the indirect showed a loss of 60·2 per cent. ; but there was now enough light in the lower part of the hall.

The next idea was to use some semi-transparent material for the reflectors. Paper was accordingly used in the first place. The results then were, brightest place 25·29 and 10·84, darkest place 16·44 and 8·43 ; averages 21·01 and 9·94 ; loss 52·7 per cent. These results are less favourable than in the previous experiments, because these tests had to be made by day, and the gas pressure was not good ; but the loss had been, in proportion, substantially reduced. Paper is, however, not a good material ; it becomes brown and useless.

The next material tried was milk-glass ; the object was to find a kind at once as transparent and as good a reflector as possible. These two qualities are, of course, mutually inconsistent ; so a medium quality of glass had to be employed. This was used in slips fitted radially in a frame ; the upper edge of each slip was rounded off, so that there was no distinct shadow on the wall dividing the room into two zones. The impression produced was more pleasing ; the room looked much brighter, and yet there was nothing blinding. The illuminations were, brightest place 32·04 direct, 11·79 metallic reflector, 13·79 paper, and 19·28 milk-glass reflector ; darkest place, 21·75, 9·08, 10·62, and 13·50 respectively ; averages, 27·05, 10·76, 12·82, and 17·48. This shows how greatly the average illumination is increased by the use of the semi-transparent reflectors ; and that the loss on the average is by their means reduced to 35·6 per cent. The worst-lit part of the room is more than sufficiently lit ; and the loss of 35·6 per cent. can be borne, especially when we already often lose 60 per cent. through the use of opal globes, and the like. On the other hand, the lighting is distinctly not so uniform with the semi-transparent reflectors as it is with the opal ones. The semi-transparent reflectors are something intermediate between direct lighting and indirect lighting pure and simple, and it is therefore a compromise ; the light is not quite uniform, and shadows are not entirely absent ; but it is a very great improvement on direct lighting. It is a question of circumstances whether one will adopt the one extreme or the other in special cases ; if the lighting power is limited it may be necessary, in order to have enough light at all, to hold by direct lighting. On the other hand, if a loss of two-thirds of the light can be afforded, as in the case of arc lighting, metallic reflectors might be used. For many purposes, however, the new middle way is the best ; and, besides, it is a method which, on account of its coolness, enables the lamps to be hung lower down, to the better utilisation of their direct lighting power.

* Roughly one candle-foot.

LEGAL INTELLIGENCE.

Henley's Telegraph Works Company v. Scott.

In the Queen's Bench Division, on Monday and Tuesday, this case came before Mr. Justice Smith.

The action was brought to recover the price of four submarine cables supplied to defendant's order, and the defence was that the cables were not made as ordered, a counter-claim being put in for the extra cost of cables which defendant had to purchase in consequence of the rejection of those supplied by the plaintiffs. From the evidence it appeared that the defendant, Mr. Ronald Scott, tendered to the India Office for the carrying-out of certain electrical work ; amongst other things required were four different classes of cable, which he did not himself manufacture. He obtained an estimate from the plaintiffs, incorporated with his tender prices for the cables, and obtained the contract. Mr. Russell, at that time manager for Mr. Scott, and Mr. Potter, traveller to the plaintiffs, attended at the Admiralty Office for the purpose of inspecting the patterns there shown.

For the plaintiffs it was contended that it was upon these patterns that their tender was made out, and the order given to them, it being asserted on their behalf that no specification was shown to Mr. Potter.

Mr. RUSSELL stated that he did show the specification to Mr. Potter, gave him extracts from it relating to the work, and gave him distinctly to understand that the work was to be done according to specification, and not according to patterns.

Mr. MORRIS, custodian of the Naval store patterns at the Admiralty Office, said it was part of his duty to explain that the patterns were intended only to show the class of work required, but that the work itself must be carried out in exact accordance with the specification.

PLAINTIFFS further alleged that they sent samples of the cables they intended to supply, and that no objection was raised to them. The cables required were of different classes, and some, which had to be lead covered, they were obliged to get done by the Fowler-Waring Company.

DEFENDANT denied having received any samples of lead-covered or jute-insulated cable such as plaintiffs asserted they had forward to him ; the only samples he received were insulated with vulcanised india-rubber, and these he sent to the India Office with his estimate. When the cables were sent in some of them, insulated with jute, were rejected. The India Office pressed defendant to complete his contract, and he had to purchase the cables elsewhere at a price in excess of that at which plaintiffs had contracted to supply them. This formed the subject of his counter-claim.

Mr. REED, Q.C., on the part of the defendant, and Mr. DURAND, on behalf of the plaintiff, having addressed the Court,

His LORDSHIP gave judgment on Tuesday morning. He said he had not for many years come across a case of a mercantile character where there was such a direct conflict of evidence ; he did not think any of the witnesses called had wilfully told him what they knew to be untrue, but that one side had made a blunder there could not be the slightest doubt. The action was for the price of work done under contract, and the defence was that it was not done according to contract. It so happened that there were two Admiralty specifications for submarine cables, one dated April 16, 1890, and the other June 17, 1891, and the difference between them was that, whereas under the first the Admiralty would take cables insulated with jute, under the later specification they required the insulation to be of india-rubber. The cables claimed for were made under the earlier specification. The first question which was in dispute in the case was as to what took place at the interview between Mr. Russell and Mr. Potter, at the Admiralty pattern office on September 16, 1891. Mr. Potter's evidence was that he saw a pattern and that Mr. Russell had no document with him at all excepting one in writing ; it was upon the pattern that he contracted and that the cables were made. The question was, was Mr. Potter's memory accurate and clear. In his opinion it was not. He had himself admitted that he might have said that the patterns must have been there for ages. But his recollection was indistinct as to how be became possessed of the document containing figures taken from the specification, and as to what was said about the specification itself. Mr. Russell's evidence was clear and positive. He said he had the specification with him, and took it out and went through it for the purpose of showing Mr. Potter what it was that was wanted ; indeed, he could not have obtained admission to the Pattern Office unless he produced the specification, and confirmatory evidence upon this point was given by Mr. Morris, who had no interest in the case at all. It, therefore, seemed to him that the plaintiffs had not made out that the order was given on the jute pattern, and not on the specification. His lordship further held that there was no evidence that samples of the lead-covered cables had ever been sent to the defendant. His view was, that the defendant and his witnesses were right, and that the plaintiffs had not proved that the contract was to make cables according to the patterns. That being so, the plaintiffs' case failed, and they were not entitled to the price of the cables, but the defendant was entitled to the amount of his counter-claim, the amount due to defendant, therefore, being £44. 2s. 11d.

Suren, Hartman and Co. v. Henley's Telegraph Works Company (Limited).

In the Chancery Division, on Thursday last week, Mr. Justice Stirling gave judgment in this action, which was brought for repayment of £500 paid by the plaintiffs in respect of certain shares taken by them in the International Cable Company (Limited). His Lordship declared that "the defendant Company are bound to repay to the plaintiffs, either in cash or in fully paid up shares of the International Cable Company (Limited), at

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the option of the defendant Company, the sums of £250 and £250 paid by the plaintiffs upon application for and allotment of the shares." Costs were also granted against the defendants, to whom two months' time was allowed to repay the £500 either in cash or shares.

Woodhouse and Rawson v. Judd, Lindsay, and Co.

This case was struck out of the list on Wednesday morning, nobody appearing upon either side.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *Feb.* 25, 1893.

The Goebel Lamp.—Since my last letter the suit by the General Electric Company against the Beacon Vacuum Pump and Electric Company of Boston, for an injunction to restrain from the sale of the lamp infringing the Edison patents, has been decided by Judge Colt in favour of the General Electric Company, the basis of this decision being that while the Goebel lamps 1, 2 and 3, which were offered by the defence in evidence of an anticipation of all that is essential in the Edison patents, were not practicable commercial lamps, and that while No 4, another exhibit, probably was a practical lamp, in the opinion of the Judge the date of its manufacture was involved in great doubt, it not having been proved to his satisfaction that it existed before the issue of the Edison patent; in fact, in the Court's opinion, the presentation and claims for this lamp involved the whole defence in a cloud of suspicion, and for this reason judgment was given for the plaintiff. While this was merely a preliminary trial, and the injunction was merely temporary, it was regarded as of the utmost importance as indicating how such a defence at this late day would be regarded by the higher courts. While the defendants are disappointed they are evidently not discouraged, and it is expected that a more vigorous defence on the same lines will be made when the case against the Columbia Company comes up for final hearing in St. Louis next month. The latter case is exactly similar to the Beacon case, the Columbia Company having been enjoined some time ago.

NEW YORK, *March 10*, 1893.

The St. Louis Meeting of the National Electric Light Association.—The National Electric Light Association held its sixteenth convention in St. Louis. The attendance was exceedingly large and representative of the electric-lighting interests of all parts of the country, and the interest was maintained undiminished to the end. The Papers read were of a higher grade than those usual at these conventions, and were largely of a practical nature as was fitting to the occasion, which, it will be remembered, was a convention of purely business men engaged in the electric-lighting interests. The titles of the Papers read, and their authors, are as follows:—"Wrought v. Cast Iron for Field Magnet Frames," by A. D. Adams; "The Relation of Insurance to Electric Lighting and Power," by Capt. Wm. Brophy; "Some Experiences with the Alternating System," by R. H. Sterling; "Thermal Storage for Central Stations," by Prof. George Forbes; "Long Distance Transmission of Powers," by Chas. S. Bradley; "Power Transmission for Central Stations," by Dr. Louis Bell; "Remarks concerning Power Transmission from the Economic Standpoint," by L. B. Stillwell; "The Vulcanising Process for Preserving and Strengthening Poles, Cross-arms, Ties, etc." by Harry C. Myers; "Underground Conduits and Conductors and the Experiences of Electric Lighting Companies of New York City," by Wm. H. Browne; "The Incandescent Lamp from a Commercial Standpoint," by Calvert Townley; and "Morals of Corporations," by E. A. Armstrong. In addition to the Papers read, a lecture was given by Mr. Nikola Tesla, on Wednesday evening, in the immense auditorium and grand music hall of the Exposition Building which was packed to its utmost capacity by those who were anxious to see and hear this already famous experimenter. Prof. George Forbes who has but recently arrived in this country, read a Paper on "Thermal Storage," a subject which has excited so much interest in England. His remarks were, therefore, listened to with great attention, and gave rise to an extended discussion which brought out many additional points of interest, which constituted one of the most important of the Papers before the convention. The attitude of the General Electric Company towards the outside electrical interests of this country during the past few months has so antagonised those interests that it seemed probable that the matter would become the topic of chief interest at the convention, and there were those who looked forward to its assuming such an aggravated phase as to endanger, if not disrupt, the Association. As a matter of fact, strong feeling was manifested on both sides, and it was only through fine generalship of the managers that it was kept within bounds. Although the subject was not one announced for discussion, Mr. Townley's Paper on the "Incandescent Lamp from a Commercial Standpoint" was made a pretext for this discussion. The matter was happily terminated for the present, however, without serious rupture between the two factions by reference to a Committee. At the election of officers for the ensuing year, two candidates became prominent for the Presidency, one of whom was supposed to be friendly to the General Electric Company's interests, and the other to be representative of the outside interests. Before the matter came to a vote, however, the General Electric Company, finding itself overwhelmingly outnumbered, made no fight, and the following were elected:—President, E. A. Armstrong; First Vice-President, M. J. Francisco; Second Vice-President, C. H. Wilmerding; Secretary, Geo. F. Porter. The place for holding the next meeting was referred to the Executive Committee. In reviewing the electrical situation in this country there is more, by far, than appears on the surface. The General Electric Company, although presumably acting within the law, has so aroused public opinion against it as to seriously embarrass it. In its recent intended fight at the St. Louis convention, it was defeated at every point, as it found united against it all other interests, as if against a common enemy, and it would seem as though it must realise that it has made a mistake in antagonising in this manner the public interests, and it is hoped that this will result in an adoption on its part of a more generous policy than that it has heretofore pursued.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This useful book contains over 1,000 pages, and several new and handy features have been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. Comparison with any similar electrical publication is specially invited.

TENDERS INVITED.—The Directors of the Lancashire and Yorkshire Railway invite tenders for the supply of a variety of articles for the twelve moths ended April 30, 1894. Some particulars are given in our advertising columns, and further information and forms of tender can be obtained at the Stores Department, Osborn-street, Manchester, where samples of the articles required can also be examined. Tenders must be lodged with Mr. C. W. Bayley, secretary of the Company, not later than 10 a.m. on Monday, April 3rd.

——— Our advertisement columns contain a notification that the Corporation of Brighton invite tenders for the supply and erection of electric arc lamps, switches, and lamp canopies. Tenders must be left at the office of the Town Clerk before 10 a.m. on Tuesday, the 4th prox.

——— Tenders are invited for the stock, plant, machinery and effects of a going concern in the electrical and general engineering trade, together with its patents, licenses, goodwill, trade name, &c. Some particulars appear in our advertisement columns, and all information can be obtained from Messrs. Lakeman and Oliver, Prudential-buildings, Park-row, Leeds, to whom tenders must be sent not later than the 12th prox.

——— The French Post and Telegraph Department invites tenders for the supply of 825,000 porcelain insulators (in five lots). Information as to the schedule of prices can be obtained from the Division du Matériel et de l'Exploitation Électrique (3me bureau), 103, Rue de Grenelle, Paris, where tenders will be opened at 11 a.m. on Thursday next, the 30th inst.

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TENDERS ACCEPTED.—We learn that the tender of Messrs. Alexander Brown and Sons has been accepted for the boilers, fuel economisers, engines, condensers, travelling crane, feed-pumps, steam-pipes, &c., required in connection with the scheme for lighting Derry City by electricity, the amount being £4,293. The tender of Messrs. Siemens, Bros. and Co. has been accepted for the dynamos, regulators, switchboard, arc lamps (Brockie-Pell), lamp carriers, and underground conductors, the amount being £8,905.

——— The tender of Messrs. Edmundsons (Limited) has been accepted for the electric lighting of the new asylum buildings at Ryhope by the local authorities, the amount of the tender being £4,083.

THE "BELGIAN" LAMP.—We have received a copy of the price-list issued by the Belgian Lamp Manufacturing Company, of Antwerp, containing particulars of the Company's incandescent lamps, and useful formulæ relating to lamps and carbons.

MESSRS. HURRY AND YOUNG.—Under this title a new firm of electrical engineers and contractors has taken premises at 16, Princes-street, Edinburgh.

RE F. SILVESTER AND CO.—The first meeting of creditors in this matter was held on March 15th, in which the adjudication under the trusteeship of Mr. C. E. Buller, C.A., Albion-st., Hanley, Staffs., with a Committee of Inspection, was decided upon, the Trustee being authorised, with the consent of the Committee of Inspection, to carry on the business for a period not exceeding six months, with a view to disposing of same as a going concern.

DEED OF INSPECTORSHIP.—A deed of inspectorship has been signed by Arthur Adam Mather and Edward James Mather, trading as gas and electrical engineers at 278, Caledonian-road, and 12, Charles-street, Hatton-garden, with a view to the payment of a composition of 12s. in the £1. The total debts are £681. 17s. 8d., and the net assets £408. 12s. Mr. R. J. Ward, Bloomsbury-mansion, Hart-street, Bloomsbury, is the trustee.

IN BANKRUPTCY.—The first meeting of the creditors of A. H. W. Radcliffe is to take place at 23, Colmore-row, Birmingham, on April 6th, at 11, and the bankrupt's public examination will be held at the County Court, Birmingham, on April 19th, at 2.

PARTNERSHIP.—Messrs. Marchant and Co., of Clerkenwell-road, electric light contractors, announce that they have taken into partnership Mr. C. Townend Young, of Sheffield, and that the firm will for the future trade as Marchant, Young and Co.

PERSONAL.—Mr. E. Mann, secretary of the Woking Electric Light Company, has accepted a similar appointment at Kingston-on-Thames.

BIDEFORD.—A Local Government Board inquiry has been held here on the question of the application by the Town Council for a Provisional Order to empower them to purchase the Gas Works. Considerable opposition to the scheme was shown, many of the largest ratepayers objecting to the purchase. Several of the opponents of the scheme stating that they have under consideration the introduction of the electric light to their private and business premises, Mr. H. P. Tabdrew announced that he had prepared a competitive scheme for lighting the district by electricity with an outlay for plant of £4,600, and an annual expenditure of £620.

BOLTON.—The Electric Lighting Sub-Committee have made the appointment of electrical engineer for the Borough. Sixty-two applications were made for the post, which were subsequently reduced to eight, and included Messrs. A. S. Bernard, H. J. Crews, W. H. Heyes, J. Oddy, J. B. Mitchell, J. Sheppard, J. H. Rider, and C. H. Yeaman. Ultimately Mr. J. H. Rider, of Halifax, was selected. This gentleman has previously held two important electrical engineering appointments, and his new position carries a commencing salary of £200 per annum. It will be remembered that the Corporation of Bolton have recently applied for powers to borrow £40,000 for electric lighting and power transmission purposes.

BOWNESS.—At a meeting of the Police Commissioners, Mr. Law recommended the purchase of ground on the banks of the Avon for electric-lighting station purposes, and stated that there was sufficient force of water in the Avon to provide power for lighting the whole of the Bowness district. The matter is to be further discussed at the next meeting.

CARLISLE.—The Town Council have agreed to an expenditure of £1,600 for the electric lighting of Tullie House. The plant includes duplicate engines and dynamos. The Mayor, in supporting the vote for the expenditure, pointed out the superiority of the electric light over gas in an institution like Tullie House, where books and pictures are kept.

EDINBURGH.—A report has been received from Mr. David Cook, mananger and engineer of the City of London Electric Lighting Company (Limited), acting as additional adviser to the Committee who have this matter under consideration. Mr. Cook expresses complete agreement with Prof. Kennedy's report, and remarks that no town which has the working of the electric light in its own hands has been compelled to draw upon the rates. He also calls attention to the saving to be effected on the expiry of the lamp patents.

THE ELECTRO-HARMONIC SOCIETY.—A smoking concert will be held in the banquet room of the St. James's Hall Restaurant, Regent-street, W., on Friday, April 7th, at eight o'clock.

FALMOUTH.—The Urban Sanitary Authority have had under consideration the question of lighting the town by electricity. Several schemes have been recommended for acceptance; but in the report of the Lighting Committee, discussed at the last meeting, a suggestion received support that a Provisional Order be obtained and the necessary capital borrowed by the Town Council, the Order to be then transferred to a Company (the latter paying the Town Council 5 per cent. on the capital expenditure, and also providing an annual sinking fund) provided satisfactory guarantees were first secured. Further consideration of the subject was postponed.

HANLEY, STAFFS.—Some misapprehension has arisen from a note appearing in our issue of March 10th announcing that tenders were required by the County Borough of Hanley for the contracts in connection with their electricity works. The note should have read for "the building contracts." Tenders have been duly received by the General Purposes Committee of the Town Council for this building work, and a contract has been entered into with Mr. C. Cornes, of Hanley, for the erection of buildings and chimney shaft for the sum of £2,990. The borough surveyor has been instructed to report upon the details of the street lighting by electricity within or adjacent to the compulsory area. In September last the tender of the Brush Company was accepted for the electrical and engineering plant for the amount of £15,760, and the sanction of the Local Government Board to the borrowing of £21,000 for the electric lighting work has been duly obtained.

HUDDERSFIELD.—The County Borough Council at their last meeting empowered the Mayor, Chairman, and Vice-Chairman of the Electric Lighting Committee to proceed to Sheffield to inspect a system of electric mains which has been adopted there, with a view to a similar plan being adopted at Huddersfield.

ILFORD.—As a result of the Lighting Committee's investigations, and on consideration of the report of the expert appointed by the Local Board, the Lighting Committee at their last meeting announced that they were unable to recommend a scheme of electric lighting.

ISLE OF MAN.—An application will be made early in April by the Douglas and Laxey Coast Electric Tramway Company (Limited) for power to construct an electric tramway through the parish of Lonan and the village of Laxey, and for the compulsory purchase of the necessary lands for the purpose.

LECTURES.—Lectures have lately been delivered on electrical subjects by Mr. S. Vyle at Derby, Mr. Mundella at Wolsingham, Dr. Dawson Turner at Edinburgh, and Dr. Riley at Dewsbury.

LLANDUDNO.—The Improvement Commissioners at their last monthly meeting discussed the question of sanctioning the erection of an electric tramway, provided the route and other detail arrangements were approved by that body. In the result the motion for sanction being given was lost. Mr. E. P. Stephenson, C.E., Engineer to the Commissioners, presented his report dealing with the electric lighting of the town, in which he estimated the first cost of the installation, including lands and buildings, at £15,000, and the annual cost of maintenence at £1,435. He further estimated that, in order to meet the necessary charges, electrical energy would have to be produced at 5d. and sold at 9d. per unit. The report is to be circulated and considered at the next meeting.

MONTROSE.—At the next meeting of the Police Commissioners a resolution will be moved that a committee be appointed to consider the advisability of lighting the town by electricity with a water-power generating plant.

MOSS SIDE (MANCHESTER)—At the last meeting of the Local Board the Chairman announced that he had been making inquiries with regard to the practicability of lighting the district by the electric light, and he hoped the Board would not rest satisfied until they had brought about this desirable improvement.

NEW DECIMAL ASSOCIATION.—At a meeting of this Association, recently held, it was decided to concentrate the efforts of the Association to the adoption of the decimal system to weights and measures, leaving the coinage to be dealt with subsequently.

NEWMARKET.—Mr. E. C. de Segundo has sent in his report on the electric lighting of Newmarket to the holders of the Provisional Order. He estimates the cost of the necessary works for the

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immediate requirements at £13,000, and recommends the adoption of a low-tension system.

NORTH KENSINGTON, LONDON, S.W.—A discussion upon the subject of electric lighting for the northern district of the parish is to occupy the next meeting of the Ratepayers' Association.

OMNIBUS LIGHTING.—Many Sheffield omnibuses are being lit by the electric light, the apparatus including a small switch under the control of the 'bus conductor.

PEMBROKE.—The Admiralty contemplate introducing the electric light at the Pembroke Dockyard.

RICHMOND (SURREY).—At the last Town Council meeting the report of the Electric Lighting Committee was discussed, and Messrs. Latimer Clark, Muirhead and Co.'s observations on certain objections made by Mr. Shoolbred as to the mains proposed to be laid by that Company were finally disposed of. It was recommended that the Council consent to the Company's mains being laid in accordance with their arrangement. Councillor Thompson stated that upon every objection made by Mr. Shoolbred the Council had supported the contracting Company, while Councillor Pillans stated that Mr. Shoolbred was now diametrically opposed to the recommendation he had himself first proposed, and had (said Mr. Pillans) turned an "intellectual somersault." It appeared to him (Mr. Pillans) that they paid their engineer £50 a year for altering his opinions. The Committee's recommendations were adopted.

SILKSWORTH.—The extensive Co-operative Stores have recently adopted the electric light, and the Seaham Harbour Co-operative Society, and several other similar societies in the County of Durham, are following suit.

SOUTH AFRICA.—A telephone line has been laid between Leydsdorp and the Silati goldfields, and is now in full working order.

SOUTHAMPTON.—The Southampton Electric Light Company have notified a reduction from 10d. to 8d. per unit, the reduction to take effect from the 1st January last.

TELEPHONIC ENTERTAINMENT.—On Monday evening last, by permission of the National Telephone Company, Mr. P. P. Kipping gave an interesting entertainment at the Lecture Hall of the Highbury Quadrant Church, London, N. Mr. Goring Thomas's opera, "The Golden Web," was successfully transmitted from the Lyric Theatre to the Lecture Hall, and at intervals during the evening cornet solos and recitations were received from Birmingham. The entertainment was so successful that it is to be repeated this (Friday) evening,

UPPINGHAM.—It is stated that this town is about to adopt the electric light.

UTTOXETER.—A request has been presented to the National Telephone Company asking them to establish a telephone centre at Uttoxeter.

WATFORD.—The Local Board have received a communication from Messrs. J. G. Statter and Co. announcing that it is proposed to form a company for lighting Watford by electricity. The Earl of Essex had consented to become Chairman. A Provisional Order is to be applied for on behalf of the Company. The clerk was instructed to advise the Board on the subject.

WHITEHAVEN.—A considerable correspondence between the Trustees and the International Okonite Company (Limited), as to the contract between the Company and the Trustees, has resulted in a notification that the contract is cancelled, except so far as to the liability attaching to the Company for any loss sustained by the Trustees in reletting and completing the contract. Fresh tenders have been advertised for, and have now been sent in. All other contracts in connection with the electric lighting scheme are being proceeded with.

WIDNES.—In connection with the proposed refuse destructor, which is to be put down for dealing with the town refuse, amongst the work which the machinery required for the destructor is intended to perform is the installation of the electric light.

WORCESTER.—The suggestion made in a letter from the Town Clerk regarding the lighting arrangements for the new workhouse buildings, that as the supply of electricity would be in the hands of the city authorities it was desirable that all public buildings should be lit by that illuminant, was agreed to by the guardians at their last meeting. It is expected that the City Council Electric Lighting Works will be in operation by the beginning of 1894.

YORK.—A Local Government Board inquiry was held in York last week on the application of the Corporation to borrow the sum of £6,000 for electric lighting purposes. It is proposed to include in the suggested alterations at the Corporation's Art Galleries the complete installation of the electric light throughout.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

February 17, 1893.

3,572. J. E. WRIGHT. London. Improvements in printing telegraph receiving instruments. (Date applied for under Patents Acts, 1883, Sec. 103. 16th November, 1892, being date of application in United States.*)

3,573. E. TAUSSIG. London. Improvements relating to the extraction of metals by means of electricity and to apparatus therefor.

February 18, 1893.

3,590. E. PAYNE. London. Improvements connected with electrical conductors and their insulation.

3,666. W. LOWRIE. London. Improvements in and relating to electricity distribution.

3,675. E. L. MAYER. London. Improvements in and connected with telephone transmitters.*

February 20, 1893.

3,690. W. R. MORRIS. Birmingham. A combined ammeter and voltmeter.

3,720. G. ANDREOLI. London "Sourdine" for induction coils.

3,729. G. KAPP. London. Improvements in the supply of electric current for electric railway, tramway, and other purposes.

3,734. A. HOUGH and O. MARCH. London. Improvements in secondary-battery plates or elements.

3,743. E. H. LIVEING. London. Improvements in the preparation of carbon electrodes for electrolytic operations.

3,744. E. H. LIVEING. London. Improvements in the construction of carbon electrodes.

3,747. M. P. LLOYD. London. Improved process for the production of electrolytic copper.*

February 21, 1893.

3,757. A. C. BROWN. London. Improvements in thermo-dynamic motors.

3,775. C. DARRAH. Manchester. Improvements in and relating to electric lamps for lighting shop windows, and for other purposes.

3,779. W. STORR. London. A new or improved carbon holder for arc lamps.

3,804. J. WARING. London. Improvements in electrophotography.

3,817. A. W. SMITH. London. Improvements in armature cores.

3,831. J. E. KINGSBURY. London. Improvements in telephone exchange systems. (The Western Electric Company, United States.)

3,833. E. W. LLOYD. London. Improvements in electrical connections.

February 22, 1893.

3,883. W. LOWRIE. London. Improvements in and relating to the distributing of electrical energy.

3,953. E. T. HUGHES. London. Improvements in the construction of field-magnets for dynamo electric machines. (Cornelius F. Daniels, United States.)

February 23, 1893.

3,966. W. LOWRIE. London. Improvements in and relating to the distribution of electrical energy.

3,979. J. F. HOFFGAARD. Manchester. Improvements in telegraphic receiving instruments.

3,980. J. F. HOFFGAARD. Manchester. Improvements in telegraphic receiving instruments.

4,024. W. P. THOMPSON. Liverpool. Improvements in storage batteries or accumulators. (The firm of A. Vogel, Germany).

4,040. W. L. DAVIES. London. Improvements in type-writing telegraph instruments.

February 24th, 1893.

4,077. H. C. L. HOLDEN. Woolwich. Improvements in the construction of electrical measuring instruments.

4,086. J. H. WARD and M. H. GOLDSTONE. Manchester. Improvements in and relating to electrical switches partly applicable to other electrical appliances.

4,087. J. H. WARD and M. H. GOLDSTONE. Manchester. Improvements in and relating to terminals for electrical purposes.

4,091. F. H. NALDER, H. NALDER, W. S. CRAWLEY and A. SOAMES. London. Improvements in electrical measuring and other instruments.

4,093. G. HAYWARD. London. Improvements in electric belts, which improvements are also applicable to corsets or other apparatus.

4,096. R. KENNEDY. London. Improvements in dynamo-electric generators, motors and motor generators.

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4,103. W. LOWRIE. London. Improvements in and relating to dynamo-electric machines.

4,106. L. EPSTEIN. London. A process for maintaining positive plates of secondary batteries in good operative condition.

4,111. F. W. GOLBY. London. Improvements in means or apparatus for establishing telegraphic communication with trains. (N. J. B. Etienne, France).

4,144. A. W. ARMSTRONG. An improvement in the electrodes of electric, galvanic, and other batteries.

February 25, 1893.

4,188. R. KENNEDY. London. Improvements in electric retouching of photographs, and in apparatus therefor.

February 27, 1893.

4,241. A. BEZANT. Liverpool. Electrical fog horn, thief detector and alarm.

4,267. T. E. WEATHERALL. Greenwich. An improvement in electro-plating.

February 28, 1893.

4,330. A. W. BOWDEN. London. Improvements in coupling joints for couplings of electric mains.

4,356. W. P. THOMPSON. Liverpool. Improvements in or relating to welding metals electrically. (Charles L. Coffin, United States.)*

4,360. W. P. THOMPSON. Liverpool. Improvements in the construction of plates for accumulators or secondary batteries. (La Société Electric Phoebus, France.)

4,363. W. P. THOMPSON. Liverpool. Improvements in or connected with electric railways. (James Hervey Bates, United States.)*

4,368. B. B. WARD. London. Improvements in electric arc lamps.*

4,390. E. CANNEVEL. Improvements in electric arc lamps.

4,416. D. F. FERNANDEZ. London. Improvements in dynamo electric machines.

March 1, 1893.

4,425. J. GILL. Halifax. Improvements applicable to gas and electric lamps for automatically turning the light up and down.

4,489. E. C. C. KROGH. London. Improvements in and relating to electric firearms.*

March 2, 1893.

4,546. J. B. MILLAR. Glasgow. Improvements in and relating to stepped pillars or standards for carrying electric lights, wire, and the like.

4,577. R. KENNEDY. London. Improvements in electrical distribution of energy and in apparatus therefor.

4,580. E. TYER. London. An improvement in telegraphic apparatus for railways.

March 3, 1893.

4,685. J. E. BATT. London. Improvements in recording and reproducing tapes for electrical ticket machines and other apparatus.

4,691. THE LITHANODE AND GENERAL ELECTRIC COMPANY (Limited) and J. T. NIBLETT. London. Improvements in the manufacture and production of elements for secondary batteries.

March 4, 1893.

4,726. J. A. HEAP. London. Improvements in the electrolytic production of chlorate of potash and chlorate of soda.

4,731. R. KENNEDY. London. Improvements in and relating to the measuring of electricity and in meters therefor.

4,734. S. G. KIRK. Nottingham. Electric fog signalling and the better prevention of accidents by collision on railways.

4,746. O. IMRAY. London. Improvements in incandescent lamps. (T. D. Bottom, United States.)*

4,759. W. M. MEREDITH. London. Improvements in electrical resistances.

4,772. T. G. MARSH. London. Insulating and preserving metal arms used for supporting electric telegraph insulators and for kindred purposes.

4,793. J. O. BROOKE. Wakefield. Improvements in the construction of the reel and battery-box in connection with portable electric bells.

4,818. C. M. DORMAN and R. A. SMITH. Manchester. Improvements in the construction of electric light switches and cut-outs.*

4,827. J. POLLITT, E. WIGZELL and G. MEDDINGS. London. An electric alarm for automatically signalling when lubricators are empty.

March 7, 1893.

4,869. W. J. GIBBS and S. P. FRANCHOT. Canada. Improvements in the process of obtaining chlorates of the alkalies, or of the alkaline earth metals by electrolysis.*

4,871. N. ROLLAND. London. Improvements in electric batteries.

4,874. H. F. FOSTER. London. Improvements in the transforming and conversion of electric currents.

4,910. E. L. JOSEPH and APPLETON, BURBEY, and WILLIAMSON. London. An improvement in electric switches.*

4,911. E. L. JOSEPH and APPLETON, BURBEY, and WILLIAMSON. Improvements in the construction of spring buffer connections for the holders of electric lamps.*

4,923. A. G. NEW. London. Improvements in conductors in telescopic standard lamp holders for electric lamps.*

4,938. G. S. RAM. London. Improvements in incandescent electric lamps.

4,941. J. TUMA and E. VON METSICZKY. London. Improvements in and relating to signalling on railways and in telegraphic relays for use in connection therewith, and for ordinary telegraphic purposes.

4,952. W. S. SMITH and W. P. GRANVILLE. London. Improvements in electrical relays and measuring instruments.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1892.

2,652. KLOSTERMANN. Voltaic arc lamps.

3,112. DE FERRANTI. Electric meters.

3,113a. DE FERRANTI. Conveying currents of high tension.

3,156. BRADFORD. Motive power engines.

3,240. LANG. Door handles, electrical insulators, &c.

3,427. SCHROEDER, C. A. J. H. and H. E. R. Electric arc lamps.

4,494. ANDERSEN. Electro-magnetic solenoid apparatus.

5,186. LENCZEWSKI. Electric arc lamps.

5,655. REES. Electric safety lamp.

6,088. BOEHM. Incandescent electric lamps.

6,465. HEYL. Secondary batteries.

6,720. KINGDON. Dynamo electric machines.

6,888. SPENCE. Electric conductors.

6,911. DAVY. Electric arc lamps.

6,989. MCMULLEN. Casings for electrical conductors, &c.

7,037. BELFIELD. Electric arc lamps.

7,252. CROMPTON and CHAMEN. Electrical distributing apparatus.

7,361. SPENCE and DEAKIN. Distributing electricity by alternate currents.

18,732. FAIRFAX. (Schukert and Company.) Arc lamps.

19,665. HOOKER. Telephonic apparatus.

20,009. SHARPLEY. Microphone.

23,805. BOMBE and SCHUCHARDT. Arc lamps.

23,906. PRENTISS. Incandescent electric lamps.

1893.

140. HARRIS. Storage Batteries.

336. BOULT (Walch). Lightning conductors.

387. BOWEN. Electric launch and sailing vessel.

471. ALLISON. (Hering.) Electric motors.

510. DE PASS. (Rice.) Electric transmission of power.

517 LAKE. (Weston.) Measuring electric currents.

518. LAKE. (Weston.) Measuring electric currents.

520. LAKE. (Weston.) Measuring electric currents.

1,356. SLOSS. Electric gas lighting.

1,502. THOMPSON. (Correns.) Secondary batteries.

COMPANIES' MEETINGS & REPORTS.

W. T. Henley's Telegraph Works Company (Limited).

The fourteenth ordinary general meeting of the shareholders in this Company was held at the Cannon-street Hotel, on the 17th inst., Mr. Sydney Gedge presiding.

The SECRETARY (Mr. White) read the notice convening the meeting. The report of the Directors and balance-sheet were taken as read.

The CHAIRMAN: I will move without any loss of time "That the report and balance-sheet now in the hands of the shareholders be, and are hereby, received and adopted." You will have already noticed, gentlemen, a difference in what has just taken place in our procedure between this year and last year, namely, that the notice convening the meeting was not read by Mr. George Sutton as formerly, but by Mr. White. The Directors thought that Mr. Sutton's valuable services ought to receive the recognition they deserve by his being elected to a seat on the Board. Under your Articles of Association that can be done. We can elect a gentleman to be one of your Directors and at the same time make him Managing Director. Mr. Sutton takes that position on the same terms, in all respects, as those on which he held the position of Secretary and Manager, with this exception, that while he is answerable for Mr. White's secretarial duties he will not perform them. I am sure you will give him a hearty welcome as a member of the Board of your Company. Well, gentlemen, we are like the happy nation which has not got much history. We are going on well and prosperously, and there is not much for me to say; in fact, I cannot do more than call attention to one or two things already mentioned in the report. Less than two years ago we borrowed £30,000 of "B" debentures for the purpose of discharging our floating debts, and the arrangement made was that, after the payment of 5 per cent. to the Ordinary shareholders, any surplus profits should be applied to the paying-off of these debentures. We have already paid off £18,000 in the course of two years, and there is a fair prospect of our being able to clear off the remaining £12,000, in other two years, and then the Ordinary shareholders will receive as a reward for the patience which they have exercised so many years considerable dividends. We have, no doubt, a great many rivals in our trade, but I am quite sure that there is none to surpass us, either in point of punctuality or in the quality of work performed. I am certain that there is not anyone that can beat us. As the report says, when we have finished our

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new works we shall "then possess the most perfect workshop of its kind in the world." That is, perhaps, singing our own praises somewhat highly, but I think that we are stating nothing more than the truth.

Mr. JENKINS: It is not gas.

The CHAIRMAN: My friend Mr. Jenkins says this is not gas—it is electricity. I myself visited the works yesterday, and though I do not pretend to be an engineer or an architect, I could see how well arranged and complete the works are. Our engineer, Mr. Hatton, in making the designs for these works, and in constructing them, is acting, as he has always done, most efficiently and economically. I am assured, by those more competent than myself to judge, that your money is being well spent, and that, further, if our business is increased there will be so great a saving in the way in which we can do our work as to yield handsome returns to the Company. We should be able in these works to make cables which we have never made before, and for the reason of our inability to make these we have lost many orders—I mean, for instance, lead-covered cables. I do not know whether anybody here takes to the fashionable game of golf. If there be, I may inform him that we are manufacturing golf balls—a branch of business which we hope will continue to increase, and if you will send your orders to Mr. Sutton he will be glad to receive them. There is not much more to say. There is one paragraph in the report which is, no doubt, pleasing to you all: "It is interesting to note that no fault has been reported in any of the submarine telegraph cables laid by the Company since 1888." In 1888 we did lay a cable in which there was a fault. If we could at that time have given a substantial guarantee that the cables should not get worse, we should have received full payment of the contract money, but we were not strong enough to do it, and we were, therefore, mulct in a certain amount. I am happy to say that the cables have not become any worse, and are working as well as ever. Of course the company for which it was done made a considerable profit at our expense. Every shareholder has had the opportunity of looking at the balance-sheet, but I am quite willing to answer any questions that may be put to me. It is not desirable that minute facts relating to profit and loss account should be made known to our rivals in business, and, therefore, I will ask share, holders, who want any private information, to come to the office and ask for it. But if there be any question which I can answer without any inquiry to the Company, either I or some of my colleagues will answer it.

Mr. R. J. JENKINS, C.E., said that he had great pleasure in seconding the motion. In doing so he would not occupy much time. He would simply state with reference to the "B" Debentures that the paying off of these would have an immediate and a most important bearing on the interests of the Ordinary shareholders, because the actual saving on the £18,' 00 already paid off was equal to 1½ per cent. dividend to the Ordinary shareholders. As being somewhat responsible as a delegation from the Board, General Hutchinson and himself, having a knowledge of engineering, had taken a great deal of care to watch all the expenditure made in connection with the extensions at the works. The whole of the capital and a considerable amount of the additional sums which some of the shareholders were good enough to supply by taking up the Preference shares last year was being laid out in improving the works, and would enable them to take not only more important contracts, but to effect immense savings in some classes of work which they were in the habit of executing. They were also providing a siding which would save a great deal of money by reason of the fact that they would get all their goods brought into the works direct from the Great Eastern Railway, instead of having to convey them by carts and vans. They had opened a branch establishment in Melbourne (Australia), and although it was known to all City men that Australia was now under a cloud, more particularly the Melbourne district, they had received from their agent there—a most experienced man, who had been connected with electrical work for important firms—returns of considerable sales effected there, and assurances of still more business. They had, fortunately, sent out goods which appeared to command a ready sale, thanks to their Managing Director, who sent out to the colony to ascertain the particular kind of articles wanted there. He had no doubt they would very shortly have good returns—certainly as soon as the cloud had lifted from the Australian markets. It would be seen that they had completed the manufacture of the Bahama and Florida cable last year, and having done so, they were able to arrange for making an effective repair of one of the Western Union Telegraph Company's cables. That produced some revenue to the Company, but they did not value it so much for the revenue it produced as for the fact that it at once established the Company in the position of cable repairers, and made it known that they were able to undertake such a class of work, and on better terms than were able to be previously negotiated. The Chairman had said that the accounts had been open to the inspection of every shareholder. The system they adopted in respect to them was that laid down in their Articles of Association, but they would be glad to answer any questions which might arise in respect to the accounts.

Mr. HUGHES-HUGHES thought that it would be of more interest to the shareholders to have a printed balance-sheet than an invitation to inspect it at the office.

Mr. FIGGESS said that he approved of the present arrangement and supported the Directors.

The CHAIRMAN said that, while the Board would take into consideration this suggestion, they thought that at present, with all due deference to Mr. Hughes, no sufficient reason had been given to show cause why they should alter the course they had hitherto pursued. He then proposed the payment of a further half-year's dividend on the Preference shares at the rate of 7 per cent. per annum, and a dividend for the year at the rate of 5 per cent., free of Income Tax, on the Ordinary shares, leaving a balance of £13,425. 9s. 4d. to be carried forward.

Mr. BALL seconded the motion, which was carried *nem. con.*

Mr. LAMONT proposed the re-election of Mr. Sydney Gedge to his seat at the Board.

Mr. GLANVILL seconded the motion, which was cordially carried.

The CHAIRMAN, having briefly expressed his acknowledgment,

Mr. HUGHES HUGHES proposed, and the Rev. R. K. HASLEHURST seconded, the re-election of Mr. R. J. Jenkins, the other Director retiring by rotation.

The motion was carried unanimously.

Mr. JENKINS, in returning thanks, said that he had endeavoured to make his 13 years' service of value to the Company, and he trusted to make them of still greater value in the future.

Mr. FIGGESS proposed the re-appointment of the Company's auditors, Messrs. Ball, Baker and Co., which was seconded by a SHAREHOLDER, and agreed to *nem. con.*

Mr. R. J. JENKINS proposed, and a SHAREHOLDER seconded, and it was carried unanimously, that a vote of thanks be and is hereby given to the Works Manager, Mr. R. J. Hatton, and the staff at the London Office and at the Works.

The meeting concluded with a vote of thanks to the Chairman and Directors for their services.

Woodhouse and Rawson United (Limited).

An extraordinary general meeting of this Company was held on Monday at the Cannon-street Hotel. In the absence of Sir Rawson Rawson, the Chairman, through a domestic bereavement, Mr. Samuel Pope, Q.C., presided.

The SECRETARY having read the notice calling the meeting,

The CHAIRMAN said that his duty in the chair would be best performed by putting the meeting as exactly as he could in possession of the facts as regarded the present position of the Company. Since they had met together to receive the report of the Committee which was appointed at the annual general meeting, a receiver had, at the instance of the debenture-holders, shareholders and the creditors, been put into possession of the assets of the Company as a receiver and manager. The Directors did not see the way to resist that appointment, nor did the trustees for the debenture-holders. In fact, Sir Rawson Rawson himself, as representing the debenture stockholders, felt that it was necessary that if a receiver were appointed he should represent the whole of the interests of the Company, and not one particular class of interests exclusively. Therefore the receiver and manager was now in possession of the assets of the Company representing the debenture-holders, the debenture stockholders, and also the shareholders. That gentleman had been, by authority of the court, enabled to raise a small sum of money for the purpose of carrying on the business of the Company to a small extent, in order that it might not subside altogether. In addition to the receiver now in office with the sanction of the court, there were upon the files of the court two further petitions praying for the appointment of a liquidator under a compulsory winding-up, and, therefore, as those petitions stood over and would not be heard until April 11th, the Directors had thought it important that the shareholders should meet to discuss the position, in order that they might decide whether in the interests of all parties it was desirable that the concern should be broken up, or that an effort should be made to keep it together in the hope that something might be done to minimise the loss of all concerned. He did not desire now to make any comments on those petitions, but he must venture to say that it appeared to him that the eagerness to break up the concern was proportionate to the smallness of the stock that each individual desiring to do so held. The first petition was on the part of a small stockholder to the extent of only £250, and it appeared to the Directors—certainly to himself—that those who had a larger stake in the concern than that should have an opportunity of deciding what was the best way of dealing with the property, instead of leaving it to somebody who, after all, had only a limited interest in it. He did not know from whom the second petition came. It would be remembered that the report of the Committee pointed out that if the assets of the Company were realised in an intelligent manner, there would probably be sufficient to pay the liabilities of the Company. [A Voice: How about the shareholders?] He would come to that. The report of the Committee pointed out that there was a fair chance that the debenture-holders would be paid off, but that if the concern was broken up altogether and the assets realised at broken-up prices, the ordinary shareholders had not much chance of getting anything out of it; therefore, the question was one for the shareholders to decide whether something should be done in the way of reconstruction, or in some other manner, to save some of the assets of the Company for the benefit of the shareholders. This seemed the question that they had to decide. It would be observed that they had been called together with the formalities which were necessary to make their resolution a binding resolution of the Company. As far as the Directors were concerned, if the shareholders saw their way under new management to reconstruct the Company, they would do all that they could to facilitate and assist such reconstruction. Speaking for himself, he thought that it was essential that, in any reconstruction scheme, those who found the sinews of war for giving it effect should have the nomination of those who would have the administration of the affairs of the new Company. He thought that he spoke the unanimous feeling of his colleagues in saying, that, in the event of the shareholders desiring such reconstruction, their seats at the existing Board would, of course, be placed at the disposal of the shareholders, who would be asked to appoint new Directors. It appeared to the present Board that no scheme of reconstruction could be likely to be acceptable to the shareholders, except upon three conditions. It seemed to them, as it appeared to the Committee who met them on the last occasion, that it would be idle to expect shareholders, or anybody else, to put more money into a concern if its profits were to be swallowed up either in the payment of liabilities or in the payment of the burdens which the debenture debt entailed. The Board, therefore, thought that if any scheme of recon-

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struction was possible, the first thing to ascertain was whether there was a good background of business worth preserving. Now, as far as he knew the facts, there was; but they must satisfy themselves, and not take the statement from his mouth. He could only take it of course *ex relatione* from those who knew about it. The report of the Committee estimated roughly, without going into details, that the industrial part of the business might command about £11,000 profit per annum, which would be enough to pay off only the debenture interest, and, therefore, would leave nothing to be divided among the shareholders. The general manager of the Company took a more sanguine view of the situation than that. That gentleman judged, from the business which he had been compelled to refuse since their general meeting in December, that the profits would be nearly three times that amount. Of course, he was only stating that that was the manager's sanguine expectation. But the receiver had, he believed, also formed his judgment of the possibilities of the business from the experience he had gained in the meantime, but he (the speaker) had not got information as to what that opinion was; but whether the income was £30,000, or £11,000, or anything between these amounts, it was clear that those who should have the first claim on the profits were those who subscribed to carry on the business. The second condition appeared to be that the old debts against the assets of the Company should be left without change of their relations, and, further, that in any reconstruction, as he was most bitterly sensible, the shareholders ought to insist on entirely new management for the industrial part of the concern. Well now, the question was whether, on some such lines as these, the shareholders thought it would be better to break up the Company—which, of course, meant the immediate realisation of the assets—or whether an attempt should be made in order to see whether a reconstructed Company might save something for the shareholders, who otherwise, he was afraid, would get nothing. If that were the view of the shareholders the resolution which was in the circular convening the meeting would be the resolution which they would have to pass, and which he would move:

"*That it has been proved to the satisfaction of this meeting that the Company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the Company be would up voluntarily, and that there be conferred on the liquidator or liquidators all the powers which, by virtue of the Companies Acts, 1862 to 1890, can be conferred on the liquidators.*"

He concluded by inviting the Company's Solicitor to explain the general character of the scheme of reconstruction which commended itself to the minds of the Board.

A short discussion took place as to whether this course was necessary, but eventually, by a show of hands, it was agreed to.

The SOLICITOR said that the suggested scheme of reconstruction was that a new Company should be formed, which would take over the assets of the existing Company, but would take them over in such a way that, whilst the charges of debenture-holders and debenture stockholders on those assets would remain fixed, the new Company would not incur any personal liability to the debenture-holders or the debenture stockholders. The new Company would take these assets, use them, and realise them, pay the proceeds to the receiver or liquidator of the existing Company, who would distribute them among the debenture-holders and debenture stockholders, and the new Company would get a certain profit in turning over the assets and realising them. By that means the existing Company would retain whatever working capital was put into it intact and unfettered by the existing Company in any way. The ordinary creditors in the existing Company would, of course, have to be met in some way, and the proposal was that they should be offered preference shares in the new Company, and if they did not accept these shares that they should retain their present position. With regard to the bringing in of capital to the new Company, and dealing with the shareholders of the existing Company, there were two schemes, with regard to which the Directors had not yet decided which was the better. One was, that the working capital should be acquired by the issue of shares, which would be paid in full by the shareholders, who should receive some sort of security in the way of income bonds, or something of that kind, which, whilst imposing no further liability upon them, would give them the right to the surplus profits of the new Company. The shares or income bonds, whatever they might be, would have to be offered first to the preference shareholders of the existing Company, and those that were not taken up by the preference shareholders would be offered to the ordinary shareholders. This was necessary because, of course, the former had a first claim on the assets of the Company and dividends. He did not think that he could go further into details now, because the scheme was before counsel for consideration, and it was one which required a great deal of thought and care to work out.

Mr. SWAIN wished to know what stake each Director had in the Company. It was all very well to talk about probable profits, but taking their balance-sheet he could see no visible means of a dividend. There was not one thing to show it. The financial business had resulted in an utter loss, and the industrial part of it had been carried on at a sacrifice. He wished before the Directors were released from their post to know what claim the debenture-holders, and debenture stockholders had on the shares of the Company.

The CHAIRMAN said that the amount of debentures and debenture stock was £142,000—a claim on the assets of the Company, not on the shareholders.

Mr. SWAIN said that the scheme was a very easy means of letting the Directors escape from their responsibilities to let them form a new Company.

The CHAIRMAN rejoined that whatever might be done it would not relieve them from a single responsibility.

Dr. DUNCAN read a number of extracts from the prospectus of November, 1891, and subsequent reports of the Directors, upon the strength of which he said he had invested his money in the Company. He strongly condemned the conduct of the Directors, and thought that the whole of their actions in regard to the Company should be made the subject of a searching investigation. In addition to this, he would ask all those shareholders who took shares on the strength of the new prospectus referred to, to support him in his determination to bring an action against the Directors for the false statements contained therein. He proposed that the Company, which was rotten to the core, should be judiciously wound up, and that the whole concern should be investigated in a proper manner.

Mr. W. S. SQUIRE (chairman of the Committee of Investigation) addressed the meeting at some length, dealing principally with some of the facts brought out in the report of that Committee, published in *The Electrician* on March 10th. He said that, however much the Directors might quibble about each individual item to which the Committee had referred, the solid fact remained that they had induced the shareholders to believe for two years that the Company was doing well and making substantial profits, whereas at the end of the third year of its existence they had to confess that they had muddled away the whole of the ordinary and preference capital. A great deal had been said about their valuable lamp patents, but it turned out, so far as the register of the Patent Office disclosed, that those patents were not in the name of the Company at all. There might be an agreement to transfer them, but, as a matter of fact, they had not been assigned. Another fact was, that when any agreements were signed, they were signed for only one-half interest in these lamp patents, and anybody who knew anything about patents at all would tell them that half of a patent, unless under certain special circumstances, was practically of no value. These and similar facts had, of course, influenced the Committee very much in arriving at the value they put upon the patents. He might mention that in his opinion, and he might say really in that of the other members of the Committee, the action of the Directors in the matter of the Phœnix Trust and Epstein affairs looked very much like an excuse for paying dividend out of capital. He did not say it was, but it appeared very much like it. With regard to the proposal for reconstruction, it was extremely difficult to give an opinion; but the only way in which the new Company could possibly do any good was by ruthless concentration.

Mr. ABRAHAM quite agreed with Dr. Duncan with reference to the proceedings of the Directors and their liability. The Directors, from Lord Aberdare down to Mr. F. L. Rawson, were undoubtedly liable. He condemned the conduct of the Board in respect to its agency business and the formation of companies.

The CHAIRMAN reminded the speaker that in each case when a company was being formed, the shareholders had received a circular detailing the circumstances and soliciting subscriptions.

Mr. ABRAHAMS was very glad to hear that proceedings were likely to be taken against the Board, and that the meeting was likely to support such a course. He would go farther, and say that it would be a public scandal if proceedings such as had taken place in connection with the Company in the past were not investigated, and if the Directors were to go free. The large shareholders were bound to stand by the small ones in order, if they could, to increase the assets of the Company by making the Directors liable.

After some further discussion,

Sir JOHN STOKES seconded the resolution.

Dr. DUNCAN moved as an amendment:—

"*That the Company be wound up compulsorily.*"

Mr. BOND said that, as a considerable shareholder, the liquidator of a Company now under voluntarily liquidation, and as a barrister, he wished to point out that it was always possible to turn a voluntary liquidation into a compulsory one, and, therefore, that to pass the resolution would not prejudice their rights in any way. By a compulsory liquidation there was very little chance of the ordinary shareholders getting anything, whereas if it were voluntarily carried out, there was a probability of their getting something returned to them.

Mr. LESLIE, representing the receiver, said that the latter had expressed his opinion that there was good work to be done in connection with the Company at remunerative prices as far as he knew. The same gentleman had expressed his surprise that there was so much work to be done. He told the shareholders frankly that if they went into compulsory liquidation they would not receive a penny.

Mr. BACON, one of the members of the Committee, advocated voluntary liquidation as the best possible course to follow.

Colonel POE animadverted strongly on the conduct of the Directors, on the strength of whose names he alleged that many of the shareholders had subscribed to the capital of the Company.

Mr. MORRISON also recommended voluntary liquidation.

Mr. PILLING (Manchester), who investigated with the Shareholders' Committee the affairs of the Company, also addressed the meeting, strongly condemning the action of the Board in respect of the manner in which they had dealt with the £75,000 guarantee fund and other items. At the same time he admitted that voluntary liquidation was the only prudent step to take in the circumstances.

The CHAIRMAN then put the amendment to the meeting, and declared it lost. The original resolution was afterwards put and declared carried without a dissentient.

Mr. BACON proposed the appointment of Mr. Pilling as liquidator.

Mr. SQUIRE seconded the motion. Both gentlemen paid a warm tribute to Mr. Pilling for the painstaking way in which he had assisted the Committee of Investigation in getting up the facts presented in its report.

Mr. WAIN proposed Mr. Young, of the firm of Messrs. Turquand, Youngs and Co., for the post.

A SHAREHOLDER seconded Mr. Young's appointment.

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The CHAIRMAN having invited the sense of the meeting as to which gentleman should be appointed, declared in favour of Mr. Pilling.

Mr. WAIN thereupon demanded a poll, which was at once taken.

In the end the voting was as follows:—For Mr. Pilling, 10,229; for Mr. Young, 7,710. Majority for Mr. Pilling, 2,519.

The proceedings then terminated.

Elmore's French Copper Depositing Company (Limited).

An account appeared in *The Electrician* of the 17th inst. of a meeting of the shareholders of the parent Elmore Company held on the 16th inst., and during the present week a report has appeared from the Committee appointed to investigate the Company's affairs, and to ascertain its exact position. It will be remembered that this Committee were fortified in their investigations by the assistance of both an electrical and a financial expert, and that Mr. A. Le Neve Foster was appointed in the former capacity, and Mr. Burnside as financial adviser. A circular issued by the Committee deals with the financial position, but it is with Mr. Foster's report that we are chiefly concerned. This report is as follows:—

"I have visited the Company's works at Dives and carefully examined everything in connection with the manufacturing business. The works are of a substantial character, well-built, and apparently suitable for the manufacture for which they have been designed. They appear to have been constructed in a somewhat costly manner, more especially as far as the plant is concerned. The works and plant have been erected for a monthly output of some 300 tons. The engines and dynamos are in duplicate and triplicate, and on a very extensive scale. Up to the present time the output has been comparatively small; hence this plant has been worked at a great disadvantage. The system of construction and working of the deposition tanks with their electrical and mechanical arrangements (this being the part embraced by the Elmore patents) were presumably constructed in accordance with Mr. Elmore's advice, aided by the experience gained by the French Company from the costly experimental work done in Paris. However, on the manufacturing at Dives being commenced, great alterations had to be made to the machinery before marketable tubes could be produced by the Elmore process. The apparatus first erected for giving motion to the mandrils in the depositing tanks caused considerable trouble, and had to be entirely remodelled before continuous working could be carried on. A large number of the tanks are still fitted with the old gear, which will require altering before the tanks can be used. The new driving gear has, I believe, been patented by M. Secretan in France, and is a marked improvement on the original plan. The original burnishers were found unsatisfactory, and new arrangements for these had also to be constructed. When it is remembered that the mechanical machinery for the entire 264 depositing tanks, covering a floor space of some 60 by 90 yards, had to be completely re-modelled, much of which there still remains to be done, it must necessitate a heavy outlay. This outlay could have been avoided had ordinary caution been exercised and the plant in the first instance tried on a less extensive scale.

I gathered from M. Secretan and others at Dives, that the system was constantly breaking down, and had in a great measure to be re-constructed before anything like saleable tubes could be produced. To-day the capabilities of the depositing tanks that are in working order are equal to some two tons per day of 24 hours. The remaining plant requires considerable alterations and outlay before they are capable of producing the 300 tons per month for which they were originally designed. These facts would seem to be inconsistent with the prospectus of the company, from which it would be presumed that the experimental stage had been passed. An extensive plant has been erected for the manufacture of copper plates, and also for wire drawing. This seemed to me to be undesirable, as the margin of profit on this manufacture is very low when compared with tubes. At the time of my visit neither the manufacture of plates or wire had been started. The electrical arrangements, as before mentioned, were planned for an output of 300 tons per month, consequently are now being worked most uneconomically. A very serviceable plant has been put down for drawing the tubes, by which means they can greatly reduce the cost of expensive mandrils that would otherwise be required for manufacture under the Elmore process. The plan of subjecting the tubes to the drawing process was, I believe, when first erected, objected to by Mr. Elmore as unnecessary. Had this plant not been put down, the orders that have already been executed by the Company could never have been undertaken. The drawing is done at comparatively small cost, and obviates delays in execution of orders. It allows the depositing tanks to be worked constantly on certain stock sizes, facilitating greatly the electrical arrangements, whilst at the same time it improves the quality of the copper.

The following estimated cost of production is for an output of 60 and 100 tons per month. My estimate is calculated upon the expenses at the works only, not including any allowance for depreciation, interest on money expended in patents, renewals and repairs of buildings and plant, &c., rent, taxes, and expenses in Paris and London. The expenditure is based upon the figures I obtained from the books at the works. An expenditure of £1,200 per month for salaries, wages, coal and sundry materials, but excluding the cost of raw copper, should prove sufficient, with judicious management, to cover a steady output of 100 tons per month. With the smaller output of 60 tons there would be little, if any, saving with the present arrangements. To these calculations I have added the value of silver and gold that may be found in the sludge of the depositing tanks. The value of this depends entirely upon the nature of the ingot copper treated. If suitable argentiferous brands of copper are used, and careful means are adopted to collect the sludge, the additional profit may readily reach as much as £7 per ton of copper treated, or even more. It is presumed in these calculations that a steady sale can be effected of the quantities in question.

Estimate of Manufacturing Gross Profit.

Tons of raw copper treated per month.	Cost of copper, manufacturing expenses, salaries, wages, &c., per month.	Cost per ton, including raw copper.	Gross manufacturing profit, including an estimated value of gold and silver recoverable of £7 per ton.
Tons.	£	£	£ s.
60	3,960	66	16 15
100	5,800	58	25 15

In the above estimate raw copper is taken at £46 per ton, sale price of tubes at £80, and of electro-deposited scrap copper at £50.

In working the Elmore system as the plant is at present arranged, it is most important that a regular output from the depositing tanks be maintained, and my figures are based upon this assumption. The manufactured copper tubes that I inspected and tested were of excellent quality, and certainly superior to ordinary commercial solid drawn tubes, and should command a ready sale at market prices. The organisation of the works at Dives was good, and the heads of departments appear to be thoroughly competent men. For works of this size the monthly expenditure is by no means excessive, whilst the administration expenses at both London and Paris appear to me to be out of all proportion to the small amount of copper that has been treated, or even for a much larger output. Respecting the value of the works at Dives, it would have been impossible for me, with the time that was at my disposal, to arrive at anything like a fair valuation; but it is very certain that in the event of a forced sale they would realise very little indeed in comparison to the immense sums expended on them.

The Elmore system, when purchased by the Company, appears to have been far from perfect, and had this fact been realised prior to the construction of the works, the heavy expenditure of the shareholders' money, incurred with conspicuous lavishness, would have been avoided."

It will be seen from this report that Mr. Foster has gone thoroughly into the value of the Elmore process, and, as was to be expected, this report was made the basis of many severe strictures at the meeting of the Company held on Wednesday last, of which an account is given below. It will be noticed that reference is made to some new driving gear for giving motion to the mandrils in the depositing tanks, which has been patented in France by M. Secretan, but no mention is made as to whether the patent is the property of the French Elmore Company. On the 20th inst., and prior to the meeting of shareholders on the 22nd, the Directors issued a reply to the circulars of the Committee in which they set out their view of the financial position of the Company, which, it is needless to say, materially differs from that of the Committee, and in regard to Mr. Foster's report an abstract of their reply is as follows:—

"The discrepancy referred to in paragraph 2 does not appear to us to exist, as the advantages set out in the original prospectus have all been confirmed. With regard to the cost of manufacture, the Directors estimated the cost at one penny per pound, while Mr. Foster calculates that, when turning out 25 tons a week, the cost would be a trifle over a halfpenny per pound, after making an allowance for the gold and silver in the copper. This calculation is based upon the prices obtained for the smaller tubes, with which M. Secretan has very rightly commenced manufacture, and does not take into account the higher prices which may be commanded for exceptional sized tubes and other work. The unsatisfactory results of the seven months' working, referred to in paragraph 3, are due to the smallness of the average output caused by the want of working capital to purchase copper. The expenses of a small output are almost as heavy as those for a large output, a fact sufficient to account for the large manufacturing profits that Mr. Foster estimates when the output is increased to 100 tons per month. The Directors think that Mr. Foster takes an exaggerated view of the cost of the modifications. A considerable number of the tanks have been modified, and the exact cost of modifying the remainder is thus known. The Directors conclude by saying that their last published estimate showed a profit per ton of finished tubes taken out of the tanks; Mr. Foster's estimate of profit is per ton of raw copper deposited, the difference between the two being copper sold as electrolytically-deposited scrap."

A meeting of the shareholders who subscribed to the preliminary inquiry instituted by Sir Thomas Farrer, Bart., Mr. William Saunders, M.P., and Mr. Samuel Storey, M.P., into the affairs of the above Company, was held on Wednesday, at the Cannon-street Hotel.

On the motion of Mr. SAUNDERS, Mr. Storey was voted to the chair.

The CHAIRMAN said that the circumstances under which they were met were familar to them all, and, therefore, he need not dwell upon them at length, but merely state them. Some of the shareholders were dissatisfied with many matters relating to the French Elmore Company. Their dissatisfaction pointed in four directions. First of all, they were dissatisfied with the absolute non-fulfilment of the promises made originally and at a later time; second, they felt a business-like objection to the method in which the works had been laid out for an enormous output before there had been practical proof that a smaller output could be produced with profit; third, they were horrified to see the loss on working during the months of last year, when the works were busy; and fourth, they were brought to bay by the fact that the Directors admitted that it was absolutely impossible to go on unless they could get a large sum of money, which he practically put at £50,000. That being their state of mind, Sir Thomas Farrer, Mr. Saunders, and himself took upon themselves, as shareholders, to send out a circular asking other shareholders to join them in ascertaining all the facts of the case. He was glad to say that the responses they received were very hearty and numerous; and by means of the funds placed at their disposal, they got Mr. William J. Burnside to make a financial and general report on the affairs of the Company, and

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they also sent Mr. A. Le Neve Foster to France to see for himself the state of matters and report to them thereon. On receiving those reports from these gentlemen they made a report on their own account, and he believed that statement had gone to every gentleman present. Inasmuch as it had been sent to them he presumed it would be taken as read. A similar course would, he thought, be taken in regard to Mr. Foster's report. Sir Thomas Farrer, Mr. Saunders, and himself had acted in a perfectly fair and above-board fashion. They had not gone behind the Directors or assumed that they were wicked men. They had put themselves in communication with the Directors, and he was glad to be able to say that they had found the greatest willingness on the part of Major Jones and his *confrères* to give them what information they could.

The circular letter sent to the shareholders and Mr. Forster's report were taken as read. Mr. Burnside's report (which was of a purely financial character) was read *in extenso*.

The CHAIRMAN then read two letters—one from a gentleman whose name was not disclosed, urging that the only way to keep the Company alive was by forcing the creditors to come to terms by raising the necessary money on debentures to meet their claims, and then appointing a Committee with a view to its forming some plan of reconstruction. The other letter was from Mr. W. Elmore, repudiating certain statements contained in the reply of Mr. Foster. The Chairman then went on to say that what they ought to try to do on that occasion was not to indulge in complaints or condemnation of anybody as to the past (although the time might come when that would be necessary), but rather, as men of common sense, to address themselves to the problem, how could they make the best of the Company. He did not know whether every gentleman present would agree with him, but he would put the position of affairs as he saw it. First of all he would put it in this way. He would say that there were three courses, and three courses only, open to them at the present time. The first was to go on. That was the advice which Mr. Rawson had given to them; that was the advice which the Directors would fain give to them; that was the advice which he would tender to the meeting, if he could be satisfied on two points, first, where was the money to be found to go on with, and second, was there a reasonable business guarantee that it could be effectually used to produce profits. Now, he spoke to gentlemen who would be prepared to find the money. Mr. Rawson would give them a good handsome sum, and Mr. Elmore too. He would like to ask this question. How did it come about that this money was wanted? Mr. Burnside had put the thing very clearly. The money was wanted at present because the money already supplied had been grossly misapplied and wasted. He would make two quotations in support of that. He had been looking through the statements made, not when the original Company was founded, but at a much more recent period. There was a report of the first general meeting on January 9, 1891, and he would like to read what the Chairman said then. "The Board had raised £50,000 additional capital on Six per Cent. Debentures issued to the parent Company in order to carry out Mr. Elmore's suggestion to increase the plant to the extent of being capable of producing 300 tons per month." M. Secretan, in his speech, stated that within three months—that was to say, from January, 1891—"we shall be in a position to turn out 370 tons of copper articles per month, the sale of which is absolutely assured." In a circular issued by the Chairman of that period it was announced that the works were completed and capable of turning out 80 to 90 tons a week, which was practically the same as 370 tons a month. The manager was very enthusiastic about the financial results, and stated that the demand far exceeded the total output of the works. Well, now, if there had been any sort of truth in these statements, it was very evident that the shareholders would not have been in their position to-day. But the fact remained: Never since that time had they got anything like 20 tons per week out of the works. He was told that 14 tons was the largest number they had ever been able to take out. Therefore he said that, unless the gentlemen were bad business men—men not to be trusted in business, although they might be trusted in other ways—different results should have been achieved. He would say one word about M. Secretan. He had not a word to say about that gentleman personally. He thought that M. Secretan was a very worthy and clever man, but begged to say that he was no business man at all. The reason why was this: If they went into a business of any kind about which there was any doubt, they would go into it like common-sense Englishmen slowly and surely. They would put down a portion of the plant, and if they were satisfied that it would be sufficient to provide them with profits, then they would put down more plant. But what M. Secretan did was, he put down huge plant, which in practice he had never been able to use, and the twofold effects were, first, that the money which they wanted was sunk in unused material, and there was an additional charge on the Company's income for the interest of that money which was giving them no return. Was there any possibility from any source of getting £50,000? And was there any gentleman, if they did get the money, who could work the business in France in a way by which they would produce good results? They might drift on as they were doing, losing largely as they did last year. They would drift on with their creditors pressing them, and the Directors meeting the pressure by renewing bills at ruinous and extortionate interest. The facts could be proved, but practically it amounted to that. Some gentlemen wanted £8,000 from this Company. The Directors could not pay, and they gave bills that ran for a year which would have cost 25 per cent. He was not going to pin himself or the meeting to the precise figure; but he could state definitely upon the examination of Mr. Burnside that these bills had been renewed at an enormous rate of interest. Every such additional charge by the creditors diminished to that extent the chances of the debenture holders and ordinary shareholders getting anything at all, and if that were the sort of thing that was going on they might find the preferential claims of creditors so great that they would absorb all the available resources of the Company. That was an argument too strong to be resisted against any policy of drifting as the Directors had been doing during the last few months. What was the alternative, if they could not raise the money and carry on the business, and if they did not want preferential claims to be created which would diminish their chances of getting anything? A third course was a disagreeable one, but it must be left to the shareholders who were interested and who had paid hard cash for their shares—they must liquidate in the wisest and best manner they could. They must not leave the liquidation to those who had reaped the profits of the thing, but put it into the hands of those who had suffered loss, and so in that way make the best attempt they could to get out of a bad business. He had unfolded the facts, and had spoken with perfect frankness to the meeting. Personally, he would not consent to go on as they were doing. He would not allow the Company to drift and create such preferential claims; but he would be willing to listen to any proposal which would amend the concern, so that they might get something out of it.

Major JONES (the Chairman of the Company) said that he had come prepared to place before them the manner in which the money that the Directors had dealt with had been spent, but he found that this was unnecessary, because Mr. Burnside, in his report, practically had given them the same figures which he (the speaker) would have given. Passing on to criticise Mr. Foster's report, he thought that Mr. Foster had clearly exaggerated the amount of money spent on alterations. As to the Elmore process, there was no question that when they purchased it, it was in operation on a very considerable scale at Leeds, where they were making tubes of large diameter of excellent quality.

A SHAREHOLDER: At a profit?

Major JONES said he did not know. He was only saying that the process was actually in operation. M. Secretan, it would be remembered, in order to meet the regular current demand for tubes, thought it would be best to commence with small-sized ones, which were not being manufactured in Leeds, and this required a certain amount of experimental work which, of course, increased the preliminary expenditure before they were in a position to commence regular manufacture. As to the buildings and plant, they knew, as a matter of fact, that the expenditure on these was small, and although Mr. Foster seemed to think that a large amount of money was unnecessarily expended on these, the Directors had reports from others who held a very different opinion. Although some few hundred pounds might have been spent on external decoration, yet on the whole there was nothing to be characterised as being in any way extravagant or wasteful. As to the future, there was no doubt that if they were called on to meet their liabilities they could not do so; but, as was shown in the circular which they had sent out, the £92,325 of liabilities included £39,000 which had been advanced by the Foreign and Colonial Elmore Company, and was secured by a second mortgage, of which there was no pressure for payment. After dealing with some of the other figures in Mr. Foster's report, he went on to say that that gentleman had calculated the profits on an output of 100 tons per month, which was just about one-third of what the works were capable of turning out if they were to carry them on. If, however, they were able to place the remainder of the new debentures, the interest payable on them would be £7,000 a year, the interest on the second mortgages was £9,400, and if they took £15,000 for depreciation and other charges referred to in Mr. Foster's report, there would be a margin of profit on an output of 100 tons a month sufficient to pay the interest on the preference shares and if they were to go on to 150 tons a month, they calculated, after paying all the standing charges, that there would be sufficient, not only to pay the interest on the preference shares, but 5 per cent. on the ordinary shares. Another point was that if they had money and would go on with the business they could not only make a profit, but re-establish confidence in the Elmore process, they would be able to get money to meet liabilities on reasonable terms, and the ordinary shareholders, who if they went into liquidation just now would lose everything, would be in a position to raise money on their holdings. If the shareholders would find the money he was convinced that the Company could soon be placed in a very much better position and the shareholders would make something out of it. No cash in the way of fees to the Directors, except in the case of the Managing Director, had been drawn for nearly two years.

Mr. GLADSTONE: What amount would you be prepared to put in?

The CHAIRMAN asked, if the shareholders were willing to find some money, how much the Directors were prepared to give.

Major JONES said that he was a poor man, and what he would lose over the Company was over £3,000; but if the shareholders were willing to take up these preference shares and enable the Company to go on, he was prepared to put in his proportion of the fresh capital.

Mr. F. L. RAWSON afterwards addressed the meeting at considerable length, and said that there was still another course open to them besides those suggested by the Chairman, and that was that they might sell the undertaking to France. He had a proposal which had been put into his hands before the meeting, the details of which he fully set forth. He strongly urged them not to wind up the Company, which, he said, would result in absolute loss to the ordinary shareholders.

Mr. STRETTOLL warmly expressed his confidence in the Board of Directors.

Mr. FOSTER said that his estimate of making copper was not an estimate of what was being done at present; it was an estimate of what copper could be made for if proper works were constructed and proper expenditure incurred. As regarded their being able to turn out 14 tons a week, his own opinion was that they could not do it commercially, and certainly they could not turn out 60 or 100 tons a month at a profit. He must say that he thought that a very large sum had been spent on the works, and that a much larger sum would still have to be spent upon them. It seemed to him that the whole work of the Directors had been nothing more or less than a huge experiment. He would like that to be really understood.

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Dr. HEDLEY, referring to the prospectuses (from which he made several quotations) issued by the Directors, said that these documents directly misrepresented the condition of the Company, because the Directors were either totally ignorant of the business they were conducting, or else they issued those prospectuses with the object of deceiving the public.

Mr. SAUNDERS, M.P., said that no proposal had been put before them but the old cry for more capital, and that they could not buy a ton of copper. Was it common sense to suppose that it was the want of copper that stopped their production when they had in their stores copper to the value of £20,000, and they were only producing £1,000 worth of manufactured copper per month? He ventured to say that such a statement was the strongest condemnation of the management of the Company that possibly could be made. Mr. Rawson repudiated any responsibility for the management. He (the speaker) was surprised to hear that, because he must confess he had come to the conclusion that Mr. Rawson was the mainspring of the whole thing, and that it would have been more honourable if he had stood by his colleagues instead of letting them down at this critical moment. It was perfectly clear that there had been either gross misrepresentation or gross mismanagement—[a Voice: Both]—perhaps both, and his impression was that Mr. Rawson was responsible for both. It was a matter which required to be gone into thoroughly. What they wanted now to do was to put a stop to the loss now being made of not less than £100 a day. In his opinion, in the report before them they had excellent advice, and under proper conditions they might be able to make a handsome profit. He concluded by recommending them to go into voluntary liquidation.

It being the evident sense of the meeting that voluntary liquidation was the best course to pursue,

A long discussion ensued as to the precise terms of the resolution to be submitted so that the property meanwhile might be properly protected, and eventually,

Mr. SEABORN moved:

"That we, the undersigned shareholders of the Elmore French Patent Copper Depositing Company (Limited), hereby signify our desire that the Company should be voluntarily wound up, with a view to reconstruction under the supervision of the Court on the following grounds:—That the Company cannot, by reason of its liabilities, carry on its business, and that the Company is unable to pay its debts, and that Messrs. Harries, Wilkinson and Raikes, solicitors, be instructed to institute the necessary steps for winding up accordingly, and that we will attend the necessary meetings with the view of obtaining the necessary resolution, and that the Directors be called upon to call a meeting for the purpose on April 5th next."

A SHAREHOLDER seconded the motion, which was carried unanimously, and a vote of thanks to the Chairman terminated the proceedings.

Notting Hill Electric Lighting Company (Limited).

The following is the Directors' report, to be presented at the sixth ordinary general meeting of shareholders, to be held at the Central Station, Bulmer-place, High-street, Notting Hill Gate, W., on Monday next, the 27th inst., at 5:30 p.m.:—

The expenditure on capital account at the date of the last balance-sheet amounted to £67,845. 13s. During the year a further sum of £9,054. 14s. 7d. had been expended, bringing up the total to £76,900. 7s. 7d. Out of this total £7,110. 7s. was expended on mains, and £1,535. 3s. 4d. on additional machinery, rendered necessary by the increase in the area supplied.

As mentioned in the last report, the Directors entered into a contract with Messrs. Crompton and Co. (Limited) to extend the mains southward into the Phillimore district, and this work has been carried out at a cost of about £6,500, under the supervision of Mr. Joseph Crookes, to the entire satisfaction of the Directors. Smaller extensions have been made by the Company's own workmen under the supervision of the resident engineer.

At meetings held on May 13th and 31st, 1892, powers were taken to issue the balance of the capital, amounting to £29,980, in ordinary preference shares, bearing 6 per cent. cumulative dividend. Of this amount £7,960 were issued up to December 31st, the proceeds of which were employed towards the capital expenditure above mentioned.

The revenue for the year, which shows a satisfactory increase, amounted to £3,513. 12s. 5d., the revenue from sale of current being £2,518. 17s. 1d. for the twelve months, as against £999. 10s. 6d. for the previous seven months. The number of houses supplied has increased from 77 to 124, and the number of lights from 6,056 to 9,438. There is every reason to expect a considerable increase for the current year. The mains at present run past and opposite to 886 houses which are not yet taking current.

The Directors are pleased to be able to report that the machinery and plant at central station, as well as the mains, are in excellent order, and that universal satisfaction is expressed with the steadiness and quality of the light.

As the profits of the Company depend, after a certain amount of output is reached, upon the amount of annual revenue per lamp, with a view to encourage development in this direction, a sliding system of rebates has been instituted, by means of which the charge for current to consumers whose lamps yield a gross revenue of upwards of 10s. a year will be proportionately reduced, the minimum rate being fixed at 6d. a unit.

The profit for the year amounts to £112. 6s. 1d., which compares with the loss of £554. 18s. 6d. (reduced by the return and postponement of undrawn Directors' fees to £304. 18s. 6d.) for the previous seven months. Having now turned the corner, there is reason to hope that the Company will soon yield to its proprietors a return on their investment.

In view of the slender amount of net revenue now available, the Directors have refrained from drawing any fees during the past year, and do not intend to draw any during the year 1893, until after the results of the working have been ascertained and the report presented to the shareholders; with a view to further lighten the prospective burdens of the Company, they have renounced 50 per cent. of their fees up to and including the end of the year 1893. In consequence of this no charge for Directors' fees appears in the accounts.

The Directors who retire are Messrs. W. Crookes and S. Waters, and, being eligible, they offer themselves for re-election.

The auditors, Messrs. Deloitte, Dever, Griffiths and Co., retire and, being eligible, offer themselves for re-election. They have expressed their willingness, in view of the Company's position, to accept a fee of £15. 15s.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below wil be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

EBENEZER TIMMINS AND SONS (LIMITED).—This Company has been registered with a capital of £20,000 in £20 shares, to acquire and carry on the business of civil mechanical, electrical, and general engineers, iron and brass founders, metal workers, metallurgists, &c., at Runcorn.

ENGLISH ELECTRIC CARBON COMPANY (LIMITED).—This Company was registered on March 18th, with a capital of £10,000 in £10 shares, to erect and establish works for the manufacture of electric light and other carbons, at The Smelt, near Brymbo, Denbighshire. The first Directors are John H. Darby, Sir Henry B. Robertson, William Darby, and Emil Mahla.

OSWESTRY ELECTRIC LIGHTING AND POWER COMPANY (LIMITED).—This Company was registered on March 2nd with a capital of £10,000 in £1 shares, to carry on at Oswestry, Salop, the business of an electrical supply company in all its branches, to generate, produce, accumulate, transmit, distribute and supply electricity, magnetism, or other similar agency; and to sell, manufacture, construct, erect, all kinds of electrical machinery, apparatus, and fittings. The subscribers (with two shares each) are—W. W. Coulson, Fernlea, Victoria-road; E. M. Gardner, 1, Clarendon-villas, Queen's-road; Robert E. Hughes, 15, The Cross; F. F. Leaver, 32, Church-street; A. Minshall, 18, Salop-road; John Minshall, and R. Taylor, Porkington-terrace (all of Oswestry).

OTIS ELEVATOR COMPANY (LIMITED).—This Company was registered on March 20th, with a capital of £50,000, in £10 shares, to adopt and carry into effect the following agreements (1) dated March 13, 1893, between the American Elevator Company and Joseph Cecil Bull (for this Company), for the sale to the Company of the goodwill of the business of manufacturers of and dealers in hydraulic, electric, and steam elevators, and other machinery, carried on by the American Elevator Company in Europe, Asia, and Africa, and of all the inventions, letters patent and other patent rights owned by the said American company; (2), dated March 7, 1893, between Otis Brothers and J. Cecil Bull (for the Company), with reference to improvements in the said inventions; and (3), dated March 13, 1893, between the Brush Electrical Engineering Company (Limited) and J. Cecil Bull (for the Company), for the manufacture by the Brush Company of the said elevators and other machinery, and to carry on in Europe, Asia, and Africa the business of manufacturers of and dealers in hydraulic, electric, and steam elevators, lifts, and other machinery, mechanical engineers, electrical engineers, &c. The first Directors are William A. Gibson, Norman S. Russell, Edward Woods, Henry Sherley Price, and Robert H. Thorpe.

PRINTING TELEGRAPH AND CONSTRUCTION COMPANY OF THE AGENCE HAVAS (LIMITED).—This Company was registered on March 17th, with a capital of £115,000, divided into 23,000 shares of £5 each. The objects are: to acquire the right to use and vend in France and to grant licences for the using and vending, of all or any of the inventions relating to printing telegraphs or improvements in the same, and to carry on in France, the business of transmitting the news of the day to subscribers, and to buy, sell and deal in all things incidental to improvements in telegraphy in France.

MISCELLANEOUS.—B. S. ROBERTS AND CO. (LIMITED), mechanical and electrical engineers. Capital, £2,000, in £5 shares.——BATES PATENTS SYNDICATE (LIMITED), manufacturers of high grade steel, mechanical, and electrical engineers. &c. Capital, £13,200, in £5 shares.——FOWLER'S ENGINEERING COMPANY (LIMITED), mechanical and electrical engineers, machine and engineering tool makers. Capital, £2,000, in £5 shares.——GEORGE JONES (LIMITED), iron and brass founders and mechanical and electrical engineers. Capital, £10,000, in £5 shares.

CHATHAM, ROCHESTER, AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to December 29, 1892, has been filed. Out of a nominal capital of £50,000, in £5 shares, 3,690 shares have been taken up, of which 1,663 have been issued as fully paid. Upon 2,000 of the remaining shares the full amount has been called, while the 27 others have had £1 per share called. The calls paid amount to £10,025, leaving £2 unpaid. Mr. Henry Jasper, of High-street, Chatham, holds 2,907 shares. An agreement, dated January

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21st last, with the said Henry Jasper (referred to as the contractor) states that it had been agreed between the contractor and the Company that certain works should be erected by the former for the sum of £16,630 in fully-paid shares, one-half payable before commencing and the other on completion of the works, and that the 1,663 fully-paid £5 shares had been allotted, and that as the Company were desirous of obtaining further plant, and of constructing further works, which the contractor had undertaken to do for £2,000 in fully-paid shares, it was agreed to allot to the contractor 400 shares fully paid. The works referred to are:—To put in a Marshall 195 I.H.P. engine; to substitute a 100 kilowatt Brush alternator for a 50 kilowatt Brush alternator; and to substitute ropes for belts for the 100 kilowatt machine

COLLIER-MARR TELEPHONE AND ELECTRICAL MANUFACTURING COMPANY (LIMITED).—The statutory return of this Company, made up to December 23, 1892, has been filed. Out of a nominal capital of £100,000, in £10 shares, 1,015 shares have been taken up. Upon these shares a call of £7. 10s. has been made, resulting in the payment of £5,110, and leaving £2,552. 10s. in arrears. An agreement, dated December 31, 1892, between the Collier Audible Telephone Syndicate (Limited), Godefroi D. Ingall, and the above Company, states that by previous agreements it had been agreed that the syndicate should sell to the Company all their property, patents, goodwill, business, &c., for £51,500 payable, £400 in cash and the rest in shares, and whereas a sum of £1,500 had been utilised for other purposes, it is therefore agreed that the remainder of the purchase consideration, viz., £46,000, shall be satisfied by the allotment of 4,600 fully-paid shares to certain persons named in a schedule to the agreement.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The annual return of this Company, which was made up on March 8th, has been filed. The whole capital of £220,000, divided into 16,000 ordinary and 6,000 preference shares of £10 each has been taken up, and the full amount called and paid.

DOUGLAS PATENT BLOCK AND ELECTRIC METER COMPANY (LIMITED)—This Company has been dissolved. The Company was registered in November, 1888, with a capital of £10,000, in £10 shares, to carry on the business of manufacturers of a patent detached pendulum and other clocks, and of meters for the measurement of electric currents, at Vyse-street, Birmingham. In reply to inquiries in 1891 the secretary stated that the business of the Company had been sold to the Electric Meter Company (Limited).

ELECTRICITY SUPPLY CORPORATION (LIMITED).—The annual return, made up to April 27, 1892, has recently been filed, and shows that at the time of making up 718 shares out of a total of 30,000 shares of £5 each, had been taken up, the full amount called, and all calls (£3,590) paid. The return for 1893, a public issue of capital having been made during the interval, made up to March 3, 1893, and filed at the same time as the foregoing return, shows that 16,556 shares had been taken up, the full amount called, and £82,780 paid in respect of calls.

L'ELECTROLYSE.—A Company, with this title, and a capital of 250,000fr., has been formed in Paris to exploit the Perreur-Lloyd system of electrolytic separation of metals.

GALLOWAYS (LIMITED).—The annual return of this Company, made up to March 3, 1893, has been filed. Out of a nominal capital of £250,000, in £100 shares, 2,108 shares have been taken up. On these the full amounts have been called, and all calls (£210,800) have been paid.

HENLEY TELEGRAPH AND ELECTRIC CONSTRUCTION COMPANY (LIMITED) (in Liquidation).—A meeting is to be held at 6, Clement's lane, London, E.C., on April 14th, at 12, to receive an account of the winding-up.

SHIPPEY BROTHERS (LIMITED).—The annual return of this Company, made up to December 31, 1892, has been filed. The Company was registered on December 30, 1887, with a capital of £30,000, in £5 shares. At the time of making up, 2,412 shares were taken up, of which 1,800 were issued as fully paid. Upon the remaining 612 shares the full amounts have been called, and all calls (£3,060) paid.

SUNBEAM LAMP COMPANY (LIMITED).—An agreement dated August 19, 1892, and recently filed, between the Company, Mrs. Margaret Clarke, Thomas Bowden, Abel H. Chapman, and John B. Furneaux, states that whereas legal proceedings had compelled the Company to cease manufacturing incandescent electric lamps until the expiry in November, 1893, of the patents of the Edison and Swan United Electric Company (Limited), and whereas the Company deemed it expedient to erect new works for the manufacture of such lamps on the expiry of the said patents, it was therefore agreed that the said Mrs. M. Clarke and Thomas Bowden should surrender 554 fully paid shares, that Abel H. Chapman should surrender a similar number, and that John B. Furneaux should surrender 35 fully paid shares, making a total of 1,143 shares surrendered; that the Directors should be at liberty to allot such surrendered shares, and also 287 original shares then unissued; that until a dividend of 5 per cent. had been paid in any one year to the other shareholders, the parties to the agreement should not be entitled to a dividend on their fully paid shares, but after such dividend had been paid they should be entitled to a similar one on their fully paid shares, and share equally with the other shareholders in any surplus profits; and that the Company should be authorised to issue mortgage debentures (out of a total of £3,000), bearing interest at 5 per cent., in payment for land and buildings required. The annual return of this Company, made up to February 8, 1893, has been filed; 1,595 shares had been taken, of which 857 had been issued as fully paid. Upon 213 shares the full amount had been called, and upon the remaining 525 shares £1 per share had been called, resulting in the payment of £2,625, leaving £30 in arrears.

CITY NOTES, &c.

ARCAS PLATING COMPANY (LIMITED).—The statutory general meeting of this Company was held on Monday at Winchester House, Old Broad-street, E.C. The Chairman (Mr. E. Wolseley) said that they had got a most valuable patent, and that as soon as they extended the works, as they proposed to do immediately, they would be able to meet after a few months' time with very satisfactory results to all. He might mention one thing, that the London Metallurgical Company, from whom they purchased this patent, had behaved in a most generous fashion to the Arcas Company. It was quite uncalled for, because they paid a large sum of money in shares for this patent—the English patent of the Arcas plating; but the London Metallurgical Company had given to them, without any charge of any sort or kind, the American patent, and, as they were aware, in America electro-plating is much more extensively used than it is in this country. They were going to exhibit in the Chicago Exhibition, and he hoped to be able to sell during the course of the year the American patent for a very considerable amount of money. The whole of the £15,000 working capital had been subscribed.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended March 19th were £880, as against £896 for the corresponding period of last year, being a decrease of £16. The total receipts for half-year amount to £10,411 against £9,404 in the corresponding period of 1892, being an increase of £1,007.

COMMERCIAL CABLE COMPANY.—This Company proposes to offer to existing shareholders 19,290 new shares at par, in order to provide funds for the laying of the third cable.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announces the payment on April 14th next of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum on the preference shares of the Company for the quarter ending March 31st, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits for the quarter ended December 31st last. The register of transfers will be closed from April 7th to 14th, both days inclusive.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The accounts of this Company to December 31st last show, subject to audit, a balance of profit of £157,093. 14s. 7d., after payment of three interim dividends. The Directors now propose to distribute on the 19th prox. the usual dividend of 2s. 6d. per share, making a total dividend of 5 per cent. for the year 1892, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year. The balance of £75,843. 14s. 7d. has been carried to the reserve fund. The share register will be closed from the 12th to 19th April, both days inclusive.——The Company also give notice that the tenth drawing for payment of the Five per Cent. Australian Government Subsidy Debentures (353 in number) will take place on the 6th prox., at the offices of the Company, Winchester House, Old Broad-street, E.C., at 11:30 a.m.

EDISON ELECTRIC ILLUMINATING COMPANY (U.S.A.).—This Company will shortly issue $3,500,000 additional stock, nearly the whole of which will be utilised in retiring its outstanding bonds, $250,000 of the amount being used for the development of the Company's business.

EPSTEIN ELECTRIC ACCUMULATOR COMPANY (LIMITED).—It is announced that Mr. Frederick R. Bluett has been appointed Secretary to the Company, and that the offices are now at 213, Gresham House, Old Broad-street, E.C.

FOWLER, LANCASTER, AND CO. (LIMITED).—A petition was presented on the 9th inst. by the Electrical Company (Limited) for the compulsory winding up of this Company (now in voluntary liquidation), and is down for hearing at the Royal Courts of Justice, London, on April 11th.

THE LONDON AND SOUTH-WESTERN RAILWAY COMPANY.—A considerable rise has recently taken place in the stock of this Company doubtless owing to the passing of the Bill for constructing and erecting an underground railway from Waterloo to the Mansion House, thus effecting access by the South-Western Company into the City.

REDRUTH ELECTRIC SUPPLY COMPANY (LIMITED).—The prospectus of this Company will be found in our advertisement columns. The Company is formed with a capital of £10,000, in 2,000 shares of £5—payable £1 on application, £1 on allotment, £1 three months after allotment, and the balance as required (after three months' notice). The Directors include Mr. Edward Tangye, engineer, and Mr. Joseph Pryor, mining engineer. The engineer to the Company is Mr. E. W. Tangye, who was lately with the Brush Electrical Engineering Company, London. The secretary (*pro tem.*) is Mr. C. Tweedy, and the offices are at Green-lane, Redruth, Cornwall. The prospectus states that the Company is formed to supply electric current to the town of Redruth, and the Directors give their services free until a dividend of 5 per cent. is declared. There is no promotion money, and the Company have the offer of a long lease of a site well adapted for the object in view at the yearly rental of £15, including the right to water, of which there is an excellent supply. The Local Board has consented to the establishment of the Company, which proposes to supply the district with current at about 4½d. per unit (=gas at 3s. 6d. per thousand). The Company has already promises of 750 16-c.p. lamps at £1 per annum per lamp. It is estimated that £5,000 capital will purchase the necessary plant for the maximum load of 1,000 16-c.p. lamps, and that the total capital of the Company (£10,000) will amply suffice to provide for 3,000 lamps. The estimated working expenses have been calculated at about £450 per annum up to about 1,500 lamps. The capital expenditure is considerably reduced from the fact that the mains go for about 500 yards in a perfectly straight course, and the Directors anticipate a fair day load from the use of motors and accumulator charging. It is proposed to use a low-pressure system.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended March 17, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,255.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended March 15th were £3,017, as compared with £2,895 for the corresponding period of last year. November receipts, estimated at £4,477, realized £4,511.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Mar. 15.		Price Wednesday, Mar. 22.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 22.	
								£ s. d.		Highest	Lowest.
			TELEGRAPHS								
£1,247,720	Stock	17/6	Anglo-American	53	54	52½	53¼	5 2 10	Jan., Apr., July, Oct.	53¼	..
£2,876,140	Stock	3⅝/0	Do. Preferred	92	93	92½	92⅝	5 17 8	" "	93⅛	92⅝
£2,876,140	Stock	5/0	Do. Deferred	13½	14	13	13⅛	..	" "	13 1/16	13¼
£250,000	100	4%	African Direct, Telegraph 4% Debentures	101	104	101	104	3 16 11	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11⅞	12⅛	11⅞	12⅛	5 6 1	Mar., June, Oct., Dec.	12⅛	11⅞
£68,200	£100	6%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	105	109	105	109	4 11 9	June and December	..	..
$7,716,000	$100	$1¾	Commercial Cable Capital Stock	178	182	178	182	3 16 11	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½	12⅝	11½	12¼	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10%	18	19	18	19	5 5 3	" "	..	..
12,981	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3⅝	4 11 5	April and October..	..	..
6,000	5	10%	Do. Preference 10%	9	10	9	10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11⅝	11⅞	11⅝	11⅞	5 17 8	Jan., Apr., July, Oct.	11⅞	11⅞
400,000	10	2/6	Eastern	14⅜	15	14⅞	15⅛	4 5 11	" "	15⅛	14¼
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16⅛	3 13 10	" "	16	15¾
£1,194 0	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113	116	113	116	3 9 0	May and November	114½	..
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107	110	107	110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15¼	15½	15¼	15½	4 10 4	Jan., Apr., July, Oct.	15½	15 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	111	114	111	114	3 10 2	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austin. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor Deb 1900	102	105	102	105	4 15 3	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101	104	101	104	3 16 11	February & August	102¼	..
180,227	10	1/3	Globe Telegraph and Trust	9⅝	9⅞	9¾	10	4 12 6	Jan., Apr., July, Oct.	9 1/16	9 1/16
180,042	10	6%	Do. 6 per Cent. Preference	15¼	15⅝	15¼	15⅞	3 17 5	" "	15⅝	15¼
150,000	10	5/0	Great Northern	19	19⅛	19¼	19⅜	4 6 1	Jan., April, and July	19⅜	19⅛
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104	107	104	107	4 13 6	March & September	107	106¼
17,000	25	12/6	Indo-European	44	46	44	46	5 8 8	May and November	44½	..
38,348	10	4/0	London Platino-Brazilian	4	6	4	6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	106	109	106	109	5 10 1	March & September	..	..
10,802	8	4/0	Reuter's	7	8	7	8	..	April and October..	..	..
3,581	£100 Cert.	30 0	Submarine Cables Trust 6%	118	123	118	123	4 17 7	" "	120	119
15,609	10	5/0	West African Telegraph	6½	7½	6½	7½	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	102¼	..
30,000	10	2/0	West Coast of America	2½	3½	2½	3½	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	105	109	105	109	7 6 10	June and December	..	..
88,321	10	6d.	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	" "	..	..
54,563	10	6%	Do. 6 per Cent. 1st Preference	10⅜	11¼	10¼	11¼	5 6 8	May and November	11¼	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1907	107	110	107	110	4 10 11	June and December	108	..
64,242	£5	3/0	Western and Brazilian	7⅞	8⅛	7¾	8¼	5 9 1	May and November	..	..
33,129	7½	3,0	Do 5 per Cent. Cumulative Preferred	5¾	6¼	5¾	6¼	6 0 1	" "	6	5⅞
33,129	7½	4/6	Do. 5 per Cent. Deferred	2	2½	2	2¼	..	" "	2⅜	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105	108	105	108	5 11 1	February & August	..	..
€237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105	108	105	108	5 11 1	" "	106	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120	125	120	125	5 12 0	May and November	..	..
€173,100	£100	6%	Do 6 per Cent. Sterling Bonds	101	104	101	104	5 15 5	March & September	102	..
			TELEPHONES.								
40,000	£5	10/0	Chili Telephone (fully paid) .....xd and rights	3	4	3	4	..	..	..	..
22,880	£2/0	1½d.	Consolidated Telephone Const. & Maintenance	⅛	⅜	¼	⅜	1 13 4	May and November	⅜	..
20,000	£1	4⅜d.	Oriental (11s. paid)	⅛	¼	¼	¼	7 18 2	Yearly	¼	..
454,747	5	2/6	National	5½	6⅜	5½	5⅝	5 11 7	June and December	5 1/16	5⅛
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15⅜	3 17 6	" "	15	..
15,000	10	6%	Do 6% Cumulative 2nd Pref	13⅞	14½	14	14⅜	4 2 9	" "	14⅜	13⅞
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref (£3 paid)	5⅜	5⅝	5⅜	5⅝	..	..	5⅝	5⅛
726 477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	1 3	116	113	116	3 7 7	January and July	113¾	..
48,000	£10	..	New Telephone, Limited (£4 paid)	..	..	..	..	..	..	..	..
58,000	5	1/0	United River Plate	2½	3	2½	3	..	January and July	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
30,152	£10	..	City of London Electric Lighting (fully paid)	12¼	12¾	12¼	12¾	..	..	..	..
20,000	£10	..	Do. 6 per Cent. Preference	10¼	10⅝	10¼	10¼	2 4 7	..	10⅝	10⅜
19,900	£5	..	Electricity Supply Co. of Spain	..	..	..	..	..	..	..	..
£150,000	£5	..	Electricity Supply Company Ordinary	..	..	..	..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	..	..	..	..	..
8,332	£5	..	House to House Electric	1⅛	2⅛	..	..	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully pd.)	5⅜	5⅝	..	..	..	..	..	..
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	6	6⅛	..	..	..	January and July ..	..	..
30,000	£5	3/6 '92	Liverpool Electric Supply (£3 10s. paid)	4⅛	4⅜	4⅛	4⅜	..	March	..	..
10,000	£5	5/0 '92	Do. (fully paid)	5⅝	5¾	5 11/16	5 13/16	..	March	..	..
111,000	5	..	London Electric Supply	⅞	1⅛	⅞	1⅛	..	..	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6	6⅛	6⅛	6⅜	..	..	6 11/16	6⅝
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102	105	102	105	4 15 3	June and December	105	104½
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5½	6⅛	5⅜	6⅛	..	..	..	..
18,680	£5	9½%	St. James' and Pall Mall	8¼	8⅜	8¼	8⅜	..	..	8⅜	8¼
7,900	£5	7%	Do. 7% Preference	8	8½	8	8½	4 2 4	..	8½	..
42,853	5	2/0	Westminster Electric Supply (fully paid)	5½	6	5½	6	4 3 4	..	5 13/16	5 11/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	1/6	Brush Electrical Engineering	3⅛	3⅜	3	3¼	..	..	3 5/16	3⅛
99,996	2	6%	Do. 6 per Cent. Preference	2⅛	2⅜	2⅛	2⅜	5 1 1	..	2 5/16	2⅜
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	103	105	103	105	4 5 9	..	104⅛	104⅜
20,000	5	5/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼	5⅜	5¼	5⅜	6 1 9	January and July	5 1/16	..
12,139	5	..	Edison and Swan United	..	..	..	..	..	..	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..	..	..	..	..	..	..	..
45,000	10	12/0	Electric Construction	2¾	3⅛	2¾	3⅛	..	..	3	2 5/16
70,000	2	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1½	2½	1½	2⅜	..	..	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	22½	23½	22½	23½	5 6 5	February & August	23 1/16	22¾
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	104	106	104	106	4 4 11	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½	3½	2½	3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6	7	6	7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0	6/0	5/0	6/0	..	..	..	..
78,949	5	4/2½	Swan United (£3. 10s. paid)	3	3⅛	3	3⅛	10 0 0	May and November	3⅜	3⅛
37,350	12	24/0	Telegraph Construction and Maintenance .... xd	35	38	34	37	4 17 3	March and July	35⅝	34½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	101	104	4 16 2	January and July	..	..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..	..	..	..	..	..	..	..
..	£5	..	Do. Preference (fully paid)	¾	1¼	..	..	..	..	..	..
			RAILWAYS AND TRAMWAYS.								
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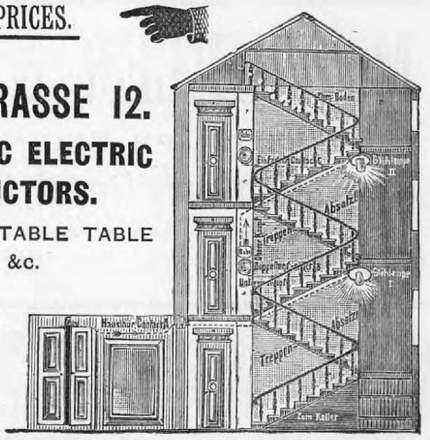

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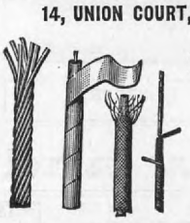

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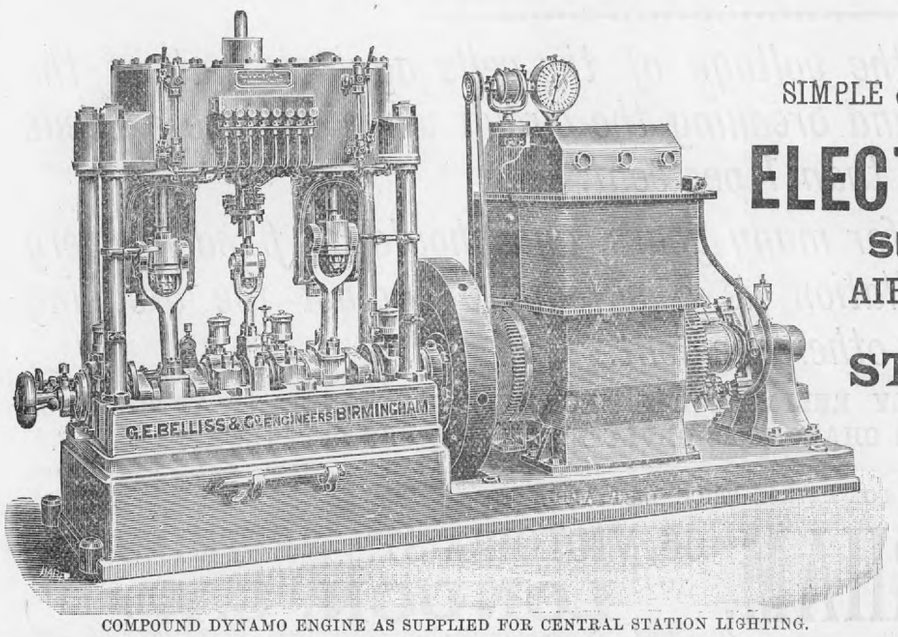

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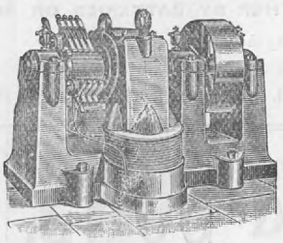

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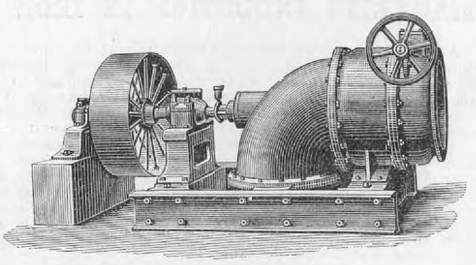

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Total Invested Funds, 31st December, 1891	£7,894,357	0	0

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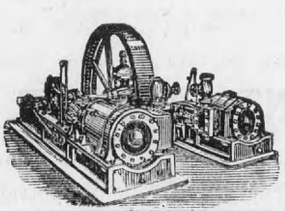

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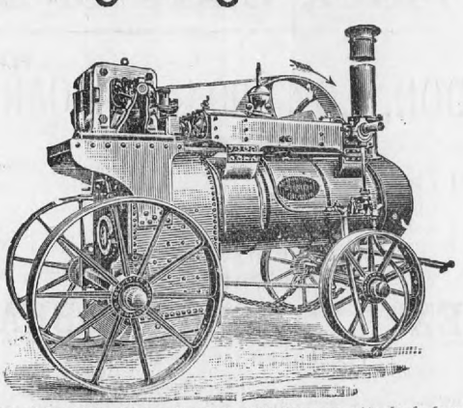

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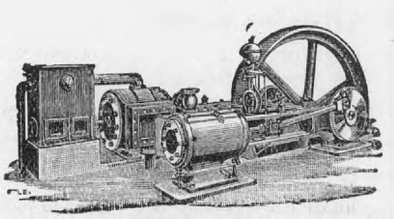

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NOTES.

The last meeting of the Institution of Electrical Engineers was very thinly attended. Photometry does not pay; there is no money in earth currents, and, at present, even less in electrical tanning. The first of the three Papers would have received more attention if presented to the Physical Society, the second to the Royal Meteorological Society, and the last to the Society of Chemical Industry. The Institution of Electrical Engineers is, in fact, thoroughly commercial at heart, though its best work is scientific. The remarks of the President in closing the meeting are well worthy of attention. Electrical engineering consists of something more than dynamo-building and transformer-testing.

Papers on the common run of subjects are easily discussed; practical men have their own ideas and trot them out, and whether they happen to support the views of the Paper or no, does not matter much. Still less are the theoretical men at a loss. But when something new is brought forward, or when a somewhat obscure or complicated matter is introduced, useful discussion is impossible unless the Paper has been previously circulated among those who may be expected to take part in the debate. The Institution of Electrical Engineers seems likely to achieve for itself the unenviable distinction of being the only scientific society that does not take the trouble of issuing advance proofs of its Papers. The rule laid down by the President that the discussions shall be confined to the Paper, and shall not circuitously regurgitate upon itself, is an admirable one, but when, for example, a photometer involving several novel points and somewhat complicated mechanism is exhibited and illustrated by photographs on a screen, it is not surprising if the discussion is diverted towards standard candles and other matters. A distinct drawback to the illustration of Papers by the lantern is that the diagrams are not before the audience during the whole meeting. If they cannot follow the author's delivery they can at least study the diagrams of the Paper which they hope some day to peruse.

The presentation of Mr. Falkenstein's Paper was doubly unfortunate. Not only would it be quite impossible to discuss such a communication without a careful study of the Paper, but it was taken at a late hour, read in disconnected fragments at a scramble, and discussion, at all events for that evening, was out of the question. A more discouraging reception could not well have been given to this, the first work of a junior member of the Institution, and since other societies are ready to do justice to such researches, it is not surprising that the Institution of Electrical Engineers by no means enjoys the monopoly of electrical Papers. Quite apart from its application to tanning, Mr. Falkenstein's Paper, so far as any estimate could be formed of it, promises to be a valuable contribution to the difficult and hitherto even un-named branch of electro-chemistry which deals with the transference of matter, and of which the migration of ions and electrolysis is but a sub-division. One well-known chemist, at all events, attended the meeting in expectation of hearing the Paper and of taking part in the discussion, and was not a little disappointed in failing to obtain a copy and in finding the discussion snuffed out.

A rather remarkable instance of triple invention is afforded by the proposal of M. Blondel to use an arc lamp and a system of perforated screens for providing a unit of light, and the identical proposal of Mr. Swinburne, and the suggestion of Prof. S. P. Thompson. The first was briefly described by our Paris Correspondent on page 539 of our issue for March 10th. The second was published in *The Electrician*, Vol. XXIX., page 65, in our report of the discussion which took place at the Institution of Electrical Engineers on April 28, 1892; the third, on p. 66 of the same volume, being a report of the adjourned discussion, when a communication was read from Prof. S. P. Thompson, who was then on the Continent. Prof. Thompson confined himself to throwing out a suggestion. Mr. Swinburne described exactly the arrangement of screens used by M. Blondel, and the author of the Paper under discussion threw cold water on both propositions, since the dusky appearance of the core of a cored carbon led him to expect a difference in the emissivity of different kinds of carbon. This difference M. Blondel finds to be negligible, and thus the value of the "arc standard of light," as he calls it, is established. At present no quantitative results have been published.

The new Déri alternate-current motor described in our columns this week, is interesting for two or three reasons. It is of the open-circuit type, and the torque at starting can be made considerable. It will run at various speeds according to the position of the brushes. It is said to be efficient and to run without sparking; but as only a small portion of the armature-coils is in action at any given moment, the

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power of the armature must be small, considering the weight of copper on it.

In a communication to the Académie des Sciences, M. d'Arsonval adheres to the widespread idea that the physiological effects of high-frequency currents is small. He refers to Mr. Campbell Swinton's explanation, recorded in *The Electrician*, December 9, 1892, p. 145, but evidently fails to grasp it. The fault is perhaps ours, since we had the privilege of publishing it in a Note. M. d'Arsonval cites an experiment to show that Mr. Swinton's explanation is erroneous. He brought a fine platinum wire to redness with a high-frequency current; he plunged it into a vessel of petroleum, and noted the rise of temperature which corresponded to the passage of the current for, say, five minutes. He then raised the wire to the same temperature by means of a continuous current, and observed that the heating of the petroleum was the same in the two cases. He adds that Mr. Campbell Swinton admits this explanation. We hope, however, that we here misunderstand M. d'Arsonval and that Mr. Swinton has not recanted, for his theory seems thoroughly sound, and we venture to add that M. d'Arsonval's experiment seems quite illusory. According to Mr. Swinton's explanation only the skin of the wire or of the lamp filament is taking part in conveying the high-frequency current. The C^2R effect depends then not on the natural ohmic resistance of the wire, but on the resistance of a cylindrical shell of unknown thickness, the interior core taking little or no part in the matter. We have already proposed that if the fall of volts could be measured, the current could be estimated from the watts, and M. d'Arsonval's calorimeter would doubtless be better than the glow lamp and photometer which we suggested. Mr. Swinton has attempted to do this with a Kelvin electrostatic voltmeter, but the instrument became filled with brush discharges in all directions, and indicated only some 500 volts or so. It is doubtful whether the filling of the whole case of the instrument with some limpid dielectric would enable a true measurement to be made. Spark length measurements are of no use here; what is wanted is the true average value of the volts.

The Westinghouse Company has acted with commendable generosity and policy in limiting its levies under the Hopkinson Three-Wire Patent to £2. 10. per annum per ton of copper laid. We have always held that the practice of keeping "master" patents in a state of quiescence, and allowing an infringing industry to grow up, either in ignorance of the very existence of the patent or in belief that it will never be made use of, although legally correct and perhaps tactically admirable is one which it is impossible to countenance. If it were possible to discover a remedy not worse than the disease, the law ought to be altered so as to stop the game. The Hopkinson patent was ten years old before its rights were enforced, and although the patentee and his assigns between them could no doubt give a very good explanation of this long delay, the fact remains, and the feeling of irritation it gives rise to exists. Under the circumstances, therefore, the Westinghouse Company has done well not to introduce the oppressive tactics of the General Electric Company of America into the United Kingdom. The Brighton Town Council, as we have already announced, stoutly repudiates the gentle insinuation that it is using the three-wire system, but the Town Councils of Dundee and Hull have wisely deemed discretion the cheaper part of valour, and have consented to be taxed by the Westinghouse Company. At Hull 22 tons of copper have been laid down, so that the Town Council will only have to pay £55 a year until July, 1896.

Telephony seems to be one of those few industries in which a reduction cannot be made "on taking a quantity," and it is said that, after a certain number of subscribers are connected, the system becomes so unwieldy that further increase is likely to diminish rather than to increase the profits. But this seems to be largely due to the necessary expenditure on new lines, wayleaves and instruments. There is, however, a very considerable *clientèle* which the National Company has hitherto neglected to cultivate, but which could be made to yield a good return with little or no capital outlay on the part of the Company, and without the smallest addition to the switchboards in the exchanges. In every direction in business London huge office warrens are to be seen, tenanted for the most part by business men to whom a telephone at a reasonable price would be a decided boon. Many of these warrens possess a common telephone. What could be easier than for the National Company to arrange with the proprietors for a simple plug switchboard to be looked after by the hall-porter, and for the running of wires from it to the rooms of those who are prepared to pay, say £5 a year, for the *n*th share of the common Exchange wire? We understand that £10 or £15 a year has been demanded for such a connection, but have not heard that it has ever been accepted. If the National Company wish to spend no more capital, the tenants or the landlords of the offices would, we think, run the wires and provide the instruments. There may, however, be working difficulties which are not apparent.

From a letter recently received by the Edinburgh Town Council it would appear that something in the nature of an Electric Traction Association is in process of formation. This is as it should be. As a matter of fact, however, it seems to us that, since so many local authorities have a more or less direct interest in tramways, an effective way of checking the clause-inserting career of the National Telephone Company would be to induce the Municipal Corporations Association to take action. If we recollect aright, something of the kind was attempted last year in the case of the Blackpool Improvements Bill, though with what result we cannot say. The Salford Town Council, to whose action in withdrawing the tramway clauses of their Improvements Bill we alluded last week, by so doing certainly succeeded in temporarily checkmating the National Company. On the other hand, the attempt of the National Company to force upon the Salford Town Council a retrospective protective clause covering the whole tramway system of that town, on the occasion of powers being demanded to double a single section, was an object-lesson in this Company's attitude rendering it advisable for the Municipal Corporations Association to have fought the

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issue out to the bitter end. While desirous that under ordinary circumstances every facility should be accorded to the National Company in the matter of wayleaves, we would point out that so far as municipal authorities are concerned, they can bring considerable pressure to bear upon their adversaries by merely refusing to assist them in their efforts to obtain wayleaves until a satisfactory *modus vivendi* has been arrived at.

We wonder how many of the 1,700 or 1,800 members and associates of the Institution of Electrical Engineers ever perform a work of supererogation by analysing the balance-sheet which they pass every year with all due formality. A remark let fall at the last meeting induced us to see if we could extract a broad fact or two from the 1892 accounts, recently placed in the hands of all those connected with the Institution. The net outcome of our examination is that the Institution has invested in various Government securities, and for various purposes, a sum of close on £5,000, that its annual receipts from all sources amount to nearly £3,600, and its annual ordinary expenditure to £2,300, being nearly £300 more in 1892 than in 1891. The net cost of the *Journal* last year, including reporting, printing, postage, and advertising, was about £750. Under the items of extraordinary expenditure we note £118. 10s. in connection with the compilation and printing of the Index to Vols. XI.-XX., of the *Journal*. The financial position of the Institution, like that of most other electrical concerns, is modest, and, unlike that of some, it is sound.

Sir John Kennaway's Committee were apparently in a rejecting mood last week. On Monday the Clapham Junction and Paddington Railway received its quietus, the professorial ferule and not "a bare bodkin" being the means of its despatch. On Friday the Kilburn, Edgware-road and Victoria line fell before the heterogeneous forces of the London County Council, a City alderman and a couple of dukes. The opposition was not only unusually powerful, but, what is rather more uncommon, it had an unusually strong case. A somewhat wanton interference with the "amenities" of valuable property, public and private, was threatened and the Committee were not satisfied that the line when authorised would not be converted into a means of filling the pockets of its promoters, with no corresponding benefit to the public. With the Central London Railway still incubating in the City and four new lines authorised, it is not altogether desirable from the point of view of broad public policy that any more lines should be sanctioned in a hurry. The Kilburn, Edgware-road and Victoria Railway would have proved, without a doubt, a boon to a large and rapidly-growing suburban population, and when the promoters of the lines already authorised have got to work —engineering work, we mean—Select Committees will not, we feel sure, unnecessarily delay further developments of our metropolitan electric railway network.

As is customary, the witnesses of the threatened property-owners rather overdid their case, and one gallant gentleman solemnly assured the Committee that he had been told by "those who possessed technical knowledge" that "the electrical currents of the railway would seriously affect the storage-power of the accumulators placed in the cellars of Nos. 4 and 5, Grosvenor-place." If the names of these possessors of such valuable technical knowledge were known, we are afraid their earning power as electrical experts would be seriously affected.

Canal Lighting.—The Corinth Canal is to be lighted at night by arc lamps placed on the banks.

Académie des Sciences.—Sir Henry Roscoe has been elected "Correspondant pour la Section de Chimie," and Sir Joseph Lister, "Associé Étranger."

Cable Interruptions—

Cables.	Date of Interruption.
Gibraltar-Tangier	February 18th
Para-Maranham	March 20th.

The London County Council (General Powers) Bill.—Sir W. Hart Dyke has been appointed Chairman of the Select Committee of the House of Commons on this Bill, and the Committee will sit to take evidence on April 13th.

Brighton.—The report of Mr. I. B. Walker and Major Cardew, Board of Trade Inspectors, with regard to the opposition of the Town Council to the granting of a Provisional Order to the Brighton Electric Light Company, has been published. It is unfavourable to the Company. Whilst of opinion that the Company has some claim upon the consideration of the Corporation, the Inspectors cannot recommend the Board of Trade to dispense with the consent of the Brighton Corporation.

The Liverpool Overhead Railway.—At the last weekly meeting of the Mersey Docks and Harbour Board the Works Committee recommended the Board to allow the Liverpool Overhead Railway Company to erect an additional flight of stairs at the terminal station at the Herculaneum Dock. Mr. Glynn, in moving the adoption of the recommendation, said he was glad to note that the Company already had so many passengers to carry that they required an extension of their accommodation. The motion was approved.

The New York Electric Light Subways.—Those who have placed their wires in the New York electric light subways have had a good deal to contend with, and, now that gas leakage has apparently been rendered harmless, ice intervenes. A short time since when some men opened the Canal-street electric-light subway in order to put a wire in, they found the conduits full of ice. The difficulty was overcome in the following manner:—A bellows, to which was attached a $\frac{3}{4}$in. iron pipe, was rigged up. Around the coils of the pipe a fire was built, and a hot-air blast was directed on to the ice-choked ducts.

The London Telephone Service.—We received the following letter from the Secretary of the National Telephone Company on Friday morning last:—

Dear Sir: I duly received your communication of the 20th instant, and in reply beg to inform you that we contemplate making a reduction in our metropolitan tariff for the connection of private residences for domestic purposes to £10 per annum on a five years' agreement, or £12 per annum on a yearly agreement, where the address to be connected is within one mile of our nearest exchange. An extra charge of £2. 10s. per annum will be made for each extra half-mile beyond the above distance.
Yours faithfully, Albert Anns, Secretary.

P.S.—The reduced rates will not apply within the area comprised in the City of London Union.

Electricity v. Gas at Lyons.—The Lyons Gas Company has, says the *Gas World*, been getting itself into trouble in a curious way. An electric-lighting company was going to supply a particular district of Lyons, and the Gas Company, in order to cut it out, began to supply gas in that district at 22 instead of 30$\frac{1}{4}$ centimes per cubic metre (4s. 11$\frac{1}{2}$d. instead of 6s. 9$\frac{1}{2}$d. per thousand cubic feet). One of the consumers in the town, hearing of this, objected to paying the full price, and claimed an equal reduction. The Court held that the Company had done

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wrong, and must yield the reduction to every consumer. The Company has appealed.

The Berlin Telephone Exchange.—At the beginning of the present year the 20,000th subscriber was connected to the Berlin Telephone Exchange. The system came into operation on April 1, 1882, with 50 subscribers; by the end of the same year this figure had increased to 458. The following are the totals for the January of each year since:—

1883	1,069	1888	6,955
1884	1,625	1889	9,199
1885	2,412	1890	11,854
1886	4,324	1891	14,490
1887	5,507	1892	17,013
		1893	20,000

Determination of Areas from Measured Diameters.—In a short Paper before the Franklin Institute, Mr. O. T. Louis discusses the effect of errors in calipering cylinders on the areas calculated from the diameters thus measured. He shows that the common opinion that the error in the area is equal to the square of the error in the diameter is erroneous, and that the actual error is never far from double the error of the diameter, when this has been over estimated. An error caused by crushing of a wire by screwing up the calipers gives rise to less error in the calculated area than an error of the same magnitude in excess. The author, therefore, suggests that it is an advantage to err in the direction of a tight measurement.

Books on Indiarubber Manufacture.—"Why does not some one 'in the know' write a book on the manufacture of vulcanised rubber goods?" says *Industries*. "There are many treatises whose externals look as if they dwelt on this subject, but on examination they are found to be written by theoretical rubber people, who make rubber goods of Para rubber and sulphur with no foreign ingredients. 'Real rubber goods' contain very little rubber. Anybody can make rubber goods out of rubber; the real art is to make them with as little rubber as possible. We believe that the mixtures used in rubber works, especially for electric cables, are kept profoundly secret; but if a writer does not know these mixtures, or does not give them in his book, he has no business to publish it. It is obtaining money—and, what is worse, wasting a reader's time—under false pretences."

The National Telephone Company and Electric Traction.—At the last meeting of the Edinburgh Town Council a letter was submitted from the Thomson-Houston International Electric Company, intimating that an Association was being formed for the purpose of resisting the demands of the National Telephone Company for the introduction of special protective clauses in all Bills and Provisional Orders where powers for traction by electricity were sought. The Lord Provost said they all knew how the National Telephone Company was really becoming a source of tyranny, and he was glad to find that other towns were wakening up to the position of affairs. Though they sent the letter to the Lord Provost's Committee with powers, it was not for the purpose of joining the Association, though he had no doubt they would be glad to join if it should seem desirable, but for the purpose of obtaining information on the matter. The letter was sent to the Lord Provost's Committee with powers.

Tanning by Electricity.—In the Pinna process of electric tanning, the hides are submitted to the action of alternating currents while immersed in the tanning liquor. A metal electrode is placed at the bottom of the pit, and the hides are piled one upon the other. The tanning liquor is then run in. The current density required is from $\frac{1}{2}$ to $1\frac{1}{2}$ ampere per square inch, according as the skins are light or heavy. The frequency of the alternations should be not less than 43. The arrangement described can obviously be adopted in the usual pits, but the vertical suspension of the hides side by side between vertical electrodes has given better results, and permits individual hides to be examined during the process. It is claimed that 100 to 400 hours, according to the quality of the skins, is sufficient for the process. According to M. Pinna the advantage of employing electricity at all lies in the fact that it powerfully assists the penetration and diffusion of the tannin into the skins in consequence of the physiogical action which electricity exerts upon the cellular tissues. Continuous currents, resulting in electrolysis of the tannin, give rise, in his opinion, to deleterious reactions.

The City of London Electric Lighting Company.—The City of London Electric Lighting Company were summoned at the Southwark Police Court on Saturday by the sanitary inspector to the St. Saviour's District Board of Works, for that they did on February 27th and March 1st, 3rd, and 6th, send forth black smoke from the chimneys at their station, Meredith's Wharf, Bankside, Southwark, in such quantities as to be a nuisance. Mr. Topham, solicitor, prosecuted, and the Company were defended by counsel. One of the four summonses was taken as a test case. Evidence was given by engineers, experts, and others for the Company to prove that theirs were the very best smoke-consuming furnaces; that only the best Welsh smokeless coal was used; and that the chimneys did not smoke. Inspector Grist and his assistant proved watching from 6 to 6:30 p.m. on February 27th, during which time dense volumes of black smoke were sent forth from the Company's chimneys. Mr. Topham contended that the magistrate was bound to convict, and that it was only necessary for him to prove that black smoke was sent forth, no matter how excellent the construction of the furnaces. Mr. Slade fined the Company £5 and 2s. costs in the first case, and in each of the others inflicted penalties of 10s. and 2s. costs.

Electric Tempering.—In *The Electrician* for February 5, 1892, we gave a brief summary of a communication made by Prof. Lagrange and M. Paul Hoho to the Académie Royale de Belgique, on the subject of the luminous sheath which surrounds a fine wire when used as negative electrode in an electrolytic vessel through which a powerful current is passing. In the *Comptes Rendus* for March 13th the same investigators point out that the sheath is not only luminous but intensely hot, the heat being very local. A piece of iron 10 centimetres long and 1 centimetre in diameter can be heated, by proper arrangement of non-conducting screens, in alternate centimetre long sections, the heated sections fusing while the cool sections are still quite cold. So rapid is this heating action that a rod of iron can be made white hot at the surface before the interior is affected, so that by suddenly making and breaking a circuit, the surface of a piece of iron is suddenly heated up and then quenched in the electrolyte, thus getting an exceedingly hard coating, the depth of which depends on the duration of the process. The authors showed samples of iron which had been treated in this way, and which exhibited totally different fractures at the surface and in the interior. Electrical heating for tempering has been in use for some years, but this process seems to permit the quenching of very fine springs and promises to be useful in case-hardening.

The Pelton Water Wheel.—According to a correspondent of *Power*, the principle involved in the Pelton wheel has a curious history. It was embodied in a turbine invented by Jearum Atkins. In due course, as was then and is now the custom in the Patent Office, the application was rejected. Shortly after, Mr. Atkins was thrown from his waggon and injured. While in that condition, however, he made many inventions, and acquired a competency. Among other things he perfected the details of his wheel, and applied for a patent, which was granted August 10, 1875, No. 166,676. In his application he embodied a full mathematical exposition of the action of the water on the wheel, showing that the entire momentum of the water is imparted to the wheel if it enters, as in the Pelton, at one side of a semi-circular bucket and escapes at the other, the direction of its motion being exactly reversed in transit. Under these conditions the wheel will move with half the initial velocity of the water, and the spent water will fall away without residual velocity. The mathematics of the specification was too deep for the Patent Office examiner, and he required its cancellation upon the ground that it was not necessary. Afterwards he admitted that he did not consider the demonstration necessary, and did not know whether it was true or not. Anyone curious to know will find it embalmed in the original specification of that application. The Pelton wheel embodies the same principle, and if more perfectly formed would realise the full theoretical value of the jet.

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ELECTRICITY AS A MOTIVE POWER.*

BY ALBION T. SNELL.

(Continued from page 564.)

§ 2. The Dynamo and Motor.

The author has not thought it advisable to enter into an elementary discussion of the principles underlying the construction of dynamo-electric machines. This is the province of text-books on electricity and magnetism. Here the object aimed at is rather to develop the lines on which these principles are applied in practice, and to give useful information to the construction engineer. Although machines suitable for the transmission of power are chiefly held in view, yet the method advanced is equally applicable to dynamos intended for lighting or other purposes.

First, it is necessary to distinguish between the dynamo and the motor. In the introductory remarks it was mentioned that the dynamo was a reversible machine, the motor being the converse of the dynamo. The functions of the two machines must now be compared. The chief conditions of working in the two cases are widely different, and these distinctions must be duly considered in the design. The dynamo will usually be driven at a speed as nearly constant as possible, and will be required to give a variable output at a constant difference of pressure. The motor will usually be run at a fairly constant E.M.F. of supply, and will be required to give a variable torque at a constant speed. The dynamo in most cases will be placed in a dry engine-room, and meet with at least as much attention and care as ordinary steam plant. The motor, on the other hand, must be in close proximity to the driven machine, and will frequently be in a dusty, dirty, and more or less exposed position; and the attendance will be most likely a few visits daily at the best. The dynamo will probably run with fairly steady loads, and not be subjected to large sudden variations of output. The motor must, in the nature of things, meet with rougher usage. If the work be intermittent, the stoppages frequent, or overloading common, the motor must meet the demand, no matter how great the strain. It follows, therefore, that the motor should be built with a larger factor of safety than is usually necessary with a dynamo; and that extra care should be given to the insulation and general details. To ensure due prominence being given to these conditions, it is the practice of the author to base the design of the dynamo on the total armature E.M.F., and to give special attention both to the maximum and the average torque in the building of the motor.

§ 3. Units and Symbols.

To make the equations suitable for the drawing office, inch-pound-minute units will be used. The author has for some time endeavoured to use the C.-G.-S. system in dynamo design; but he has invariably found it necessary to convert the measurements into English quantities before the drawings can be used in the shops, because the workman uses a foot-rule and thinks in eighths and quarters of an inch. The decimal system is admirable, but it has not taken in this country; and until it has there is nothing to be gained by making the duplicate measurements. To the pure physicist the C.-G.-S. system of units offers a real advantage, for it simplifies his work; but to the construction engineer, at present at any rate, it only means an increased number of figures with a corresponding chance of error from clerical slips. The symbols will be as nearly as possible those used in the fourth edition of Prof. Silvanus Thompson's "Dynamo-Electric Machinery," because these are no doubt already widely used, and so will be readily followed by the majority of men interested in the subject.

Symbols used in the following Calculations and Equations.

A = area in square inches.
$A T_s$ = ampere turns with armature on open circuit. } Both refer to field
$C T_s$ = compensating ampere turns for full load. } magnets.
B''_a = the magnetic induction per square inch of armature cross section.
B''_f = the magnetic induction per square inch of field-magnet cores.
B''_g = the magnetic induction per square inch of the area of the air gap.
N_a, N_f, N_g = the total magnetic fluxes severally in the armature, field-magnet, and air gap.
C_a = the total number of conductors in the armature, counted all round the external periphery, and therefore applicable to either drum or gramme winding.
C_s = the total number of turns of wire on the shunt coils of the field-magnets.
C_m = the total number of turns of wire on the main or series coils of the field-magnets.
D = the outer diameter of the armature,
d = the inner diameter of the armature,
r = radial depth of the iron of armature,
l = the length of the armature reckoned over the iron, } in inches.
E = the total electromotive force generated in an armature, either dynamo or motor,
e = difference of potential from terminal to terminal, } in volts.
η = efficiency or economic coefficient.
F = force (push or pull) in pounds weight.
i = current in external circuit,
i_a = current in an armature,
i_s = current in shunt coils,
i_m = current in series or main coils, } in amperes.
μ = coefficient of magnetic permeability.
n = number of revolutions per minute.
p = number of pairs of poles.
R = resistance of external circuit,
r_a = resistance of armature coils,
r_s = resistance of shunt coils,
r_m = resistance of series or main coils, } in ohms.
T = torque or turning moment.
v = coefficient of allowance for magnetic leakage.
δ = length of the air gap *on one side only*,
w = width of the polar cavity,
L_g = length of the polar cavity,
m_a = mean length of magnetic path in armature core,
m_f = mean length of magnetic path in cores and pole pieces, } in inches.
m_{f1} = mean length of magnetic path in yoke,
W = work per minute in foot-pounds.

§ 4. First Approximation to the Size of Armature for a given Output and Speed.

The first point to determine in designing a dynamo is the size of armature that is best suited to meet all the requirements of the problem. Usually the volts, amperes and speed are fixed, and frequently the selling price too. The latter cannot be specially discussed, but a few hints gathered from practice will be given when possible. We know, then, e, i and n. The size of machine can generally be selected by reference to a price list, and by making a few rough calculations. But if the type be new to the shop, no data are available, and it is necessary to resort to a few figures and to solve a few simple equations.

The output of any dynamo is proportional to the volume of the armature, the number of revolutions per minute, and the magnetic flux. Hence output $\propto l D^2 n \mathbf{N}_a K$, where K is a dimensional constant to reduce the product to watts or horse-power. The author first published empirical equations of this form in 1888, and coupling $\mathbf{N}_a$ and K he based the resultant value on an average magnetic density and radial depth of core. Such assumptions are found to be fairly correct for the greater number of bipolar machines with outputs of from 10 to 100 H.P.; but below and above these limits the equations are not so nearly in accord with actual results. Small machines realise smaller outputs than this theory indicates, owing to the disproportionate resistance of the air gap; while in large machines the output is so largely affected by the design of the field-magnets and the arrangement of the poles that separate calculations are needed for every type. Nevertheless, similar equations can easily be determined for any size and type, but the constant must be adjusted to suit the conditions. For gramme armature dynamos the author finds the coefficient 0·01 to give fair results between the limits stated; and for drum machines 0·015, the output in each case being in watts. Thus for dynamos:—

$$\text{Watts} = l D^2 n\, 0{\cdot}01 \text{ (gramme)}, \quad . \quad . \quad . \quad (1)$$

$$\text{Watts} = l D^2 n\, 0{\cdot}015 \text{ (drum)}, \quad . \quad . \quad . \quad (2)$$

and for motors, estimating the output in brake horse-power:—

$$\text{B.H.P.} = l D^2 n\, 0{\cdot}00001 \text{ (gramme)}, \quad . \quad . \quad (3)$$

$$\text{B.H.P.} = l D^2 n\, 0{\cdot}000015 \text{ (drum)}. \quad . \quad (4)$$

It should be noted that a drum armature is capable of giving an output which is 50 per cent. in excess of a gramme ring of the same over-all dimensions. This enormous advantage in the weight efficiency of drum armature machines is

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well recognised, and where the conditions of running admit of the design it should be invariably used. Indeed, if it were not for the difficulties in the winding and insulation of drums, gramme armatures would soon be obsolete. The superiority of the drum lies chiefly in the following points: (*a*) it has no inside wires to cause an internal field, as well as to increase the dead resistance of the winding; (*b*) there is less inequality of E.M.F. in the coils, since each turn of wire embraces the whole armature field; and (*c*) the iron can be carried right to the shaft, and therefore the magnetic induction per unit of area may be made low, though the total flux is very large.

The gramme winding, although causing an internal field and a more irregular distribution of the lines of force, is better adapted for rough work, since coils of very different potentials are not in close contact, as occurs with ordinary drum windings. There are arrangements of bar windings with specially shaped end connections which obviate this objection to some extent; but experience has all along pointed to the gramme type of winding as the safer for hard work. The author has tried both methods, and has no hesitation in advising the gramme winding for high-tension transmission dynamos and motors. For lighting, dynamos of, say, from 100 to 200 volts, the drum type, with bar windings, and spiral strip connections, is the better, and is generally adopted now when other considerations do not prevent its use.

The rough dimensions of the armature for dynamo or motor may now be assumed to be known, and the calculation of the winding may be proceeded with.

§ 5. Fundamental Equation connecting the Total E.M.F. with the Armature Constants.

The factor of prime importance in armature design is E, the total E.M.F. The value of E is determined by the relationship—

$$E = e \pm i_a r_a. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The positive sign must be used for the armature of a generator, and the negative for that of a motor. The armature current i_a is known from the conditions of the problem; but r_a has to be determined, as the winding is not yet chosen. An assumed value must be substituted in (5), which can be amended when the gauge and number of turns of wire are definitely fixed. The numerical value of $i_a r_a$ cannot be given, but can be conveniently expressed as a percentage of E. The following table of approximate values will be of use at this stage:—

Table A.

Output of dynamo or motor in H.P.	$i_a r_a$ expressed as a percentage of E.
2·5	6 per cent.
5	5·5 „
10	5 „
15	4 „
20	3 „
25	2·75 „
30	2·5 „
50	2·25 „
100	2 „

The total armature E.M.F. is given by

$$E = C_a \mathbf{N}_a n \frac{10^{-8}}{60}. \quad . \quad . \quad . \quad . \quad . \quad (6)$$

C_a, the number of turns of wire counted all round the periphery, is the most important variable; n is the number of revolutions per minute, and is given by the conditions of running. $\mathbf{N}_a$ is the total magnetic flux, and is numerically equal to the product of the number of square inches in the cross section of the armature and the magnetic density per square inch, or

$$\mathbf{N}_a = \mathbf{B}_a'' 2 r l 0{\cdot}85. \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The coefficient 0·85 is introduced to allow for the insulation between the plates of the armature.

The value of l was fixed when the over-all dimensions of the armature were chosen; and so in practice would that of r be; for the radial depth of core has presumably a fixed ratio to the diameter of armature for a given type of field-magnet. Various considerations determined by experience fix the magnetic flux per unit area at from 90,000 to 110,000 lines of force. Therefore $\mathbf{N}_a$ can readily be determined as soon as the size of armature is selected.

(To be continued.)

LIGHTNING ARRESTERS IN THE UNITED STATES.

BY ALEXANDER JAY WURTS.

During a trip made last summer through various sections of the United States, I took especial pains to note the troubles that were experienced by electric light and power plants during thunder storms. In the eastern states thunderstorms seem to be local, and I repeatedly found electric plants within 50 miles of each other, where in the one case troubles from lightning were incessant, and in the other a thunderstorm was almost unknown. From Chicago, Ill., all the way to the western coast frequent thunderstorms seem to be taken as a matter of course, but these were particularly violent along the valley of the Mississippi and in the neighbourhood of the Rocky Mountains. A certain plant in the state of Illinois reported the loss of over 30 converters during a single storm. Further west, the loss of four or five converters during a thunderstorm was a common occurence. The destruction of electric railway apparatus was not so frequent, but this was largely due to the fact that at the first sign of approaching trouble, trollies were tied down and the switches at the station thrown out till all danger was passed. The pecuniary loss is, nevertheless, considerable even under such circumstances, for not only are the net profits to the company severely curtailed, while expenses still run apace, but there is also great loss in public confidence. In Colorado there is a large electric railway plant that is forced to shut down for an hour or two nearly every afternoon during the months of June, July, and August. Still further back among the mountains are many alternating-current plants operated by water-power, and these are reported as being almost inoperative during the afternoons of the summer months. It will thus be seen how vitally important an efficient lightning arrester is in this country of thunderstorms.

There are two general methods of protecting electric systems; one is by means of the simple discharge circuit containing a spark-gap and connected directly from line to earth. Disruptive discharges, however, form nodes, where there is little or no tendency to discharge. If, then, a spark-gap arrester be connected at a node, a discharge will be more likely to occur at some other point. These nodes are constantly shifting their positions in the system; it is evident, therefore, that efficient protection by means of spark arresters can only be secured with any degree of certainty by distributing a large number of arresters throughout the system. I recommend three or four per mile in particularly exposed districts. The subject of these nodal points is a complicated one, and a discussion of it here would be out of place. The other method is to prevent the accumulation of charge on the line by stretching, near and parallel to the line to be protected, a bare wire thoroughly grounded at frequent intervals. The overhead grounded wire forms, as it were, a shield to inductive effects, and, at the same time, tends to equalise the difference of potential that would otherwise exist between the neighbouring atmosphere and the earth. The first method is a cure, the latter a preventative. Both of them involve difficulties; the latter is the more efficient of the two.

When spark-gap arresters are connected to both legs of a circuit, a discharge will almost invariably take place from both legs at the same instant, thus causing a short circuit on the generator. A spark-gap arrester must, therefore, be so designed that it will instantly interrupt this short circuit and automatically adjust itself in readiness for a succeeding discharge. This would not be a difficult matter were it not for the fact that electromagnetic devices offer an enormous resistance to the passage of a discharge. Many devices have been brought out and patented which should accomplish the desired end, but nearly all have combined one or more serious objections—such as moving parts and general complications. A spark-gap arrester to be reliable must be simple, cheap, free from moving parts, and certain to instantly interrupt the short circuit without injury to itself or other apparatus, and without blowing fuses. The non-arcing arrester meets all these requirements for alternating-current circuits. More than a year ago, I discovered that if the electrodes of a spark-gap arrester were made of certain metals, it was not possible to maintain an arc across the spark-gaps when connected to an alternating-

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current generator. In a Paper read by me before the American Institute of Electrical Engineers, on March 15, 1892, under the title of "Lightning Arresters and the Discovery of Non-Arcing Metals," will be found detailed information regarding this discovery and the remarkable properties of these metals, which are zinc, antimony, bismuth, cadmium, and mercury. The electrodes used in the non-arcing metal arrester are made of zinc, combined with a certain proportion of copper.

An arrester of this kind is illustrated in Fig. 1. It is made double-pole, so that it may be connected to both legs of the

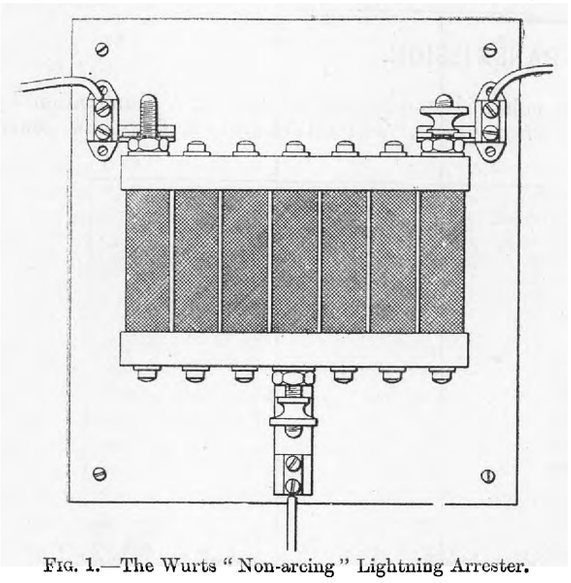

FIG. 1.—The Wurts "Non-arcing" Lightning Arrester.

circuit, and consists essentially of seven non-arcing metal cylinders, each three inches long and one inch in diameter. The cylinders are solid, knurled on the surface, and are mounted on a white marble back with their axes parallel to each other, and are separated from each other by $\frac{1}{64}$th of an inch. When in service, the two outer cylinders are connected respectively to the two legs of the circuit, and the middle cylinder to the ground. There are, therefore, between line and ground three air gaps of $\frac{1}{64}$th of an inch each.

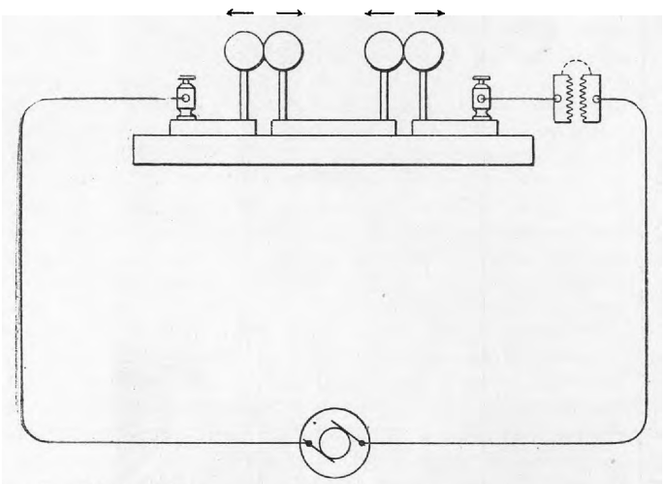

FIG. 2.—Diagram of Arrangements for Experimenting on the "Non-arcing" Property of Certain Metals.

In testing this arrester, the two outer cylinders are connected to the terminals of a 1,000-volt alternator, in series with a switch, the air spaces are bridged with small crumbs of tinfoil, and the switch thrown. The short-circuit thus established is so instantly interrupted that a 20-ampere fuse placed in series with the arrester will not be melted, and often three or four of the tinfoil crumbs will remain intact. The remarkable properties of this metal are, however, more emphatically illustrated by the following experiment: I have mounted two pairs of these cylinders on thermostatic supports (*see* Fig. 2) in such a manner that the two cylinders in each pair normally rest in contact with each other, so that when this device is connected across the terminals of a 1,000-volt alternator, a short circuit is established through the four thermostats and the non-arcing metal cylinders in series; also in such a manner that upon the passage of the current the thermostats shall so act as to separate the two cylinders from each other in each pair. With this device a short circuit is automatically opened and closed every two or three seconds, without injury to the electrodes. If a spark-gap be connected in the circuit and bridged with a bit of tin foil, the short circuit will be instantly interrupted, and, of course, remain so. Perhaps the most remarkable feature about this metal is that it manifests non-arcing properties only when the air gap is very small, in fact, the smaller the better. If the air gap is increased to about half an inch, the short circuit will be maintained with a large and vicious arc.

During the past season, over 2,000 of these non-arcing arresters have been in actual service in various sections of the United States, and so far not one of them has failed. More of them would no doubt have been used and much valuable property saved, had it not been that many central station managers were loath to try any such radical departure from past practice. They feared that the non-arcing metal might not be all that it was represented.

For direct-current circuits the field is still open. Many useful and ingenious devices are, however, already on the

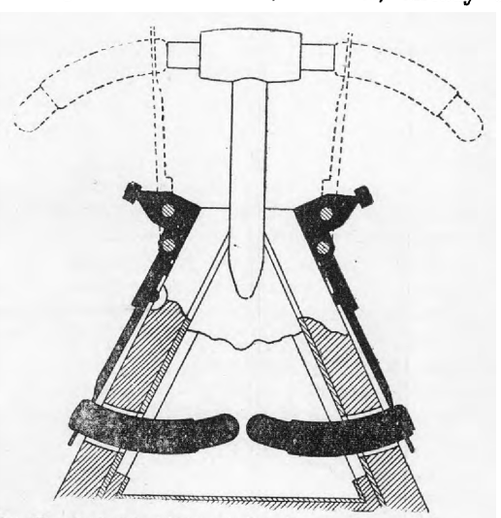

FIG. 3.—"Air-blast" Lightning Arrester. Latest form.

market, the most recent being the "Tank Arrester" described in *The Electrician* for December 2, 1892. The spark-gap arresters most commonly used on street-railway circuits are the "magnetic blow-out" and the "air-blast" arresters. The former is unreliable. Before the magnet has time to act, the electrodes of the spark-gap often become fused together and a permanent short circuit is established. The latter, often called the "keystone" arrester, has the objectionable feature of moving parts. It, however, gives excellent satisfaction when properly installed. This arrester, the latest form of which is illustrated in Fig. 3, has swinging electrodes. These are seen on either side of the keystone-shaped air chamber, and are forced into the positions shown in dotted lines by the sudden expansion of air within the air chamber, the expansion of air being due to the arc formed at the spark gap. The spark-gap is seen located centrally within the air chamber. As this arrester depends for its action on a short circuit, it is necessary that a thorough short circuit should be established each time a discharge takes place. To secure this end, the ground terminal of the arrester should be connected to the rail or ground-wire return of the generator, as well as to a ground plate.

As already mentioned, the over-head ground-wire method is the more efficient and generally available one for the protection of over-head circuits, the chief difficulty which it presents being the fact that the "live" circuits are thus brought into close proximity to the ground. Not only does this combination often endanger the linemen, but it also renders the system

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liable to trouble from accidental contact between the line and ground wires. In a number of instances familiar to me, and in which lightning troubles have been particularly severe, the over-head ground wire has been used with most satisfactory results. In one instance a barbed wire was stapled to the tops of the poles and grounded about every 700ft. by running connecting wires 5ft. or 6ft. into the ground. Before this wire was erected the plant was almost inoperative during thunderstorms; and now, although spark-gap arresters are still connected at the station, they are seldom called upon to discharge the line; an occasional snap is heard, but no trouble is experienced whatever. In large cities where the overhead wires are protected by high buildings and church spires, lightning arresters are seldom used, or if so, merely as extra precaution. It is also noticed that when arc and incandescent circuits are run on the same pole line, discharges occur from the arc-circuit arresters, while the incandescent circuits are comparatively free from trouble.

THE TIVOLI–ROME TRANSMISSION.

When, in 1888, the demand for electric light in Rome was assuming some importance, M. Pouchain, the Director of the Roman Gas Company, wisely decided to have the new system as an ally rather than as a competitor. The Company registered their enlarged undertaking as one for "illumination by gas *and other systems*," and established a first-class generating station on the Ganz system. About this time, however, the project was formed of deriving power from the falls of the

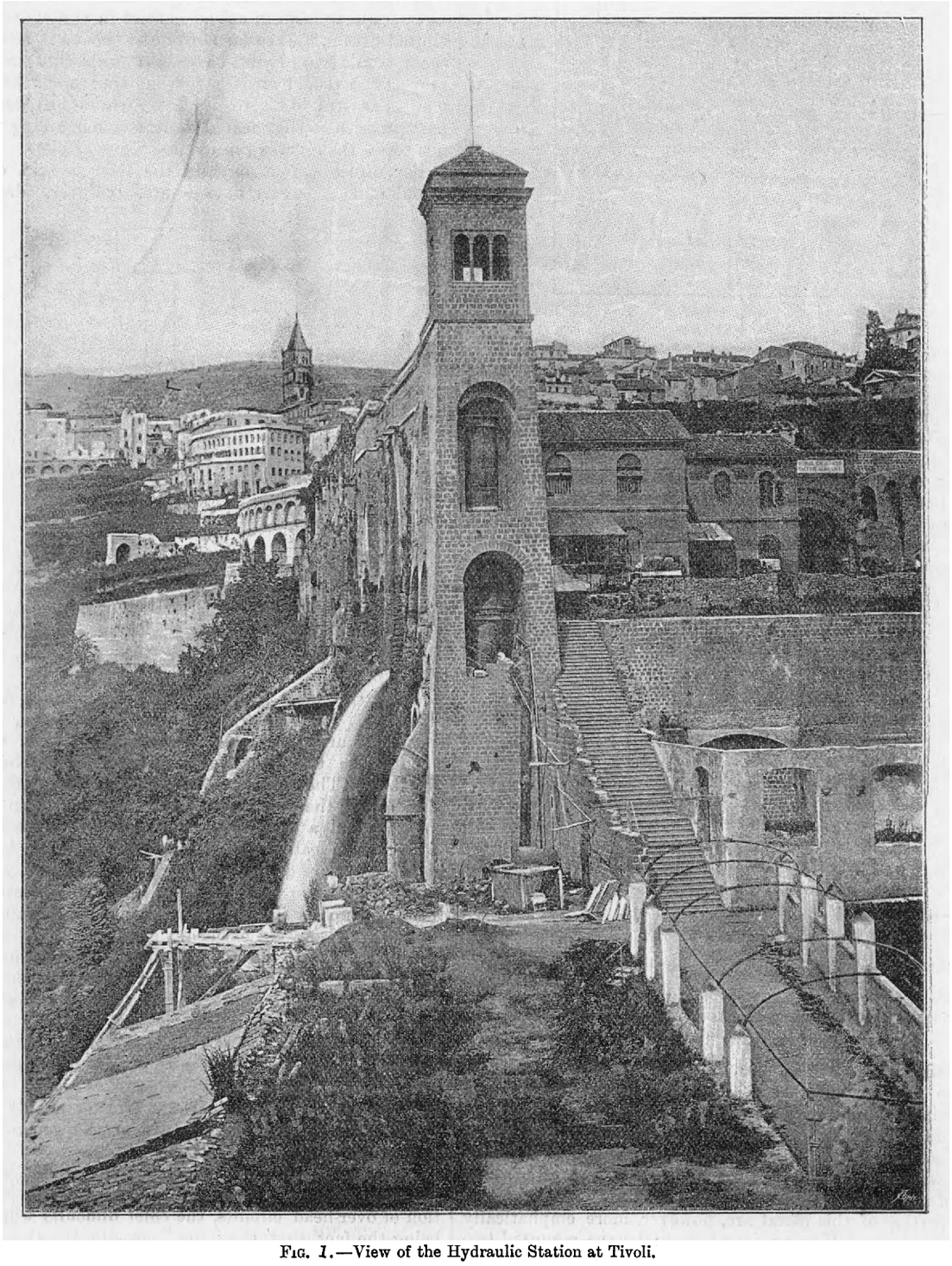

Fig. 1.—View of the Hydraulic Station at Tivoli.

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Anio at Tivoli. This plan was successfully carried out and finished in July, 1892.

A description of the Tivoli generating station was given in Dr. Fleming's articles on Alternating-Current Electric Supply Stations in *The Electrician*, Vol. XXVII, p. 608. The illustration, for which, together with this information, we are indebted to *L'Elettricista*, shows the tower at the end of the aqueduct conveying the water from the falls, the machinery being below to the left of the observer's position. The iron tube descending through the tower is 5 feet in diameter, and gives a head of water of 160 feet, a fall of as much again being at present unutilised. The water is distributed among nine Girard turbines, coupled direct to Zipernowsky alternators, and three smaller turbines driving the direct-current exciting dynamos. The larger turbines have a diameter of 6 feet 6 inches, run at 170 revolutions per minute, and develope 350 H.P.

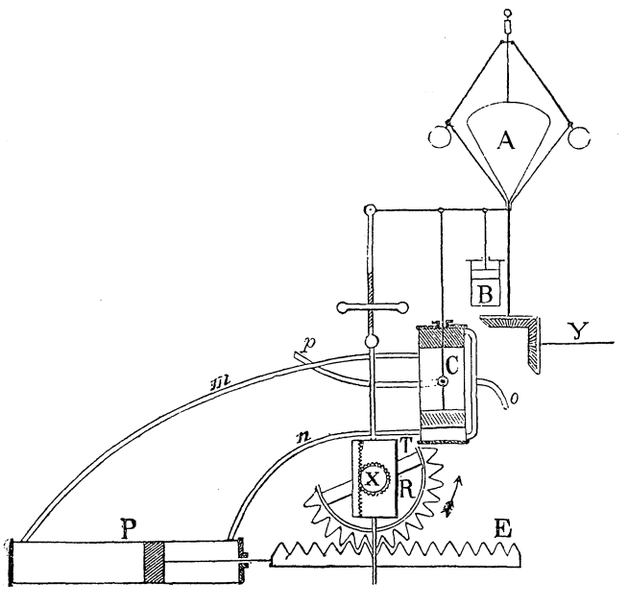

FIG 2.—Automatic Water Supply Regulator.

The water supply is regulated automatically by means of the contrivance shown in the figure. A is a centrifugal governor actuating a slide valve C regulating the pressure supplied through P. The tubes *m* and *n* lead to the two ends of the cylinder P, containing a piston driving a rack E and pinion R. A rotation of the axis X of the latter opens or closes a series of cocks controlling the supply to the turbines. After the action of the slide valve in either direction, it is restored to its original position by means of the rack and pinion motion T, which raises or lowers the fulcrum of the governor lever.

The alternators, which are coupled to the turbines direct by means of an elastic coupling, give a pressure of 5,100 volts. The normal current is 42 amperes. The diameter of the revolving field magnet is 7 ft. 7 in., and there are 30 poles.

PHOTOGRAPHIC DEVELOPMENT BY ELECTROLYSIS.

The reduction of sulphurous acid or an acid sulphite by means of zinc, gives rise, as is well known, to the formation of the salts of an acid in a lower state of oxidation than sulphurous acid, and, therefore, termed hyposulphurous acid. It must not be confused for a moment with the body popularly and commercially known by this name, or rather by the name of its salts, the so-called hyposulphites, familar to the practical photographer by the endearing abbreviation, "hypo." The latter substance is properly thiosulphuric acid, and its salts are, therefore, thiosulphates. True hyposulphites are much less common, their industrial use being chiefly in the preparation of a form of indigo vat of tolerably recent introduction in which the indigo is reduced to the condition of indigo white by their operation. The difference will be at once apparent on writing the formulæ for the real and the pseudo-hyposulphite of sodium. The former is $Na_4 S_2 O_4$ (until lately it was supposed to be $Na H S O_2$), and the latter is $Na_2 S_2 O_3$. The reduction of an acid sulphite can also be effected by electrolysing its solution, hyposulphite appearing at the cathode. Now, like many reducing agents, sodium hyposulphite can act as a developer to a photographic image, a fact that was observed in 1886 by Eder. The negatives thus developed are very soft and full of detail, and are grey in tone, but not so bluish grey as those developed by ferrous oxalate. On account of the ease with which sodium hyposulphite is oxidised by exposure to the air, no practical use has hitherto been made of this observation, but a simple variation in the procedure by R. E. Liesegang, described by him in the *Photographisches Archiv*, has recently brought it into a more workable form. This modification consists in electrolysing a nearly saturated solution of acid sodium sulphite in the developing dish, the cathode being a platinum plate dipping direct in the dish, and the anode being contained in a porous cell and thus the oxidised products appearing thereat prevented from mixing with the hyposulphite produced. The current given by half-a-dozen Gassner dry cells suffices for reducing the acid sulphite. On immersing a fully exposed bromide plate in the bath, an image, brownish red in tone, is developed in the course of a few minutes, the oxidation of the hyposulphite by the air or by the work of development, being made good by its being immediately reduced again by the action of the current. The image is not very strong, and fades somewhat on fixing, but it retains its characteristic colour. It is curious that there is a discrepancy in the accounts of the colour produced, given by Eder and Liesegang; the cause is probably a difference in the nature of the sensitive film. It is obvious that the same plan of electrolytic development could be applied to other bodies, such as hydroquinone which could be reduced from quinone, but as in this case the less oxidised bodies are more stable than sodium hyposulphite, they can be prepared by ordinary chemical means and used as wanted, instead of being produced at the moment of development.

THE ELECTRIFICATION OF GASES BY FRICTION ON METAL.*

The question whether gases become electrically charged by friction against metal has been taken up by many investigators, some of whom have answered in the affirmative and some in the negative. The experiments of Faraday and of Sohuke among others are so far open to objection, that the gases were not sufficiently carefully dried and filtered from dust. The author took air, compressed to 100 atmospheres pressure, also pure oxygen supplied by the Elkau compressed oxygen factory (Berlin), and liquid carbon dioxide supplied by the Berlin Carbonic Acid Company.

The method of experiment was in general that of Faraday. The tube through which the gas was forced out of the holders had an enlargement in the form of a funnel, in which a metal plug fitted, which was connected to the electrometer. Funnel and plug were in a tin box. Air which contained moisture and dust was found capable of being highly charged by friction on metal; but this property became as small as one pleased if the air were thoroughly dried and filtered; so that it may be assumed that with pure air there would either be no effect at all, or very little. Oxygen was found to behave similarly to air in the purified state. Liquid carbon dioxide charged the metal positively, but in the gaseous form was not found to be affected by friction.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

THURSDAY, April 6th.

INSTITUTION OF CIVIL ENGINEERS.

2:30 p.m. Students' visit to the new lock and weir works, at St. Margarets, Richmond.

FRIDAY, April 7th.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at St. James's Hall Restaurant.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

* Abstract from Paper by K. Wesendonck (*Wied. Ann.*, No. 12, 1892)

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CRITICISM.

'When critics disagree," says a brilliant but superficial paradoxist, "the artist is at one with himself." This disagreement is, perhaps, one reason why a criticism seldom draws a rejoinder. Another reason for ignoring the opinions of critics is that they often make no pretence or attempt at producing any original work. "The talent of judging," wrote D'ISRAELI the elder, "may exist separately from the power of execution. An amateur may not be an artist, though an artist should be an amateur. And it is for this reason that young authors are not to contemn the precepts of critics." In the field of science, fortunately, the critic does not set himself up as a professional arbiter and connoisseur as in the arts; scientific reviewers, however, are generally engaged on actual work of the kind which they are called upon to examine. Reviews form an important part of current literature, their importance being attributable, perhaps, to the laziness of readers who prefer to skim pages rather than volumes. But what author is really satisfied with anything but praise, and who will admit, when pointed out by someone else, the weak argument or faulty passage of which he has long been fully conscious himself? "So men are valued!" wrote BURTON, "their labours vilified by fellowes of no worth themselves, as things of nought; who could not have done as much? Some understande too little, and some too much."

Many *leges non scriptæ* go to make up a code of conventions which tradition has fastened upon literature, and for some reason that is not easy to discover there appears to be a reluctance on the part of authors to reply to the criticisms of reviewers. We are inclined to regard this, however, as a mere custom, and that a bad one, if only because the reviewing of books is one of the only opportunities that is allowed by custom for free and candid comment. One other opportunity

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is afforded in debate, and in the course of discussions at the meetings of scientific societies free criticism is allowed, and is not considered offensive. Every facility is given for reply in the latter case, and there is no reason why it should not be granted in the former. Favourable criticism seems to be peremptorily demanded in a good many cases when the article submitted for "notice" is a new switch or a price list, and the mildest comment in such cases, if anything else than laudatory, appears to give more offence than a column of slashing reviews of worse than useless books. Criticism seems to be considered out of place by some in a description of a new central station, but where an opportunity is given for reply, it is difficult to see what harm can be done; for harm can come of it only by unjust or mistaken comments, or perhaps by an ambiguity of phrase unthought of by the writer but wounding a too sensitive reader. Reviewers, it is to be regretted, too often shelter themselves behind an ambush of anonymity, are too seldom called to account for thoughtless utterances, and are rarely challenged to support doctrines which they have lightly sketched in opposition to the carefully-considered convictions of the author. At present there seems to be no choice for the injured person but speechless disdain or a costly libel action.

REVIEWS.

Electric Ship-Lighting. By J. W. URQUHART. (London: Crosby Lockwood and Son.)

The information in this book is well arranged and up to date; and numerous practical hints and diagrams are given for the assistance of engineers. Electric ship-lighting may be classified under three heads: (1) Internal incandescence lighting; (2) arc lighting for navigation purposes; and (3) arc lighting for naval attack and defence. The first of these differs from ordinary low-tension wiring chiefly in the use of an "earth" or ship return, and in the difficulties which are encountered in connection with water-tight bulkheads and magnetic compasses. By far the greater portion of Mr. Urquhart's book deals with this department of lighting; the subjects of wiring, fitting, testing, and the choice and arrangement of lamps, switches, and cut-outs being dealt with in a practical fashion. The text is assisted by numerous illustrations, and the value of the information enhanced by a worked-out example of the wiring of the s.s. "Majestic," of which vessel a frontispiece is given. Chapters I. to IV. deal with preliminary arrangements—such as the choice of a system, plant, and attendant—and with the management of the machinery during running or at a breakdown. Chapter IX. treats of the use of accumulators, and describes one or two accumulator systems. Arc lighting is more particularly deal with in Chapter V., though the early chapters relate to this as well as to glow lighting. In this chapter several forms of arc and search lamps are described. The use of this form of light for naval attack is, however, barely mentioned, although the arrangement of circuits and projectors on men-of-war is essentially different from that on vessels of the mercantile service. It is an astonishing fact that automatic lamps have never seriously replaced hand-fed, hand-regulated projectors, either on naval or commercial vessels. Some very ingenious automatic-fed projectors, which can be electrically controlled by an operator at a distance, have, we believe, been fitted on one or two ironclads. But the fact that these have not been very successful is, we suppose, the reason why no mention is made of them in this treatise. An introduction on electric theory is intended to prepare the beginner for the practical part of the book. We think, however, that before attempting to study electric ship-lighting, a beginner should learn more of the principles of the science than could be given in such an introduction. After that, if he takes up Mr. Urquhart's book, he will do well.

Electric Light: Its Production and Use. By J. W. URQUHART. (London: Crosby Lockwood and Son. Fifth Edition.)

The demand for a fifth edition is in itself considerable evidence of the value of this work, and a proof that it meets the requirements of a certain class of readers. Mr. Urquhart has essayed a very difficult task in this book, in combining a historical account of the evolution of electric light machinery, from its most remote stages, with a scientific explanation of the principles and practice of modern electric lighting. The difficulty—one may almost say, danger—lies in yoking the two things together; for, like a couple of ill-matched steeds, they do not run well. Or, like the camel and the Arab in the fable, the one it apt to squeeze the other out of existence. Indeed, these two sections of the book appeal to two very different classes of readers. The beginner who finds it necessary to study the chapters on primary batteries and elementary mathematics, is not in search of obsolete arc lamps or primitive dynamos; he looks for descriptions and drawings of types now actually at work. On the other hand, the scientific antiquarian, patentee or expert who may need to explore the past, has no necessity to do so by wading through descriptions of Bunsen batteries and methods of jointing. With due consideration of the cry of "privilege" which we notice in the preface, we still think that a work under the above title should have more complete information on modern practice and less of the lumber of the past.

Polyphased Alternating Currents. By E. HOSPITALIER. (London: Alabaster, Gatehouse and Co.)

At the time these articles were originally written, it was quite correct to say that "The question of polyphased alternate currents has become the topic of the day," but it is far from true at present. The Lauffen-Frankfort experiments drew general attention to a system of transmission previously unknown, and with the close of the Frankfort Exhibition, interest in this subject has to a very great extent dropped out of existence. After all, the main interest in the experiments centred in the possibility of transmitting a large amount of power efficiently over a distance of a hundred miles, rather than in the method of transmission employed. Nevertheless, the work which has been done with polyphased currents is of general interest, and forms the most important attempt yet made to solve the problem of alternating motors. The polyphase systems of electrical transmission are, perhaps, only transitory, but they have constituted a new development of electrical industry, the final importance of which no one can as yet foretell.

The present little work is a description in very simple language of polyphase machinery. It is mainly concerned with the dynamos, motors, and transformers used in the Frankfort transmission experiments. The style is clear, the book is well illustrated, and the printing is good. The work is mainly descriptive, little or no attempt being made to put forward theoretical views, and all mathematical argument is rigidly excluded. There is very little criticism in the book, but it contains much useful information, and may be confidently recommended to those interested in the subject. Two appendices are added, the first containing all the experimental results which have as yet been published regarding the Frankfort experiments; the other being a reprint from the *Electrical Review* of a valuable article by Mr. Reckenzaun, containing particulars of the Heilbronn-Lauffen plant used for transmitting 900 H.P., by polyphase currents, over a distance of 12 kilometres.

Die Accumulatoren zur Aufspeicherung des Elektrischen Stromes, deren Anfertigung, Verwendung und Betrieb. By J. ZACHARIAS. (Jena: H. Costenoble, 1892.)

This book is another of the compilations of patents, and articles which have already appeared in the technical Press, to which the Germans are gradually accustoming us. To anyone who does not possess Hoppe, and is in need of a well illustrated collection of descriptions of the principal forms of cells in use, and which have been introduced from time to time, the book will be of service. There are the customary chapters on the arrangement of cells for the different uses to which they have been put, and the methods employed

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for their regulation; the results of efficiency tests on various makes of cell are given, and the author has also collected some data on the effects of changes of temperature on the working efficiency of cells employed in central stations. This is a point on which more information is much required, as it would help to elucidate many of the difficulties connected with the chemical theory of the action of accumulators.

Telegraphic Connections, embracing recent methods in Quadruplex Telegraphy. By C. THOM and WILLIS H. JONES. (New York: D. Van Nostrand. London: E. and F. N. Spon, 1892.)

This is an admirably-written and well-printed account of the modern American ways of using the polar-relay and other instruments in duplex and quadruplex telegraphy. It is of little use to European electricians, as it assumes the American closed circuit system as the basis of operations, and makes the statement—astoundingly untrue for all the rest of the world—that until 1872 this was the only method of telegraphy in general use! The writers appear never to have heard of Gintl or of Heaviside, for they credit duplex and quadruplex telegraphy to American electricians whose respective work was of later dates. One interesting feature of the book is the connections used when dynamos are employed instead of batteries at a central telegraph office. Twenty plates, some printed in colours, clearly show the numerous circuits and their connections.

Carte Générale des Lignes Télégraphiques Internationales. By MM. PAUL JACCOTTEY and MAXIME MABYRE and M. ÉMILE LEVASSEUR. (Paris: Institut Géographique Ch. Delagrave, Rue Soufflot.)

This is a coloured map designed to show the submarine cables of the world, and also, as far as the information is obtainable, the land-lines of the various states and companies. The map is dated November, 1892, but the mileage figures given for a large number of the cables are in many cases inaccurate. The figures appear to coincide with the statistics given in "The Electrician" Electrical Trades' Directory and Handbook for 1890 or 1891, the lengths of the cables more recently laid not being included. So far as we have checked the figures, this seems to be invariably the case. Amongst the cable-owning companies included in the list is the India Rubber, Gutta Percha, and Telegraph Works Company, which is credited with three cables of a length of 145 nautical miles. The Eastern Telegraph Company's cables are shown with a total of 25,374, instead of 25,896 nautical miles, the Cuba Submarine Company's figures as four cables with a mileage of 1,049, which should be five cables and a mileage of 1,500 nautical miles. The list does not include the South American Company's cables at all, although coloured in the map. Notwithstanding this incompleteness, however, the map will be found useful.

A NEW DÉRI ALTERNATE-CURRENT MOTOR.*

A new alternate-current motor has been constructed by Max Déri on the principle shown in Figs. 1 and 2. The armature coils are not all connected together, as in the case of the direct-current dynamo, but the two ends of a coil (or parallel or series group, which is symmetrically placed in the field, such as s_1 s_2 in Fig. 1) are connected to two corresponding collector sections and insulated from all the other coils and sections. The coils or groups of coils so arranged come one after another into contact with the brushes, two or more such groups being put in parallel as the brushes pass the sections; it is said to be a good arrangement to send current into several of the circuits at once, but the circuits must be such as to have about equal electromotive forces. Fig. 3 shows an arrangement by which the circuits are spread nearly evenly over the armature, which is desirable; the arrangement is self-explanatory; the current causes consequent poles at the points where it enters and leaves. Fig. 4 shows another kind of winding. The principle is the same as that of an old arrangement of Déri's; it consists in reversing the winding at points equidistant from both leading-in and leading-out points—in this case the armature is divided into twice as many portions as there are magnet poles—and the result will be noted that the consequent poles are now formed at those reversing points at which the leading-in and out wires are not joined on. It will be noted that since, in these methods of construction, the armature coils are always in parallel, the simplification indicated in Fig. 2 becomes possible—viz., that one end of each circuit can be joined to a common collecting ring or similar arrangement of some kind.

In all these forms the working current flows through the coils so placed on the armature that the poles hereby caused are in such a

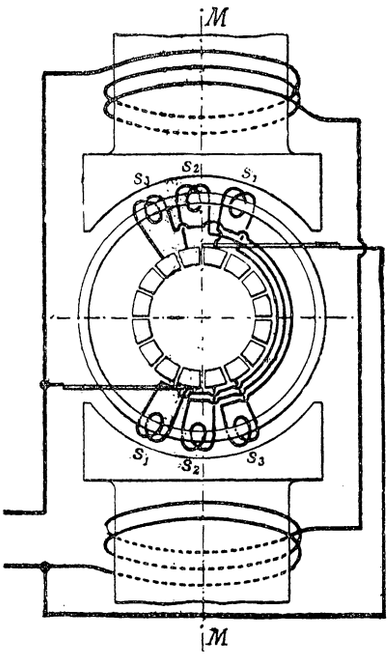

FIG. 1.

position as regards the field poles as to produce the maximum torque. It will be noted that since the armature coils are only intermittently traversed by current, it is possible to use a correspondingly higher current density than is allowable in the case of a direct-current dynamo or motor for the same amount of heating; and this fact enables a high efficiency to be obtained in spite of the fact that a portion of the armature is lying idle.

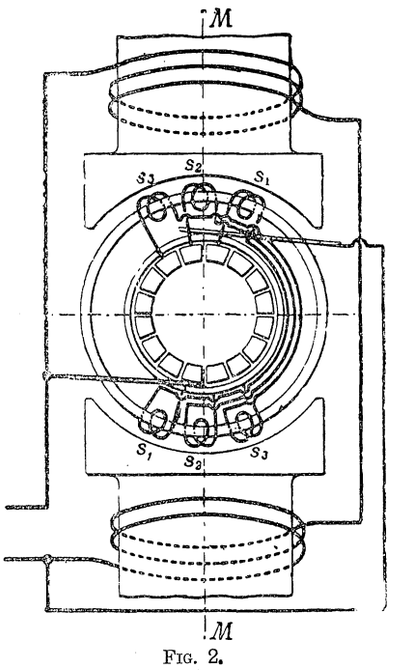

FIG. 2.

The theory of the action is explained as follows:—The armature in such a machine, where both field and armature are traversed by alternating currents, may be said to be subjected to two inductive influences—first, the inductive action due to the change of induction in the fields, which is independent of the motion of the armature, and secondly, the inductive effect due to the rotations, which depends on the speed. Fig. 5, gives a graphic representation of the two effects, showing the electromotive forces due to each. The abscissæ are lengths of arc round the armature, starting from the

* Abstract from the *Zeitschrift für Electrotechnik*, March 1, 1893.

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line M M as zero, and the ordinates are the electromotive forces on the connector wires at corresponding points. The voltage due to the change of field-magnet strength is greatest at 0deg., and becomes nothing at 90deg. from this point.* On the other hand, the electromotive force due to rotation is greatest at 90deg., and least at 0deg. The resultant pressure is determined at 0deg. by the change of field, and at 90deg. by the speed of rotation.

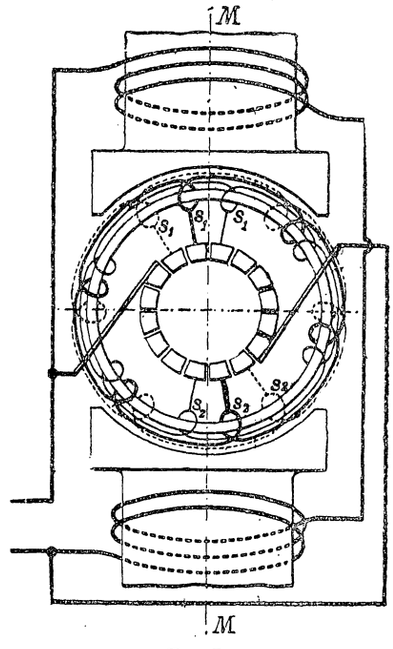

FIG. 3.

Déri now applies an electromotive force of about the value of that of the armature at 0deg. If, then, the brushes be placed at the corresponding point on the collector (the two electromotive forces being in opposite directions) there will be no current in the armature. There will be similar positions for various speeds of rotation, also at other points on the circumference. If, now, the brushes are displaced in any direction, the pressure of the applied

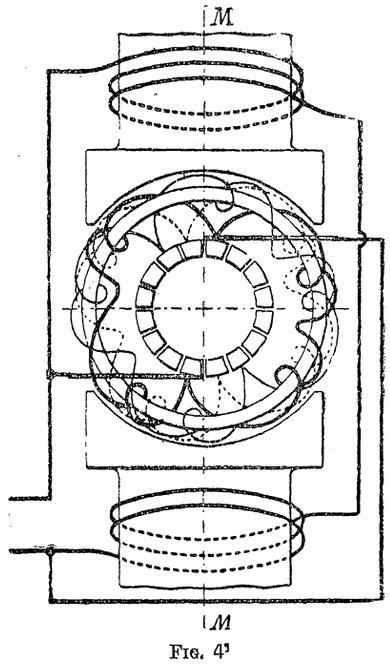

FIG. 4.

current will be higher than that of the coils, and a current will pass through the armature, which will produce a torque. Following up these considerations, the inventor has found the constructional requirements, which make the arrangement of the field in shunt not only possible but very advantageous. The fields are in a sense the primary portion of a transformer, whose secondary is the armature; and if the windings on the magnets and armature are so arranged that the voltage on the armature at M M, in consequence of the induction, is about equal to the voltage of the current caused by the field magnets—that is to the working pressure ($E = e\,n$)—then the motor becomes very easily capable of regulation.

The motor is started by displacing the brushes from the line M M gradually to such position (m), that the difference in pressure ($E - e\,n$) is sufficient to produce the required torque. As the speed increases, the electromotive force of the armature becomes greater, and the brushes are further displaced until the necessary difference in pressure takes place. If the brushes be displaced in the opposite sense, the armature rotates in the reverse direction, and the machine can be quite sparklessly reversed by gradually shifting the brushes through the centre line to the other side. It will be noticed that since any torque from nothing to its maximum can be obtained by shifting the brushes, the regulation can be obtained without any resistances, and reversals also take place without any special apparatus. It is also possible with a slow speed to get a large torque on the armature without great expenditure of energy, because the machine, in virtue of its transformer action, can develop a large current at small pressure.

The machine is to be regarded, says the inventor, as a transformer with two primary currents, the exciter current in the fields, and the working current in the armature; the latter current is opposed by the current induced in the armature by the fields. In the calculation of the energy used, the current in the armature (which is dependent on the difference $E - en$, and suffices to produce the necessary torque) must be multiplied, not by the pressure E of the working current, as in other electromotors, but by the difference ($E - en_0$).

The article points out that the regulation is somewhat analogous to the governing of engines by regulation of the expansion, in contradistinction to that hitherto used, which may be compared to

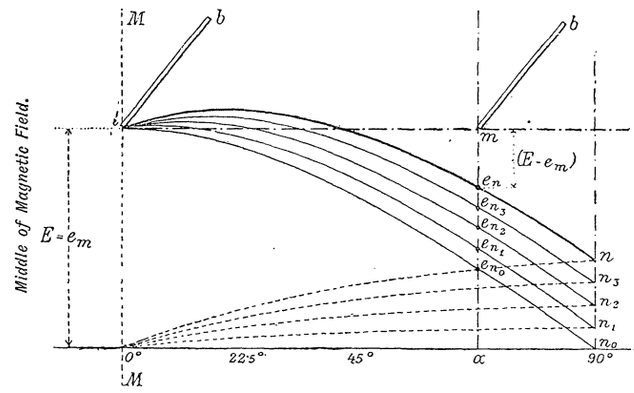

FIG. 5.

governing by the throttle valve, and this regulation may be accomplished by automatic shifting of the brushes, either with the speed or with the current strength; while for tramway work or electric railways a hand regulator, worked by the driver, would consist of a simple lever for shifting the brushes. Finally, the machine is said to be a very efficient one.

* This does not appear to apply to Figs. 1 and 2.—ED. *E.*

PARLIAMENTARY INTELLIGENCE.

HOUSE OF COMMONS—TUESDAY, MARCH 21ST.

Edgware Road and Victoria Railway.

The Bill for the construction of an electric underground railway from the Brondesbury Station of the North London Railway to Victoria came before Sir John Kennaway's Committee of the House of Commons on Tuesday. Mr. Pembroke Stephens, Q.C., Mr. Worsley Taylor, Q.C., and Mr. Hume Williams appeared for the promoters, and the opponents of the Bill were represented as follows:—The Belgrave Mansions Company and their sub-lessees by Mr. Cripps, Q.C., and Mr. Lynden Bell; the Duke of Northumberland and Lord Iveagh by Mr. Littler, C.B., Q.C., and Mr. E. Page; the Duke of Westminster by Mr. Littler and the Hon. A. Lyttleton; the Authorities of St. George's Hospital by Mr. C. T. Giles; the London County Council by Mr. Freeman; the owners, &c., of houses in Grosvenor-place and Grosvenor-gardens, by Mr. Cripps, Q.C., Mr. Lynden Bell, and Mr. C. G. N. Trollope; owners, &c., of houses and property on or near the line of the proposed railway by Mr. E. Boyle and Mr. Terrell. There were several other petitioners against the Bill who did not appear by counsel.

Mr. PEMBROKE STEPHENS, in opening the case for the promotors described the course of the line, which he said followed a course direct as the flight of a crow for about 4½ miles and tapped a district abounding in every kind of traffic. Apart from the direct through traffic it afforded the most direct and convenient lateral communications with the existing railway systems, the London and North-Western, the Great Western, the

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Metropolitan, and the southern lines at Victoria. The present difficulties of north and south communication were very great, and by this line the time now consumed in getting from Kilburn to Victoria would be reduced by at least one-third. Though the present Bill did not go before the Joint Committee of last year, it complied with the conditions laid down in their report and no doubt if it had been before them would have received the same stamp of approval as the other Bills did, and which were only recommended as instalments of the communications which were required. The capital for the line was £1,200,000 share capital, with £400,000 borrowing powers, which would allow a cost of over £350,000 a mile. The manner in which the line should pass by the side of Hyde Park had been arranged with, and assented to, by the Crown, and at Hyde Park-corner it would utilise a large waste space, which at present is only devoted to the purposes of a refuge. The learned counsel then dealt with the petitions against the Bill, the objections contained in which, he urged, were of a sentimental character, and said that the evidence he should call would show that the line was one which, if accompanied with reasonable protection for any of the interests which might conceive themselves to be affected, ought to be sanctioned by Parliament.

Mr. GREATHEAD, the engineer to the line, was then examined by Mr. WORSLEY TAYLOR, and described the objects and course of the line, which he said would be made with easy curves and gradients, and would, it was expected, receive a large traffic, not only from the streets which it traversed, but from the railways with which it would form communications. Land was scheduled at the north end of the line adjoining the London and North-Western Railway for a depôt for carriages, and other land was scheduled on the Paddington Basin for a generating station. That was a site suggested by Lord Brassey, when the original Central London line was before him, as being a very good place for a generating station, and on looking into it they found it was so. It was convenient, because it would enable them to get their coals cheaply, and enabled them to use condensing engines, which was rather an important matter. The depth of the line would be from 45 to 100 feet below the surface, and from the borings be believed they would be in the London clay throughout. He did not think there would be any vibration felt on the surface, and there would be no possibility of interfering in the slightest degree with the park or the growth of the trees in it.

A MEMBER of the COMMITTEE: Would the electrical action have any effect upon them?

The WITNESS: No, nor would there be any sensible vibration to affect them. Vibration certainly would not affect the trees, because on the Thames Embankment they grew very well quite close to the Metropolitan District Railway. There would be a two-minute service, and on the assumption that the trains were half full they would carry 27½ million passengers a year. That, at an average of 1¾d. per passenger would afford an ample return. The working expenses he estimated at £46,000.

Mr. H. W. PRIMROSE, C.S.I., Permanent Secretary to the Commissioners of Works and Public Buildings, said that they had considered whether the line would have any prejudicial effect upon the drainage and the vegetation of the trees, and considering the mode of construction and the great depth of the line below the surface, and the fact that it would be entirely in the London clay, they came to the conclusion that there was not the least fear on those grounds.

Mr. GREATHEAD was then cross-examined by Mr. LITTLER, who said that London seemed to be about to be scored like the skin of ribs of pork with lines north and south. He inquired as to the interest of the promoters of the Bill, but the witness stated that he could not give any information on that subject, having confined himself entirely to the engineering.

In cross-examination by Mr. FREEMAN, replying to a question as to whether they would not have very much more powerful locomotives and a very much stronger electric current than on the City and South London line, the witness stated that the pressure of the current would be the same. The locomotives would be a little more powerful, but very little more so than the last locomotives supplied to the City and South London line. The weight of the locomotives proposed to be used on this railway would be 15 tons; on the City and South London none were less than 10 tons, and some 13½ tons.

Replying to Mr. LYNDEN BELL, he said that he would pledge his professional reputation that he did not apprehend any subsidences or any vibration that could be felt.

The witness was cross-examined by Mr. WILLIAM TERRELL as to subsidence that was alleged to have taken place in connection with the City and South London line at Blackman-street, for which the Company had had to pay £900 in respect to repairs. That was owing to the works created for the purpose of a station, and not to a shaft that had been sunk some 260 feet. In reply to the Committee as to what was the life of the tubes used in the construction of the tunnel, he stated that he thought they would last for ages. It was impossible for corrosion to take place, as the tubes were encased on the outside in a shell of cement.

Does that preserve them better than the clay?—Yes. In the first instance, the iron is dipped into a composition which forms a rough coating of varnish, and then the cement on the outside of that prevents all action on the outside, so that it would remain perfectly fresh for a hundred years. I do not believe there would be a sign of any deterioration at all. On the inside it is intended to fill up the space in the same way, with concrete and cement, so that the whole tube will be perfectly protected both inside and out.

Does the action of the electricity have no effect?—No.

Mr. THOMAS BATE, a surveyor of Kilburn, was called to speak to the feeling of the residents of that district, which, he said, was distinctly in favour of the line, the present means of conveyance being very indirect and tedious. In his opinion it would enhance rather than depreciate the value of property, and would probably prevent the construction of a tramway which would be very objectionable. At the place where it was proposed to place the generating station there was not much property to injure, it consisting principally of laundries, Carter Paterson's warehouses, and so on.

WEDNESDAY, MARCH 22ND.

Mr. RICHARD SEXTON, a grocer living at Brondesbury, with business premises in the Edgware-road, said that for himself personally, and many of his neighbours, the line would prove a very useful means of communication. The Brondesbury district was rapidly increasing, and they really wanted a railway by means of which to reach the West End quickly.

Mr. JAMES ROBINSON, secretary to the Alexandra Hotel Company at Hyde Park Corner, said the line was favourably regarded by his Company.

Mr. J. F. SABINE, a bank manager at Brondesbury, said that the line would be welcomed by the people in the district. A large number of working men lived in the district, and the line would greatly convenience them by enabling them to get quickly and cheaply to and from their work.

Mr. HENRY HOADLEY, draper and warehouseman in the Buckingham Palace-road, employing 100 assistants, spoke as to the advantage it would be to the customers of his own and similar businesses in the neighbourhood to be able to travel by the line. He would certainly welcome it as a means of developing his business.

Mr. OLIVER C. ROBSON, engineer and surveyor to the Willesden Local Board, said there was a necessity for a better class of quick communication from Willesden and Kilburn and the West End. The population of the district had increased from 38,000 in 1883 to 68,000 in 1893, the whole of the district being of a residential character.

The CHAIRMAN said that it might be assumed that Kilburn was growing, that a great many people wanted to travel, and that the establishments and shops would very much like customers to be brought to them.

Mr. WORSLEY TAYLOR said they had a large number of witnesses, and the traffic was enormous, but he had some special working-class witnesses whom he would like to call.

Mr. S. T. CHANDLER, a compositor, living at Kilburn, and employed in Berwick-street, Oxford-street; Mr. SAMUEL CRANE, a carpenter, living at Rye-lane, Peckham, but employed at Kilburn, to and from which he journeyed daily, then gave evidence in favour of the line.

Superintendent CHARLES W. SHEPPARD produced statistics of traffic at Grosvenor-place on March 16th (weather showery) between 8 a.m. and 12 midnight, showing 12,717 foot-passengers and 10,293 vehicles, out of which 2,474 were omnibuses.

Superintendent COLE produced similar returns.

Mr. EDWARD LAFONT HEATLEY, merchant of Gracechurch-street, one of the promoters, and one of the Directors, named in the Bill, gave evidence as to the circumstances attending its promotion, stating that the Directors were responsible for the deposit, and no one else had any control over the Bill. They were satisfied as to the commercial prospects of the line, and he would be prepared to recommend his friends to invest in the undertaking. There was no lack of capital. The only thing was that there was lack of confidence as to what were the best investments, and at such times in his experience it was such undertakings as these that people would invest in. Sir Frederick Johnstone was also a Director, but was too unwell to attend to give evidence. In cross-examination by Mr. Littler, he said that Messrs. Fowler, the solicitors, introduced him to the scheme, and he proposed to take a considerable stake in it, though to what extent he was not at present prepared to say. He had not contributed to the preliminary expenses, that part of the matter having been arranged by the solicitors. In further cross-examination by Mr. Cripps, the witness stated that the amount of the deposit was £47,000 for which a security had been provided to the bank, and for repayment of which he and the other Directors were responsible. He and those associated with him had found very large sums of money for their own enterprises abroad, sometimes as much as half a million of money, and therefore he was well acquainted with a number of people in the financial world, but he had never been connected with the financing of a railway project in England.

Sir DOUGLAS FOX, joint engineer with Mr. Greathead to the scheme, said that of all the underground railways he thought this route presented the fewest difficulties. There would be no injury to St. George's Hospital from noise or vibration either from the construction or the working of the line. The estimates for the work were sufficient, but they thought it necessary to provide first of all for the cost of an electrical installation and various subways which were not technically included in the estimates. Then there would be the whole of the engineering and the other services connected with the carrying out of the works, but they had adopted the precedent of the Great Northern and City Railway which was sanctioned by Parliament last year, and the proportion would be about the same. The estimate was £1,200,000, and the share capital was fixed at a million and a-half. The borrowing powers would supply the rolling stock and things of that sort.

Mr. A. T. WALMISLEY, an engineer who had been engaged for owners of property in connection with the City and South London line gave evidence that although he hoped to find some damage there he had not been able to do so, and there was no complaint from the tenants of property overhead.

Mr. H. A. HUNT, surveyor to Lord Cadogan, the Dean and Chapter of Westminster, &c., gave evidence as to the land estimates, which amounted to £8,000. As representing the Paddington Trustees, he said they hailed the line with great satisfaction, because they had never been able to get proper access to their estate.

This closed the case for the promoters, and

Mr. CRIPPS addressed the Committee on behalf of the owners of Belgrave-mansions and residents in Grosvenor-place and Grosvenor-gardens. He said they were satisfied that there was no intention to interfere in any way with the surface of Lower Grosvenor-gardens, but their general objection to the proposal was, first, that no public case had been

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shown in its favour, and that there was no reasonable probability if the Bill were granted that the line would ever be made. Their special objection, however, was to the proposed station at Hyde Park-corner, which, bringing at that point a large number of passengers, would be not only a great inconvenience, but a very serious nuisance to the residents of Grosvenor-place. When the Hyde Park-corner improvements were carried out £11,800 was privately subscribed towards them in order that the open space might be kept and the traffic properly regulated, and the object for which that money was subscribed would be entirely defeated if the proposed station were placed there. He criticised the financial basis of the scheme, and said that, considered as an ordinary business of a commercial nature, it was ridiculous, it being altogether unlikely that the money would be subscribed. The opponents represented a much larger public interest and a more substantial interest, for the line was really of a bogus character, both as regards its convenience and its future prospects.

Sir JOSEPH PEASE, M.P., residing at 44, Grosvenor-gardens, was then examined in opposition to the Bill, and said that although the promoters did not at present propose to interfere with the surface of Grosvenor-gardens, he felt sure they would do so hereafter. His own experience in the railway world led him to believe that wherever a railway company got its feet in it would get its head and shoulders through afterwards. The line would greatly depreciate his property, and destroy its amenites ; in fact he would not have bought his house if he had not thought he was free from a railway of that description close under its foundations. The project of the line had already depreciated property in the neighbourhood, though he admitted that the objection was a sentimental one to a certain extent. The whole of the residents in Grosvenor-gardens and Grosvenor-place were opposed to the scheme, and he did not consider that the line was wanted, the traffic being more east and west than north and south. If a large number of people were to be landed at Hyde Park-corner, it would be a great detriment to all the houses, and especially to the hospital. It would interfere with the traffic arrangements, with the crossing arrangements, and the general user of the public. The whole place was laid out for picturesque purposes, and was perhaps one of the greatest metropolitan improvements that had been carried out for a long time. But if the Company once got permission to make a staircase down to the station there, they would come another year and want something more.

Cross-examined by Mr. PEMBROKE STEPHENS, Sir JOSEPH said he much feared that there would be vibration. He already felt the vibration of the District Railway, which was much farther off. In his opinion Parliament would be going far beyond its ordinary scope to give to two or three speculators a power which would damage the value of property of over a mile of good houses.

Mr. E. N. SHACKLE, surveyor and estate agent, also testified that the construction of the line would lead to the depreciation of such residential property as that at Grosvenor-place and Grosvenor-gardens. In the case of the Central London line, he had met with failures of negotiations because the Company had got their powers and had not used them, and Hereford-gardens had certainly depreciated in value since the Central London Bill was passed. The station at Hyde Park-corner would add to the dangerous character of that crossing, and the feeling of the neighbourhood was unanimously against the line. He estimated that the depreciation of property in Grosvenor-place would amount to 25 per cent., which would mean £250,000 roughly.

The Committee then adjourned.

THURSDAY, MARCH 23RD.

Mr. HENRY LOFTS, estate and house agent and surveyor, of Mount-street, Berkeley-square, said that he had had to deal with property in Grosvenor-place. The capital value of four of the mansions with which he had dealt would be £180,000, but if the line were passed the depreciation, he estimated, would be quite 25 per cent. When he had a short time ago to deal with No. 4 for the Duke of Grafton, he looked upon it that his property was considerably improved by the open space which had been made by subscription from various owners in the neighbourhood. People had a prejudice against a railway coming near them, because it was the thin end of the wedge, and they did not know how it might be enlarged or the traffic increased. He had recently an instance of a property on the underground railway where he had to advise the purchaser, and told her that the only drawback was the proximity of the railway, and that it caused vibration. The lady had a cup and saucer put on the floor of the dining room, and said she did not object to the vibration ; but a few months afterwards she complained that the vibration had become most serious on account of the weight of the engines having been doubled. In cross-examination by Mr. Pembroke Stephens the witness said that it was not simply prejudice against railways which would lead to the depreciation ; but the station would bring around it a number of idlers, people who sold flowers and matches and newspapers and that kind of thing.

Mr. FREEMAN addressed the Committee for the London County Council, but intimated that he should call no evidence. The Council, he said, had thoroughly impartially considered this particular Bill, but they considered it would be injurious to the metropolis, and therefore, in the public interest they asked the Committee to reject it. They feel that it was not a *bona fide* line intended to be made. The Central London line, of which Mr. Greathead was also the engineer, had not yet been commenced, owing to difficulties connected with the City, but he contended that there was no financial support behind this line, and that at any rate before it was authorised they were entitled to see a substantial beginning made with the Central London line. At present this was only an engineers' and solicitors' line, and stood in an entirely different position from the Central London and Great Northern and City Lines, where there was a mass of substantial evidence, and persons of weight came forward who said they were prepared to carry out the schemes. When a Bill came before Parliament with so shadowy a foundation, so unknown a promotion, and so unreal a backing, the County Council, as responsible for the control of the metropolis, felt that they entitled to ask Parliament to withhold their approval to it. But they were specially objected to the interference with the open space and roadway at Hyde Park-corner, which was created and preserved for the assistance and protection of the general public, towards which the Metropolitan Board of Works contributed £20,000. The Council thought it their duty, on public grounds, to strenuously resist the making of the line at all, and they especially asked the Committee not to do away with the good effect of the improvement of 1883 by sanctioning at Hyde Park-corner something which must be a nuisance, and which would shortly become an eyesore to the place.

Alderman GEORGE FAUDEL PHILLIPS was then called in support of the opposition of the Duke of Westminster. He said he resided at 52, Grosvenor-gardens. The Underground Railway from Victoria to Sloane-square passed under his garden, and he fancied under the corner of his house. He had spent a large sum of money in putting up iron girders with a view of stopping some of the vibration and oscillation, and though it had done some slight amount of good, yet that very morning he was awakened at six o'clock by the fire-guard rattling in the grate, caused by the passage of the workmen's train. If anyone were ill in the house that would be very serious, and he believed that if another railway were to come, his house would be more of a liability than an asset, as he would not be able to live in it, and was perfectly certain that he could not sell it. In cross-examination he admitted that he knew nothing of the present scheme, how near it would be, how deep it would be, or how much it would affect his property.

The Hon. W. F. D. SMITH, M.P., who lived with his mother, Lady Hambledon, at 3, Grosvenor-place, also opposed the Bill. His father was one of the subscribers to the improvement of the open space between Hyde Park-corner and Grosvenor-place. Both he and his mother objected to the scheme on the ground that it would seriously depreciate the value of their house. It was proposed to place both the entrance to the station and public lavatories for men and women on the open space, and that would be very objectionable to the inhabitants.

Mr. ALFRED GILES, civil engineer, who for many years was M.P. for Southampton, said that he resided at 21, Grosvenor-place, being lessee under the Duke of Westminster. He considered that there was no necessity for the line and was doubtful how long it might be kept hanging over the heads of the residents in Grosvenor-place in reference to the subscription of the capital as it was entirely a speculative scheme.

Mr. EUSTACE BALFOUR, surveyor to the Duke of Westminster, agreed with previous witnesses that the scheme was a speculative one, and seemed to be an isolated effort to deal with the question of subterranean traffic. While the Duke of Westminster would not object to any great public improvement, he objected to this scheme on the ground that it seemed to be ill-considered, that it was very elementary in its character, that it was not part of any broad metropolitan scheme for subterranean traffic, that the engineering details did not seem to have been sufficiently considered, and that it would be a pity to take up ground of that kind, and possibly injure the houses in the neighbourhood in various ways unless it formed part of some very broad scheme for the benefit of London as a whole. It would be a serious nuisance to the open space in front of St. George's Hospital, partly from the gathering together of a very large traffic, and partly from the fact that there must be some structure above the ground, and however quietly that was done, it must be an eyesore. The duke and his trustees subscribed £3,000 towards that open space, and it would be extremely unfair to them that that money should be thrown away.

Lieut.-Colonel R. H. ATKINSON was called on behalf of the Duke of Northumberland and Lord Iveagh, and said that he was private secretary to Lord Iveagh, who subscribed to the Wellington-place improvement. Nos. 4 and 5, Grosvenor-place were lighted by electricity, which was generated by engines in the cellars of the premises, and the line would come within a few feet of those cellars. He was told by those who had technical knowledge, which he himself did not possess, that the electric current of the railway would seriously affect the storage power of the accumulators placed in the cellars.

Mr. DANIEL CUBITT NICHOLS, architect and surveyor, said that the cellars of the houses in Grosvenor-place were 11ft. below the roadway, and extended within the limits of deviation.

Mr. RICHARD HASSARD, civil engineer, said the railway could not be constructed without doing damage to the houses in Grosvenor-place, and after it had been made further damage would ensue from vibration.

Mr. EDWARD SEATON, also a civil engineer, who was engaged in the construction of the Inner Circle completion, also expressed the opinion that there would be difficulties in the constuction of the line, which would be dangerous to the house property, and

Mr. JOHNSON, foreman to Warner and Sons, who built the houses in Grosvenor-place, proved that they had to go down as deep as 40ft. to reach the London clay before they could make the foundations.

Mr. THOMAS P. PICK, surgeon of St. George's Hospital, expressed the view that the placing of the station opposite to the institution would be detrimental, and that the patients would suffer from noise and vibration. In the operating rooms electric apparatus was used, and if that were interfered with by the railway it would be prejudicial to the patients undergoing the operations. They might find the electrical apparatus fail in the middle of an operation.

Mr. W. H. BENNETT, also a surgeon at St. George's Hospital, gave similar evidence.

Mr. GILES then addressed the Committee for the hospital authorities, contending that the station at Hyde Park-corner would be a serious nuisance, and on the question of electrical disturbance as affecting the instruments in use at the hospital appealed to the evidence given before the Committee on the Clapham Junction and Paddington Bill.

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The case of owners, lessees, and occupiers of houses and property on or near the line of proposed railway was then entered upon, Mr. ARTHUR S. M. BLUNDELL, civil engineer, and Lord STANLEY of ALDERLEY giving evidence on their behalf. Lord Stanley thought the line was not required, and that it would injure his property to the extent of £3,000.

Mr. BOYLE then addressed the Committee in support of the case of these petitioners, urging that there was no public want for the railway, and that not 10 per cent. of the traffic found its way north and south. Facts were stronger than Mr. Greathead's ideas; his ideas had proved to be wrong in the past, and they had no reason to imagine that they would be right in the future. The City and South London line had not been a success, paying only 6s. 3d. on its ordinary shares; but even if it paid £6 there would be no justification for such a line as the present, which was, as he termed it, a cross-country line. If the scheme was a necessary one, and the inhabitants were to suffer the consequent damage, he asked that it hould not be in the hands of a speculative promoter—another Oxford-street scheme, only worse—to be hawked about the City in the hope of getting somebody foolish enough to take it up, but which could only be the means of ruining all who were ignorant enough to have anything to do with it.

Mr. LITTLER also addressing the Committee on behalf of the Duke of Westminster, the Duke of Northumberland, and Lord Iveagh, said that east and west communications were the only ones which would pay, and that this line was chosen, not by anyone on the line of route or by anyone who wanted to travel by it, but by some highly estimable solicitors in Westminster who thought it would be a good thing to have the line. He commented upon the absence from the witness-box of the promoters other than Mr. Heatley. Nothing was worse than to have a speculative scheme hanging over property, with extension after extension of time, which was always the result of speculative schemes, and he respectfully protested against either lawyers or engineers coming for speculative purposes and interfering with property of such vast value as that in Grosvenor-gardens and Grosvenor-place.

At the close of Mr. Littler's speech the Committee adjourned.

FRIDAY, MARCH 24TH.

Mr. PEMBROKE STEPHENS replied at some length to the arguments of the counsel for the opposition, urging that the promotion of the line was perfectly *bonâ fide*, and that only illness prevented them from having the advantage of Sir Frederick Johnstone's evidence, while the damage to the Hospital and other property, of which so much had been made, would not be realised.

The Committee then consulted in private for about a quarter of an hour, and on the re-admission of the public,

The CHAIRMAN said they had given the scheme the most anxious and careful consideration, but they felt bound to come to the conclusion that the preamble had not been proved.

The Bill was therefore rejected.

Hampstead, St. Pancras, and Charing Cross Railway.

On the consideration of the Hampstead, St. Pancras, and Charing-cross Railway Bill by the House of Commons on Friday last the following clause was, on the motion of Mr. T. H. BOLTON, substituted for clause 81 in the Bill as reported to the House:—

"The Company, at all times after the opening of the railway for public traffic, shall, and they are hereby required to, run at least three trains which shall call at every station each way every morning in the week and every evening in the week (Sundays, Christmas Day, Good Friday, and Bank holidays excepted) at such hours, not being later than seven in the morning or earlier than six in the evening respectively, as the Company think most convenient for artisans, mechanics, and daily labourers, at fares not exceeding one penny for each journey. Provided that in case of any complaint made to the Board of Trade of the hours appointed by the Company for the running of such trains, the Board shall have power to fix and regulate the same from time to time. Provided, also, that the liability of the Company under any claim to compensation for injury or otherwise in respect of each passenger travelling by such trains shall be limited to a sum not exceeding £100."

The Bill as amended was ordered for third reading.

Royal Assent.

The following Bill has received Royal Assent:—The Baker-street and Waterloo Railway.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March 17*, 1893.

Prof. Elisha Gray's Telautograph.—On Tuesday, March 21st, a private exhibition will be given to the Press, both in New York and Chicago, of the workings of Prof. Elisha Gray's telautograph, which, as might be inferred from the name, is a means of transmitting over electrical wires autographic communications, which are reproduced at the further end in facsimile. The public has already heard something of this system, but the knowledge that has heretofore leaked out has been somewhat vague and uncertain. The writer has just had a private view of the operation of this instrument, and can state from observation that the reproduction is an exact facsimile of the original, and that the sender's signature can be recognised as readily as can a speaker's voice over the telephone. The transmitting instrument consists of an ordinary lead pencil, to which are attached two strings at right angles to each other, which convert the motion of the transcribing pencil into two components at right angles to each other, each modifying an electric circuit in exact proportion to its component. The paper upon which the transcription is made rests upon a metallic plate normally out of contact with the circuit, but which is brought into contact by means of a slight pressure of the pencil. When the transmitting and receiving instruments are placed side by side their operation reminds one most forcibly of the operation of the two ends of a pantograph, which, in fact, they resemble most closely, the connection between the sending and receiving stylus, however, being electrical instead of mechanical as in the pantograph. It is claimed that some 35 words per minute can be transmitted in this way to the same distance to which telegraphic messages can be sent without the assistance of relays, and that this distance may be increased as far as desired by the usual relay methods adopted in telegraphy. In fact, as to speed of transmission, it is claimed to be limited only by the ability of the writer to transcribe the words with the lead pencil or pen. It is, however, manifest that this is not strictly accurate, as one cannot operate the sender as rapidly as he could write the same words with a pencil unattached to the controlling strings. The speed, however, will compare favourably with that of transmission by means of Morse signals by hand. The receiver transcribes the message by means of a glass ink tube or pen similar to the receiving stylus employed in the siphon recorder in ocean cable telegraphy, this motion being the resultant of the rectilinear motions transmitted. Figures and outline drawings are also reproduced with great fidelity. In the original system invented by Gray four wires were employed between the two instruments, two circuits being required. The obvious simplification, however, of employing but a single return for these two circuits has more recently been adopted, so that now but three wires instead of four are employed. Prof. Elisha Gray is well known in electrical circles, and is Chairman of the Advisory Council of the World's Congress of Electricians, to be held at Chicago, at the time of the Exposition. He will also be remembered as having been one of the claimants for the invention of the speaking telephone, his own device for the transmission of speech having been exhibited at the Centennial Exposition in 1876, at the same time that Bell first publicly exhibited his invention. It is proposed to connect telautograph subscribers together through a central exchange in a manner exactly similar in principle to that with which we are so familiar in telephony. When one subscriber, A, wishes to communicate with another, B, both connected through the same exchange, A merely writes on the paper "A to B," when the operator makes the connection, and the two are in communication.

The Bell Telephone Patent.—A great deal of interest is being manifested just now by the public at large in the telephone situation, as the basic patent granted to Bell in 1876 has expired, and the art is now open in this country to the public. This first patent is limited to the use of a parchment diaphragm, and it is claimed by the Bell Company that it does not cover the use of the all-metallic diaphragm, which was given to them in a subsequent patent in January of the next year. They, therefore, claim that the art of telephony will not be open to the public until 1894. There is, however, at the present time talk of new companies to be organised for telephonic work in competition with the existing Company, but these the Bell Company is discouraging by every means in its power, among which are claims of fundamental patents in switchboards, transmitters, and other accessories, which, however, are not likely to frighten anyone who seriously contemplates entering into the business.

The Chicago Exhibition.—Mr. Frederick Sargent, so long at the head of the mechanical and electrical departments of the World's Fair, has recently resigned. It is understood that a conflict in authority, which he felt seriously crippled his work, was the cause. The duties thus laid down by Mr. Sargent have been assumed by Mr. R. H. Pierce, Mr. Sargent's former assistant.

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THE BATTLE OF THE "TICKERS."

As will be seen elsewhere in our columns, during this week a company called "The Printing Telegraph and Construction Company of the Agence Havas (Limited)" has appealed to the British public for a capital of £115,000 to enable, amongst other things, a system to be carried out of electrically transmitting to and printing news in the offices of subscribers in France. The experience obtained in this country during the last twenty years in connection with similar systems cannot fail to throw light upon the amount of success likely to be obtained in this new departure across the Channel.

The first point that strikes a reader of the prospectus of the Company named is "Why should the public here be appealed to for the money required?" If the credit of the Agence Havas is so high, should it not be able to secure the amount in question in France? There must be a reason for money being sought here for a purely French undertaking, and it is possible that this may be found in the fact that the Agence Havas have been severely affected—their shares have fallen from about 600fr. to 200fr.—by the competition of the Agence Dalziel, which has also a concession, prior to that of the Agence Havas, from the French Government for electrical news printers, and is now engaged in constructing its system and obtaining subscribers, the instrument used being that known in this country as the Exchange Company's Column Printer.

It should also be pointed out that two previous unsuccessful attempts have been made to introduce news-recording instruments into France, the last having been made some twelve years ago under the auspices of the Agence Havas itself. It may, however, be admitted that *prima facie* in some respects there is a better field in Paris than in London, where the rapidly-recurring editions of the afternoon and evening papers make news instruments less necessary; but the prospectus estimate of 1,000 subscribers for this particular Company's instruments in Paris, according to all experience here, is not likely to be attained for a number of years, if ever.

By internal evidence the prospectus before us has not been drawn up by anyone acquainted with the working of these instruments. The gross receipts to the new Company are given as £27,600, with the estimate of a dividend of 15 to 20 per cent. Taking an average of 17½ per cent., which would absorb £20,125, there would be left £7,475 for working and maintenance of instruments, royalties to the French Government, and general expenses.

To commence with, there is the royalty of £1 per instrument, the charge made by the Government for maintaining a metallic circuit in place of the single wire used here, the heavy cost of paper in France, and other items. In our view even double the sum named would not nearly suffice for these expenses.

There are several points in the prospectus which ought to give pause to intending subscribers. For instance, under the concession "The French Government are entitled to purchase at a valuation, at any time, at a price *exclusive of any value for the patent*" (for which, and certain other minor considerations, no less than £75,000 is to be paid), "the whole of the plant, property, and machines of the Company in Paris and its environs." Again, after thirty-five years the machines, wires, plant, &c., &c., which are to be paid for by the Company, are to become the property of the Agence Havas, which is also to receive £8,850 in fully paid shares of the Company and 54 per cent. of the gross receipts from subscribers. This large percentage does not include up-keep, installation, wages of operators, taxes or other administrative expenses. It is, therefore, reasonable to describe this undertaking as an Agence Havas Relief Company.

It is claimed that the instrument to be used in Paris is faster than any column printer now in use, and that it costs 30 per cent. less; but there does not appear to be much in the claim, in view of the fact that a French paper, after inspecting both the Wright instrument (adopted by this Company) and that best known here as the Column Printer, stated that there appeared to be little difference, except that one was driven by a weight and the other by an electric motor, and the fact remains that the "Exchange" type printer was patented some time before the Wright instrument.

Finally there remains a sum of only £40,000 for working capital, which is certainly insufficient, seeing that the Company have to purchase the instruments and apparatus, to pay the cost to the French Government of installing the wires, &c., even should the reports current in the City as to the high percentage of commission offered to underwriters prove unfounded.

BOOKS, &c., RECEIVED.

"Die Berechnung Elektrischer Leitungsnetze." By J. Herzog and C. P. Feldmann. (Berlin: J. Springer.) 350 pp., 8vo.

"Anordnung und Bemessung Elektrischer Leitung." By C. Hochenegg. (Berlin: J. Springer.) 180 pp., 8vo.

CORRESPONDENCE.

THE REVIEWING OF NEW BOOKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: An author has not much protection against the irresponsible reviewer, and generally it is not considered etiquette to question the latter's dictum; but when a palpably unjust notice appears in what is generally considered the leading electrical paper, it is time to protest against the carelessness of the reviewer. This, Sir, is my excuse for writing to you, and I hope you will do me the justice to consider my claims.

Your reviewer (in last week's issue) starts with the binding of my book, surely a point to be considered last of all. He might have guessed that the work when complete would be issued as one volume. When such is the case, it is usual to issue the parts in paper covers. He next attacks the table of conductors and insulators; surely an engineering student would wish to know the comparative conducting powers of metals. The difference between conductance, resistance, conductivity, and resistivity, cannot be too soon impressed on the student. How many people carelessly use the term *conductivity* as the reciprocal of *resistance*. Anent this, I would ask you to refer to my enclosed article.

An engineering student is not a student of pure science, and therefore hand-rules, *e.g.*, are admissible. One of my students originated a hand-rule for finding the + direction round the magnetic field of a straight current-carrying conductor. This, obviously, is a fundamental rule, and it was characterised as "excellent" by one of our greatest electricians, whose name however, I am not at liberty to publish. In this rule, the hand can only be placed with the thumb in the direction of the current, and the fingers in the direction of the field; and it is clearly convenient that other hand-rules should be made to agree with this. I enclose an article of mine on this subject.

There are two *real* faulty points which your reviewer mentions, and for which I am grateful. In all my published works I have written for the beginner, and though they do not strike very new ground, I have been led to think that they will be found original in arrangement and treatment. The despised elementary book is quite as much wanted as the advanced treatise; else how are we to keep up our supply of electricians, and how are the public to get initiated?—Yours, &c., W. PERREN MAYCOCK, M.I.E.E.

96, George-street, Croydon, March 24, 1893.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Kindly allow me to make a few remarks upon Mr. Maycock's strictures on my review of his book. In the first place, the phrases, "irresponsible reviewer" and "leading electrical paper" involve, as Mr. Maycock uses them, a contradiction in terms. A reviewer who writes for any paper of standing, and especially for a leading paper, cannot be irresponsible. Indeed, the responsibility connected with reviewing is very complicated; there is not only the responsibility to the editor, there are also grave responsibilities to the author and to the public. One feels these very much in dealing with a book of the class to which Mr. Maycock's letter especially refers. Justice is one's first and last consideration; and this sometimes leads one reluctantly to write those unfavourable reviews of which Mr. Maycock is complaining. Reviewers, of course, are human—very human; and they are as liable to err as authors are. Were one, however, to give a roseate hue to the review where blacker lines were needed, the public would soon discover that the review column was unreliable and useless reading. The review of Mr. Maycock's book was only written after mature consideration.—I am, Sir, &c.,

London, March 28, 1893. THE REVIEWER.

[Mr. Maycock is fully entitled to protest, and our reviewer, who has, by-the-bye, our full approval, to reply. Many people, Mr. Maycock observes, "carelessly use the term *conductivity* as the reciprocal of *resistance*." But they do so in good company. In the lecture delivered at the Institution of Civil Engineers on March 3, 1883, by Sir William Thomson, he said, "We want

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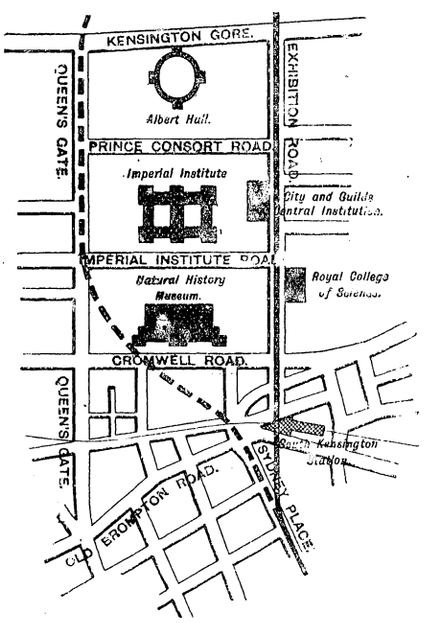
a name for the reciprocal of resistance. We have the name 'conductivity,' but we want a name for the unit of conductivity," and he then tentatively suggested the "mho." The well-known "hand-rule" in which the thumb indicates the direction of the north pole as well as the deflection of the needle, while the fingers point in the direction of the current, was taught at Cambridge by Prof. Garnett, while demonstrator to Clerk Maxwell in 1877, and is, therefore, of considerably older standing than the whole industry of electrical engineering. And yet Mr. Maycock says that it is clearly convenient that other hand-rules should be made to agree with his! We cannot follow the connection between the deluge of elementary books and "our supply of electricians." Must a new book come out for each hundred infatuated lads who rush into electrical work because it is supposed to be "the coming thing?"—Ed. *E.*]

CLAPHAM JUNCTION AND PADDINGTON RAILWAY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of the 24th March, p. 597, you reproduce from "a plan issued by the promotors" the "projected route of" the proposed "railway," with a deviation "as proposed by Professor Ayrton," shown by a dotted line.

I shall be much obliged if you would will be so good as to allow the enclosed plan to appear in your next issue, as it more



accurately gives the two routes. The sketch plan that you have followed, was, when drawn last year, only intended as a general indication of the line and position of the stations, and is not accurate enough in detail to give an idea of the merits of the two routes.

Your readers will judge for themselves of the material difference between being able to prove an "effective" line in one case and the other, especially in the case of the use of cable traction which was included in the Bill, but an important difference which led the projectors to reject "Professor Ayrton's route" (which, by the way, we had fully considered), was that it would have necessitated the acquisition of private property, both freehold and leasehold, the value of which must have added considerably more than £100,000 to the estimates. —Yours etc., C. E. Webber.

Portland House, E.C., March 27, 1893.

[The above diagram has been engraved from General Webber's plan so far as it relates to the streets and to the projected route of the line as shown in black. He had indicated a dotted line passing with a radius of about six chains under Thurloe-place into Cromwell-road, and turning with a similar radius up Queen's Gate. As this hardly represented the proposed deviation, we have submitted the plan to Prof. Ayrton, who has laid down a route, as shown by the dotted line. The plan sent to us by General Webber is, however, inaccurate in several particulars. The end of South Kensington Station, for example, should be in a line with the west side of Sydney Place. Prof. Ayrton's route runs for the most part under a mews in passing from Sydney Place to Cromwell-road, and below only one house in Cromwell-road. As this proposed route is not contemplated in the present Bill, further discussion of the matter is unnecessary.—Ed. *E.*].

PLUMBAGO-CLAY RESISTANCES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with interest your editorials, relative to resistances made of plumbago and clay, in your issue of February 24th, 1893. I have been experimenting off and on for some years in this direction, and have made some of these resistances, which have proved to be very satisfactory indeed. I have also used them as you suggested, in electrical supply circuits for ringing electric bells, and found them to give most satisfactory results. In addition to this, I have used them in connection with electrical apparatus on circuits of very high voltage; moreover, in experimental work, I have found them of great advantage on voltages running up to 10,000 or 15,000. I frequently use other substances in addition to the plumbago and clay, and in some cases have found that the temperature coefficient was very small indeed. To illustrate how tough some of these have been, I might say that with 1,000 volts I have heated a piece four inches long to a uniform red heat without any apparent disintegration of the carbon pencil. I believe in the future, resistances of this kind will be much more extensively used than they are at present.—Yours, &c., Henry W. Fisher, Electrician,
Standard Underground Cable Company.

Pittsburg, Pa., March 14, 1893.

MAGNETIC EFFECTS FROM THE ELECTRIC RAILWAY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Your editorial remarks may convey the impression that I was first to observe the particular character of the magnetic effects of the Electric Railway, but the credit of these magnetic observations is entirely due to Prof. Ewing, for, previous to his investigations, I had only interested myself with the earth currents.—Yours, &c., F. H. Glew.

Clapham Road, London, S.W., March 27, 1893.

THE BROWN SINGLE-PHASE ALTERNATE-CURRENT MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Since the appearance of my article on single-phase alternate-current motors, some little correspondence on the subject has arisen, to which I now beg to submit the following answer. I should have written before this, but I have been for some time absent from Baden, and I also wish to give time for the other side of the question to be fully stated before replying.

On reading the various letters, I was really amused to notice how that, after the publication of the particulars of my motor, everyone has suddenly discovered that he invented it himself long ago. I can only remark, and I imagine that most readers of the correspondence will agree with me, that had any of these motors come within measurable distance of a solution of the problem they would long ere this have come into general use. Prof. Elihu Thomson claims to have produced such a motor in November, 1888, and MM. Hutin and Leblanc had as early as May, 1891, so complete an insight into the underlying principles of the problem as to write an elaborate mathematical article upon the subject. In neither of these cases, or in that of Mr. Tesla, who also worked in the same direction, was there any lack of capital to assist in bringing the motors before the public; yet although in each case ample time has elapsed, the machines have not come into use in practice, in spite of the fact that there has always been a great demand for a self-starting alternate-current motor

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without a commutator. I have no wish to underestimate the importance of the work done by Prof. Thomson, Mr. Tesla, and other early workers in the field, but I would point out that certain points in their machines were inherently defective, and that it was only by remedying these that I have succeeded in producing a practical single-phase motor. As some further elucidation seems to be necessary, I will describe more exactly the points in which my motor differs from the earlier ones, and to which I attribute its success.

From the published figures and descriptions of the motors of Thomson, Tesla, and Leblanc, it is apparent that the arrangement and winding of the magnetic circuit, both in the fixed and rotating parts is suitable only for synchronous working, the number of poles and windings being the same in both. It will also be noted that all the above-mentioned motors have very sharply-projecting poles, so that the magnetic resistance varies according to the position of the rotating part with regard to the fixed. The result of this will be that the former will have certain positions in which it will tend to place itself, and only when in these positions can currents be properly induced in it. Such a motor can only give power when running synchronously, and cannot be started with a two-phase current, even if of exactly 90deg. phase difference as produced from a two-phase machine except, perhaps, with very low periodicities, and even then without appreciable torque. In fact, in most cases the motor will only run if first brought up to almost synchronous running by some external means.

In the motor described in my article, on the other hand, there is no correspondence whatever between the winding or form of the magnetic circuit in the outer inducing and inner induced parts. On the contrary, they are, and must be, completely different from one another. It will also be observed that there are no sharply-projecting poles, but that the inducing winding is carried in a large number of holes which are uniformly distributed over the whole surface of the iron. The short-circuited induced winding is also carried in holes uniformly distributed over the surface of the rotating part. The numbers of holes in the induced and inducing parts respectively must have no common factor. The result of this arrangement is that when a single phase current is sent through the outer or inducing winding, the inner part has no tendency to place itself in any particular position. If, in such a system, a second current is employed, as more exactly described by me in my article, having a difference of phase from the first, a turning moment is produced, the motor is started, and on reaching a certain speed this second current is cut out. The motor then runs up to a speed corresponding to its load, and only when running light will the speed approach synchronism. When loaded the speed of the rotating part sinks so far below synchronism that the current produced by this difference of speed gives the necessary torque. The extent of this drop depends on the form of the rotating part, as explained in my former article. With regard to speed and armature current, the motor is, therefore, exactly analagous to a direct-current, shunt-wound motor. The bedding of the winding in holes, as so often explained, is for the purpose of reducing the current required for the excitation and thus securing a high-plant efficiency. I would also point out that the weight efficiency of these motors is entirely dependent upon the proper choice of the various proportions. By suitable design remarkably favourable results may be obtained. Thus I have now several 10-H.P. motors at work giving this power at the low speed of 800 revolutions, with a weight of only 500 kilogrammes and the heating is practically *nil*. As a matter of fact, one of these has been at work (in a saw-mill at Ragaz) day after day giving over 15 H.P. with moderate heating and has even been braked to 20 H.P. without pulling it up. Preliminary experiments show that the motor has a commercial efficiency of 88 to 90 per cent., the apparent watts being only about 12 per cent. in excess of the real watts. I must not omit to mention that this motor has no sliding contacts, and had sufficient starting torque to set in motion a line of shafting.

With regard to the letter from Herr Arnold, which appeared in several technical journals, I can simply state that the development of my motor dates from 1891, as stated in my article, and that after definitely settling all details I also applied for patents. Unfortunately, I was sufficiently incautious to explain my improvements to various interested people, so that the secret more or less leaked out. In his letter Herr Arnold attempts to treat the motor as a mere copy of those of Tesla and Thomson—whether from ignorance or design I am unable to say.

With regard to the letter of MM. Hutin and Leblanc, claiming priority in the invention of the motor in its essential principles, I would only say that from an examination of the French patent specification No. 204,456 it may be seen to be a two-phase motor of the Tesla type, the two phases being produced either from a special generator or by splitting the original current by means of a condenser which is always kept in circuit. Judging from my own experience, I must rather doubt if this motor would start even with two-phase current of 90°-phase difference, as the whole design points to synchronous working.

Referring to the American patent No. 487,633 mentioned by Prof. Elihu Thomson, I find no trace of the principle which he so prettily illustrates at the end of his letter, but which is, on the other hand, the principle of my motor. He shows a motor having sharply-projecting poles and corresponding windings both on the fixed and rotating parts, and he specially mentions in his specification that the number of poles in both parts must be the same, thus producing, as mentioned above, a synchronous non-starting motor. If, as Prof. Thomson says, he could have made these motors work successfully at low periodicities, and was only prevented from introducing them into general use by the high frequencies in vogue in America, I would only point out that there was nothing to prevent the adoption of a lower frequency in the then early stage of development of the alternate-current system, especially when we remember that now, after an immense number of high-frequency plants have been installed, American practice is beginning to come down to lower frequencies. It seems incredible that Prof. Thomson could have been short-sighted enough not to have seen the enormous importance of the practical development of such a motor.—Yours, &c.

Baden. C. E. L. Brown.

TRADE NOTES AND NOTICES.

The 1893 Edition of "The Electrician" Electrical Trades' Directory and Handbook is now ready. This useful book contains over 1,000 pages, and several new and handy features have been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

Tenders Invited.—The Great Western Railway Company invite tenders for Baltic redwood sleepers and crossing timbers and for Quebec yellow pine planks and scantlings. Tenders must be in by Wednesday, April 12th, to Mr. G. K. Mills, secretary, Paddington Station, London.

Tenders Accepted.—The following is the complete list of tenders for lighting the Sunderland Borough Lunatic Asylum, for which the tender of Messrs. Edmundsons (Limited) has been accepted :—

	Without motors.	With motors.
Charlton and Co., Newcastle-on-Tyne	£3,858	£4,108
Edmundsons (Limited), Westminster, London ...	3,673	3,963
A. A. Campbell Swinton, Westminster, London.	4,051	—
Ernest Scott & Mountain, Ld., Newcastle-on-Tyne	3,975	—

——— As announced in *The Electrician* of March 24th, complete tenders have now been accepted for the public street lighting of Londonderry, the gross expenses to date amounting to £15,793, as shown below :—

Accepted tender of Siemens Bros. and Co. for dynamos, arc lamps, conductors, &c.	£8,905
Accepted tender of A. Brown and Sons for engines, boilers, &c.	4,293
Accepted tender of M. M'Clelland for buildings	995
Accepted tender of M. M'Clelland for purchase of site	600
Amount of tender for opening and closing streets	300
Engineer's fees	700
	£15,793

In all 36 tenders were received, some for the whole of the work, others for sections only. The lowest tender was not in all cases

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accepted, and it will be seen that the work has been entrusted to two firms. Messrs Alex. Brown and Sons did not tender for any of the electrical work, the result being that they have received the contract for all the sections tendered for by them. The highest tender for the whole of the work was £15,979, the lowest £12,903, the accepted tenders amounting to £13,198.

REMOVAL NOTICES.—Messrs. Wake and Sanders, mica merchants, have removed from Fowkes-buildings to 3, Crosby-square, E.C.——The offices of *Lightning* are removed from Charing Cross-road, W.C., to 11, Queen Victoria-street, London, E.C.——The General Hydraulic Power Company (Limited) are about to remove from 46, Holland-street, Blackfriars, to Palace Chambers, 9, Bridge-street, Westminster.

MESSRS. CROMPTON AND CO. (LIMITED).—We have received advance sheets of the new price list of arc lamps, accessories, and sundries issued by this firm, in which some useful information is given, as well as a list of prices and particulars of the arc lamps and accessories manufactured by the firm.

RE WOODHOUSE AND RAWSON UNITED (LIMITED).—Notice is given that a petition for the winding-up of this Company by the High Court was presented on the 16th inst., and that the petition is directed to be heard at the Royal Courts of Justice on April 11th. The petition is at the instance of the Rate and Tax Payers' Assessment Protection Association (Limited), of Serjeant's-inn, E.C., for whom Messrs. Alpe and Ward, of 3, Serjeant's-inn, Fleet-street, act as solicitors. Parties who desire to appear on the hearing of this petition must communicate with the solicitors not later than six o'clock p.m. of April 10th next.

RE A. H. W. RADCLIFFE.—The first meeting of the creditors in this matter will be held at the offices of the Official Receiver, Mr. L. J. Sharp, 23, Colmore-row, Birmingham, on Thursday, April 6th, at 11 o'clock, to receive a report. The debtor's statement shows a total liability of £766. 13s. 6d., with assets estimated to produce £59. 7s., or a deficiency of £707. 6s. 6d. The bankrupt attributes his insolvency to a claim made by the wife of his deceased brother, bad trade, and losses on contracts.

BANKRUPTCY—A second and final dividend of 7s. 5¼d. is payable on and after to-day (Thursday) in the bankruptcy of Frederick George Williams (lately carrying on business as an electrical engineer, at Crown Point, Denton, near Manchester), at the Trustee's, Town Hall, Halifax.

"ENGINEERING AND MINING JOURNAL" (NEW YORK).—The proprietors of this journal have opened a branch office in London at 20, Bucklersbury, E.C., under the charge of Mr. Edward Walker.

"WILLING'S BRITISH AND IRISH PRESS GUIDE."—We can recommend this useful publication, in which are given very exhaustive lists (alphabetical, classified, and topographical) of newspapers, magazines and other publications issued in Great Britain and Ireland, in addition to lists of colonial, American, and foreign newspapers.

MESSRS. RUSSELL AND CO.—This firm have recently been busy wiring and fitting for the electric light a number of different premises, amongst which may be mentioned a residential flat at Albert Gate, the large mansion, 56, Holland Park, a private house at Coburg-place, and a bicycle works at Walham Green. The marine and locomotive boilers and vertical compound steam engine, of which the firm make a specialty, are finding favour with the trade.

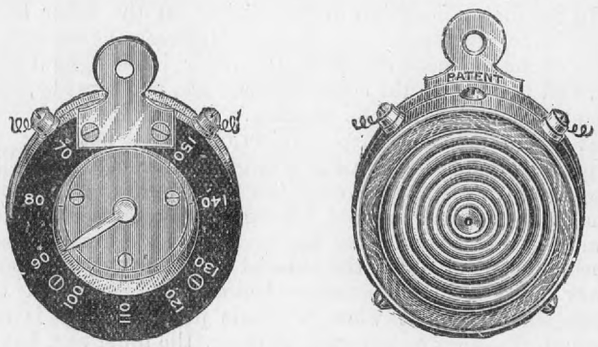
GENERAL ELECTRIC POWER AND TRACTION COMPANY (LIMITED).—The Council of the Royal United Service Institution have instructed this Company to put down an electric lighting plant in the old Chapel Royal, Whitehall, which is being altered for the new museum of the Institution.

MESSRS. GENT AND CO.—This firm have secured the contract for twenty sets of combination telephones and a twenty-station central indicator and switchboard for use at the Holborn Union Infirmary.

INDIA-RUBBER, GUTTA-PERCHA AND TELEGRAPH WORKS COMPANY.—We have received a copy of this Company's last price list of electric light cables and wires, which was noticed in *The Electrician*, Vol. XXIX., p. 653. In the copy now to hand, however, additional divisions have been made in red ink in classes P, Q, T, J, M, which specify vulcanised cables with a nominal resistance of 300 megohms to the mile. Mr. Preece's Paper on insulated conductors has apparently rendered manufacturers alive to the fact that when the thickness of the dielectric is increased in proportion to the weight of copper, the specific resistance by no means remains constant. In fact, the smaller sizes of cable possess a much higher insulation resistance than had previously been ascribed to it, so we have the first ten of the smaller sizes of classes P, Q and T, with an insulation resistance of 1,200 megohms attributed to them instead of 300 as formerly, and 800 megohms are put down for the remaining cables in these classes. In other classes of lead-covered and braided cables similar alterations have been made.

ELECTRICAL POWER STORAGE COMPANY.—This Company send us a copy of a revised price list, in which considerable reductions are made in their specialities, dating from April 3rd. About two years ago, when introducing the new "K" type of cell, the prices per ampere discharge were reduced by about 40 per cent., so that with the further reduction which the Company is now making it is possible to obtain a battery for the same rate of output at less than half the price of three year ago. Another important item, more especially for central stations, is that the battery now occupies only half the space it formerly did. This step must certainly (from the point of view of users in any case) be one in the right direction, and doubtless the increased business resulting from this liberal policy will more than recoup the manufacturers. We are pleased to note that the terms to the trade are to remain the same as previously.

GENERAL ELECTRIC COMPANY (LIMITED).—The third edition of the Electro-Medical Supplies Catalogue issued by this Company is just published, in which illustrations are given of a comprehensive collection of the best apparatus for applying electricity to medical uses. The General Electric Company has, for some years past, interested itself in the collection of this apparatus, and the evidence of their success is shown in thirty large quarto pages filled with illustrations, prices and particulars of a quantity of apparatus in actual use. The illustrations include a variety of coils and batteries, surgical and dental outfits, magnets, electro-medical machines, switchboards for using the current obtained from a central station for galvanisation, electrolysis and faradisation. Electrodes, cauteries, and a large number of other useful instruments complete the catalogue. The whole of the apparatus is of an essentially electrical character. We illustrate a fire-alarm and heat-indicator,



which it is suggested should be of great value in hospitals, sick rooms, &c. It consists of sensitive corrugated diaphragms on the aneroid principle, and gives an alarm by an electric bell when the temperature rises to a degree previously set by an adjustable index finger.

MESSRS. RASHLEIGH, PHIPPS AND CO.—This firm have during the past week secured orders for wiring and lighting the residences of Lady Pearson, Onslow-square, S.W.; Dr. Watson Cheyne, Harley-street, W.; Mrs. Hart, Gloucester-terrace, W.; Mr. Herbert Lousada, Green-street, Park-lane, W.; and additions to the residence of Baron Ferdinand de Rothschild, M.P., at Piccadilly, W.

MILL LIGHTING.—A concession for the establishment of jute factories at Orizaba, Mexico, has been obtained by Mr. T. F. Kinnell, and an extensive jute mill is to be at once erected at Barrio Nuevo, the £100,000 capital for which (the *Mexican Trades* states) has been successfully placed in London. There is an ample waterfall near the site of the mill equal to 11,000 H.P. The huge building is to be lighted throughout by electricity. Pelton wheels are to be exclusively used, and the whole of the machinery is to be driven by electricity.

PULLMAN CAR LIGHTING.—The new Pullman cars erected by the London, Brighton and South Coast Railway Company are lighted throughout by electricity by means of 25 electric lamps in each car. Oil lamps are provided for use when the cars form portion of the trains not electrically lighted. Each seat or chair is provided with an electric bell push connected with the conductor.

LECTURES.—At the Royal Victoria Hall, Waterloo Bridge-road, London, S.E., on the 11th April, Prof. Garnett will lecture on "Some Pioneers of Electricity." Lectures of a popular character will also be delivered on the 4th, 18th, and 25th April.

——— Recently lectures have been delivered on "Electricity and its Applications," by Mr. Mordey, at Stoke-on-Trent; Prof. Jamieson, "On the Hellesen Dry Battery," at Glasgow; Dr. G. J. Stoney at Dublin, and by Mr. Geary at Swadlincote.

BEDFORD.—The Electric Lighting Committee have recommended, and the Town Council have adopted the recommendation, that a sub-Committee of eight be formed, with power to advertise for and

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receive orders from persons or companies prepared to take over the Provisional Order for lighting the town.

BRIGHTON.—The *Brighton Gazette* recently contained a sympathetic article on the new electric railway scheme, in which reference is made to the "mysterious agency of light and power *from which future generations are expecting so much.*" It would be interesting to learn how the writer ascertained the expectation of future generations.

BRISTOL.—It is anticipated that the electric light will be ready for public supply by September next. Rapid progress is being made with the buildings, and the engines, boilers and dynamos are ready to be placed in position immediately the structure is ready. Messrs. Siemens Brothers and Co. will commence laying the cables forthwith. At the last meeting of the Electric Lighting Committee of the Corporation tenders for the switches, &c., for the Temple Back station were opened and discussed, and were afterwards referred to Mr. W. H. Preece for his report.

DONEGAL, IRELAND.—Messrs. Laurence, Scott and Co. (Limited) are supplying the plant for a lighting installation at the residence of Mr. J. Watt, Claragh, in the extreme North of Ireland, to the specification and under the superintendence of Mr. A. Fahie. The plant includes an oil engine working direct to a Norwich compound dynamo and a set of E.P.S. accumulators controlled by a specially-devised switching arrangement, enabling one-half of the batteries to be charged while the lamp-circuits are running, the engine, while running, working by this means always on a full load.

EAST LONDON.—A public meeting was held last week to support the action taken by the Limehouse District Board of Works in furtherance of the electric lighting scheme for the district. A motion approving of the action of the Board of Works and urging them to bring their efforts to a speedy conclusion was passed unanimously.

EDINBURGH.—The Town Council have drawn up a series of further questions to be submitted to Prof. Kennedy, asking for additional information supplemental to the report which he recently submitted to the Lord Provost's Committee.

FALKIRK.—In reference to the proposed electric lighting of the extensive Fever Hospital at Falkirk, we understand that the result of the inquiries made has led to a proposed extension of the original lighting scheme.

GLASGOW.—Messrs. R. D. Smillie and Co. have just completed a second set of arc-lighting plant for the large steel and iron works of Messrs. David Colville and Sons at Motherwell.

HAMPSTEAD.—The Vestry have referred to their Electric Lighting Committee a letter received from the Local Government Board approving the acquisition of a piece of land of 15,000 square feet area as a site for the new central station.

LANCASTER.—At the last meeting of the Town Council the report of the Electric Lighting Committee was presented, which recommends that a low-tension continuous-current system with insulated cables on the Callendar-Webber system be adopted, and that only a portion of the machinery originally contemplated should be put down. It is intended by the scheme to make provision, so far as cables and buildings are concerned, for the supply of electrical energy for 6,000 16-c.p. lamps, in accordance with the Committee's original scheme. A central station is to be erected in Martin-street yard, on ground belonging to the Corporation, and mains are to be at once laid in several of the principal streets, with an ultimate extension to other districts as soon as the demand justifies the necessary outlay. The Committee recommend the acceptance of the tender of the Brush Electrical Engineering Company for £12,683, which is exclusive of the cost of buildings and the laying of mains, which is to be carried out by the Corporation at an estimated cost of about £5,000. It is proposed to charge 7d. per unit for lighting current.

NEWMARKET.—The Board of Trade have decided to dispense with the formal sanction of the Local Board to the installing of the electric light, but the Local Board was to have an opportunity of showing cause why its consent should not be dispensed with. The Clerk has written to the Board of Trade offering no opposition to the course pursued, but specifying that the public roads should not be open during race weeks.

SHEFFIELD.—An exhibition of electrical lamps suitable for 'bus lighting bicycles, &c., was held in Sheffield during last week in connection with the introduction of electric lighting to the public vehicles of the district.

WEST COWES.—The Clerk to the Local Board at the last meeting read the correspondence between the Electric Light Company and the Board of Trade in reference to the raising of the necessary capital for the purposes of the Company. A letter was read from Messrs. Crompton and Co. (Limited) stating that if the order were placed with them they would commence work at the beginning of April and be in a position to supply the light by July. The question of completing the electric lighting of the town was briefly discussed, and the decision of the Local Board as to its relations with the Company was deferred for one month.

WOOLWICH.—The London County Council have formally disapproved of certain works in connection with the lighting of Woolwich district, details not having been supplied.

TRAIN LIGHTING.—The Great Northern Railway Company of Ireland have for some time past had under consideration the introduction of the electric light for their train service, and on Saturday last a party of gentlemen connected with the Press were afforded an opportunity of testing the completeness of the Company's electrical system, which proved a great success. In a train of five carriages 65 incandescent lamps are fitted. The current is obtained from a set of 25 E.P.S. accumulators in the guard's van which are capable of supplying the whole of the train for three hours without using the dynamo, which is also fixed in the guard's van and is driven off the axle of that compartment. While the train remains at the station the lamps are fed from the accumulators only, but as soon as a speed of from thirty to thirty-five miles is acquired, the dynamo is automatically switched into the supply circuit and is also employed to charge the accumulators. The first-class carriages are each provided with four 5-c p. incandescence lamps, and the second and third-class carriages with two 6-c.p. each, with suitable reflectors, arranged in a manner to supply ample light for reading purposes, and in the first-class are provided with switches to three of the lamps, so that passengers desirous of sleeping are enabled to turn three out of the four lamps off. The dynamo has been specially designed by the General Electric Power and Traction Company (Limited), and the electrical fittings and general work has been done by Messrs. Curtis and Sons, as has also the new system of heating by steam adopted for their general train service by the Great Northern Company.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inven tions, or where complete specification accompanies application an asterisk is suffixed.*

March 7, 1893.

4,976. SIEMENS BROTHERS AND CO. (LIMITED). London. Improved apparatus for working railway switches by means of electrical energy. (Messrs. Siemens and Halske, Germany.)

March 8, 1893.

4,992. H. HURST. London. Improvements in electric lamp sockets and like electric fittings.

4,994. W. H. HAWORTH. Swinton, Lancs. Electric cinder sifter and ashpan.

5,051. T. COAD. London. Improvements in primary batteries.

5,064. J. CAUDERAY. London. Improvements in electric clocks.

March 9, 1893.

5,084. E. C. DAY. Glasgow. An improved method for fastening electrical conductors, wires, cables, and the like, in wood casings by means of adjustable clips or clamps.

5,101. G. E. FLETCHER. Liverpool. Improved system of electrically interlocking signals and points, and in apparatus therefor.

5,109. W. LOWRIE. London. Improvements in and relating to the methods and means of coupling alternating-current dynamo-electric machines in synchronal relation, and maintaining them in that relation.

5,110. W. LOWRIE. London. Improvements in and relating to apparatus for charging electric accumulators.

5,142. Sir C. S. FORBES, Bart. London. Improvements in incandescent electric lamps and in apparatus connected therewith.

5,143. Sir C. S. FORBES, Bart. London. Improvements in microphones.

5,171. D. TOMMASI. London. An improved electric safety lamp.

5,181. J. LANG. London. An improved combined lamp and electrical igniting device therefor.

March 10, 1893.

5,197. J. HARGREAVES and T. BIRD. Liverpool. Improvements in the production of alkali and in apparatus therefor, the said apparatus being applicable for electrolysis generally.

5,198. J. HARGREAVES and T. BIRD. Liverpool. Improvements in and in making electrolytic apparatus.

5,214. O. HAWKINS. Glamorgan. Safety electric molten lock for miners' lamps.*

5,261. R. D. BOWMAN. London. Improvements in electric belts.

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5,336. E. TORRINI. London. Improved method and means of fixing the "lead" or conducing wires of electro-incandescent lamps.

5,337. J. A. EWING. Cambridge. Improvements in conductors for electric railways.

5,339. R. LUNDELL and E. H. JOHNSON. London. Improvements in and relating to alternating-current electric motors.*

5,340. R. LUNDELL and E. H. JOHNSON. Improvements in and relating to alternating-current electric motors.

5,341. C. P. SHREWSBURY, F. L. MARSHALL, J. COOPER, and J. L. DOBELL. London. Improvements in or connected with electric batteries.

March 13, 1893.

5,355. G. ROLF and W. C. MOUNTAIN. Newcastle-on-Tyne. Improved means for rendering the sparking of commutators, switches, fuses and the like harmless in explosive atmospheres.

5,406. F. P. SCHLOSSER. London. Improvements in electric railway signalling.

5,419. H. H. CASS. London. A new or improved manufacture of electric switches.

March 14, 1893.

5,470. H. SIBERY. Ashford. Railway electric fog signals.

5,486. A. W. WESTON. London. Improvements in commutators for dynamo electric machines, and method of constructing the same.*

5,495. W. P. THOMPSON. Liverpool. Improvements in or relating to the electro-deposition of metals. (Franklin Leonard Pope, United States).

5,505. H. WATKIN. London. Improvements in apparatus for moulding the bodies of electric switches, bell pushes, ceiling roses, and other like articles in china and earthenware.

5,525. T. J. HOLLAND. London. Improvements in electrolytic apparatus for decomposing chloride of sodium or potassium in solution, and for leading away the products of decomposition.

March 15, 1893.

5,580. E. A. MCLACHLAN. London. McLachlan's electric stern attachment for the propulsion of rowing boats, &c.

5,594. J. A. TIMMIS. London. Improvements in the arrangements for working railway signals electrically.

March 16, 1893.

6,638. W. J. DAVY. London. Multiple changeover mechanism for electric arc lamps.

5,652. J. R. KAY. Improvements in switches in connection with electricity.

5,655. C. RICHARDSON and E. G. HERBERT. Manchester. Improvements in electric arc lamps.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1892.

4,025. MILLER. Effecting electrical communication.

6,145. BOYNTON. Electric railway system.

6,364. LAKE (Wilbrant). Electric arc lamps.

6,637. HEYL. Battery electrodes.

7,466. SHIELS. Electrical railway communication.

7,655. NUNN. Electrical call, &c., apparatus.

8,212. SMITH and WILSON. Electric conductors, &c.

8,268. GRIMSTON and DYKE. Electrical steering gear.

9,758. BEAUVALET (E. E. and L. C.). Electric arc lamps.

9,941. SMEETON and PAGE. Electrical contacts.

11,817. MARINOVITCH and SZARVADY. Distributing telephone currents.

22,915. WISE. (Buckingham.) Printing telegraphs.

22,931. WISE. (Buckingham.) Printing, &c., telegraphs.

24,147. Bradford. Telegraph keys.

1893.

1,561. LAKE (Lundell and another). Electric motors.

1,621. BRADLEY. Distributing alternating currents.

PRINTING TELEGRAPH AND CONSTRUCTION COMPANY OF THE AGENCE HAVAS (LIMITED).—The prospectus of this Company has been issued during the past week, in which some remarkable financial results are set out. France, which until now has practically tabooed the "tape" machine, is all at once to evince an uncontrollable desire to introduce it into every home. It is estimated in the prospectus that 1,000 of the column-printer machines will at once come into use, and that from this source dividends at the rate of about 15 per cent. upon the capital issued by the Company is to be earned. On the directorate is M. D. Monnier, Professor of Industrial Electricity at L'Ecole Centrale de Paris. The secretary *pro tem.* is Mr. T. J. Ford, and the temporary offices are situate at 10 and 11, Queen Victoria-street, London, E.C. The total capital is £110,000 in shares of £5 each, of which the vendors (Messrs. R. D. Radcliffe and Viben-Smith) take 3,100 fully-paid shares (£15,500) and £59,500 in cash or shares at the option of the Directors, leaving £40,000 as working capital, supposing the whole to be subscribed without underwriting commission. Subscriptions are payable—5s. on application, 15s. on allotment, £1 on the 5th prox., £1 on May 5th, and £2 on June 5th next. The list closed on Wednesday.

COMPANIES' MEETINGS & REPORTS.

Direct Spanish Telegraph Company (Limited).

The thirty-ninth ordinary general meeting of the Company was held at Winchester House, Old Broad-street, on March 24, 1893, under the presidency of Mr. Edmund Etlinger.

The MANAGER (Mr. Ch. Gerhardi) having read the notice calling the meeting,

The CHAIRMAN said: Before commencing our business to-day, I regret to have to state that our Chairman (Sir James Anderson) is absent owing to illness; but I am, on the other hand, glad to hear this morning that there is a decided improvement in his condition. I, therefore, hope that before long we shall have the pleasure of again seeing him among us (cheers). In accordance with our usual practice, I will now ask the Manager to read the minutes of the last general meeting.

The MANAGER having read these minutes,

The CHAIRMAN said: The half-year under review to-day—namely, the half-year ended December 31, 1892—has been very uneventful. Our traffic receipts have shown a very slight increase, but a very slight increase only. On the other hand, our expenses have been very much the same as they were before. Now, considering that the commerce of the world has not been brisk—in fact, I believe people say that it has been very slack—and also considering that there has been no political event which would throw any extra work on Spanish international wires, I think we may be satisfied with the result we have obtained; the result being that we are better off by £410 this half-year than we were a year ago for the corresponding period of 1891. We may also congratulate ourselves upon the fact that during the half-year there has been no occasion to spend any money on cable repairs, and the small works we had to carry on in connection with the land-lines at Falmouth, Bilbao, and Barcelona have been completed for the small expenditure of £171, which has been charged against revenue. If you will turn to the balance-sheet, at pages 8 and 9, you will see that we expended nothing on capital account; we have raised no additional capital, and we have contracted no loan. The debentures remain exactly as they were before, but as you were told at our last meeting, these debentures fall due in May, 1894. That fact, however, I think, need cause us no anxiety whatever. We shall by that time have a reserve fund of £40,000; we have a yearly net income of £14,000, and we have uncalled capital of £13,000. Under those conditions there can be no difficulty whatever, when the time comes, of arranging about these debentures. To-day there is no occasion to go into the matter at all. As to the reserve fund, it stood, at the end of 1892, at £30,331, whereas this time last year it stood at £23,946. We have therefore increased our reserve fund during the past year by £6,386, and I think you will regard that as satisfactory. With reference to the outstanding liabilities of £12,688, they represent the balances of telegraph accounts with other telegraph administrations due by us at December 31, 1892, but these amounts are more than counterbalanced by those due to us by foreign administrations, which come to £13,000. I need hardly say that since the 31st of December last, both these sums have been very much reduced. The balance to profit and loss account amounts for the half-year to £5,438. 19s. 7d., which represents our profit for the half-year, less the debenture charges for that period, and it is really the amount which we have to deal with on this occasion. If you refer to the revenue account at pages 4 and 5, you will find that our expenditure for the second half of last year was £4,982. 4s. 2d., whereas the expenditure for the corresponding period of 1891 was £5,381. 0s. 7d., so that in the past half-year our expenditure was less by £398. 16s. 5d. If you add to that, that our total receipts have increased by the very small amount of £11. 10s. 3d., you will find that the total result of the half-year's working is that we have increased our receipts by £410. 6s. 8d. That is not much, but it is not unsatisfactory under the circumstances. The balance of profit for the half-year is £7,252. 9s. 7d., while last year it was only £6,842. 2s. 11d. That, of course, is the exact difference I gave you before of £410. 6s. 8d. to the advantage of this half year. At the bottom of the same pages you have the appropriation account, a statement showing how the £5,438. 19s. 7d. is dealt with. In the first place we put, as per arrangement, £2,500 to the reserve fund; secondly, we also carry to the reserve fund £442 on account of the repayment of a certain amount which we borrowed from the reserve fund in 1891, for cable repair purposes. The total amount then repaid of the sum so borrowed will be £883, leaving £1,393 to be repaid out of future half-years. Then we recommend you to declare the preference dividend at the rate of 10 per cent. per annum, amounting to £1,462. 10s., and a dividend of 4 per cent. per annum on the ordinary shares, amounting to £1,034. 9s. 7d., together making £2,496. 19s. 7d. These sums will absorb the whole of the available balance of £5,438. 19s. 7d. I will now for a moment ask you to turn to the report, and I will refer you particularly to paragraphs 2 and 3. If you read those paragraphs by themselves as they stand there, they would not show you the same result as I have indicated; they would not show as great an increase of profit as £410. The explanation of that is that in the report, when we deal with the receipts, we only deal with traffic receipts. We do not in those paragraphs allude to other receipts, such as transfer fees and interest on money from our bankers; and in regard to working expenses, we only include the regular working expenses for doing message business, not special expenses, such as the construction and repair of land-lines and so on, to which I just now referred. You must not therefore read those two paragraphs by themselves but in connection with the accounts as I have done, when you find that the increased profit for the half-year has been £410. Then, the fourth paragraph tells you that the Company's cables and the land-lines in connection with them have continued in good working order throughout the half-year. I have already

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told you that on cables we spent nothing last half-year. I now come to paragraph 5, which is as follows:—

"The Directors, with a view to strengthen the good relations existing between the Company and their Staff, propose to follow the practice adopted by many companies, in assisting the employés to make provision for their old age, or for their representatives after death. Arrangements have been made for taking out Endowment policies on which, under certain conditions, the Company pay one-half of the premiums. It is calculated that the amount which the Company can be called upon to contribute will not exceed £250 per annum."

I have very little to add to that paragraph, because it speaks for itself but I may say that the Directors feel confident that every shareholder will heartily concur in this arrangement, by which, at a moderate sacrifice, the Company will assist the employés in making provision for their old age, or for their families after death. On the one hand, the arrangement will relieve the employés to some extent in their natural desire to provide for their families in the future, and on the other hand, it will indicate that the scale of salaries, as now arranged, will be permanent. I commenced by saying that the half-year had been uneventful, and therefore I am not able to make you a long speech. I will therefore conclude by moving—

"*That the report and accounts now presented be and are hereby received and adopted.*"

Mr. J. DENISON PENDER: I will second that.

The CHAIRMAN: Before submitting that to the meeting I will ask if any gentleman has any question to put. No shareholder rising to address the meeting, he submitted the resolution in the usual way, and declared it carried unanimously. Continuing, he said: The next resolution is—

"*That the dividend at the rate of 10 per cent. per annum (less income tax) on the preference shares and a dividend at the rate of 4 per cent. per annum (free of income tax) on the ordinary shares, both for the half-year ended December 31, 1892, be and are hereby declared.*"

Mr. J. DENISON PENDER: I have much pleasure in seconding that.

The resolution was carried unanimously.

The CHAIRMAN: The next resolution refers to the re-election of Directors. You are aware that, by our Articles of Association, two Directors have to retire every year, and it so happens that on this occasion Mr. Pender and I retire. We are both willing to be re-elected if it pleases the shareholders to do so, but we find some difficulty in proposing our own re-election.

Mr. JOHN GLOVER: I beg to move—

"*That Mr. Edmund Etlinger and Mr. J. Denison Pender be and are hereby re-elected Directors of the Company.*"

Mr. J. T. CROWE: I will second the resolution with much pleasure.

The motion was carried unanimously.

The CHAIRMAN: There is only one more resolution, which refers to the auditor.

Mr. WM. HIBBERDINE: I beg to propose—

"*That Mr. Herbert R. Duke be and is hereby re-elected Auditor for the present year, with a remuneration of 20 guineas.*"

Mr. CROWE seconded the motion, which was carried unanimously.

The CHAIRMAN; That is all the business we have to transact to-day, and I am much obliged to you for your attendance.

Mr. GLOVER: Before we separate it is always usual to propose a vote of thanks to the Chairman and Directors. I am very sorry to see that our Chairman is not here to-day. I do not not say that out of any disrespect to our present Chairman, but we should all have liked to see our old friend Sir James Anderson with us. I beg to propose a vote of thanks to the Chairman and the Directors.

Mr. CROWE seconded the motion, which was unanimously carried.

The CHAIRMAN: I am sure that Sir James Anderson will be very glad to hear the remarks you have made, and on his behalf and on behalf of the Directors I beg to thank you.

The proceedings then terminated.

Notting Hill Electric Lighting Company (Limited).

The annual general meeting of this Company was held on Monday last at the Company's central station, Bulmer-place, Notting Hill-gate, Prof. Wm. Crookes, F.R.S., presiding.

The SECRETARY (Mr. W. H. Fox) read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: Ladies and gentlemen, you will doubtless think it unnecessary for me to refer to any great extent to the accounts, as they are published in such full detail that I think they really speak for themselves. There are one or two points, however, which perhaps you might feel interested in having a little information on, and I will therefore devote a few minutes to these matters before moving the adoption of the report and accounts, although I think most of the subjects are explained in the Directors' report, which you have before you. In table No. IV. there are one or two items on the debtor side to which I must draw attention. The first is the cost of hiring temporary boilers, £16. 17s. 6d., and to this may be added a further sum of £18. 12s. 6d. for wages and stores in connection with the same, making a total of £35. 10s., which will not appear in the accounts for this year as the boilers have been dispensed with, our load now being sufficiently good to render the continued use of our large boilers economical. Another item to which I would refer is rents payable, £161. 10s., which, as stated at the foot of the revenue account, includes a sum of £100 for rent of special local office at 105, High-street, Notting Hill, which has now been given up, as it was not considered advisable in the interests of the Company to take a further lease of the premises, and, as a matter of fact, the Directors had previously endeavoured to let the house, but could not do so at a reasonable rent. There will, therefore, be a saving of £135. 10s. in the accounts for this year from these two sources, and we also do not expect that the law expenses will be anything like so large as those appearing in the accounts before you. As you will see by the credit side of account No. IV. the amount of revenue from the sale of current for the year was £2,518. 17s. 1d., which shows a very satisfactory increase over the £999. 10s. 6d. earned during the previous seven months. The bad debts for the year amount to only £5. 10s. 2d., which, I think, reflects credit on the management in the choice of customers, and in requiring guarantees in doubtful cases. Perhaps a little explanation is needed with regard to the fee of £250 from the New Telephone Company (Limited), which appears in the revenue account. The fee was paid by them to this Company merely for entering into an agreement whereby amongst other things the Company agrees to allow the Telephone Company to lay wires in our culverts for telephonic purposes at a certain rental per mile of wire, the minimum rental being fixed at £100 per annum, but the provisions of the agreement take effect conditionally upon the granting of the necessary approval by the Board of Trade and other Authorities, which I understand has not yet been obtained. We now come to Table V., the net revenue account, on the debit side of which appears an item of £92. 16s. 10d. for "interest on loans," and we do not anticipate any similar liability being incurred this year, as the charge is for interest payable to the contractors in connection with the construction of the Phillimore district mains, to which I shall again refer. The debit balance of £617. 5s. 7d., which appeared on the net revenue account at the end of the previous year has been reduced to £347. 16s. 4d., but this is chiefly through the amount of £250 of Directors' fees being re-credited in the accounts, and perhaps a little further explanation would not be out of place here with regard to Directors' fees. As you are aware, the total amount of fees payable to the Directors under the Company's Articles of Association is £1,000 a year, and as was stated in the last report, the Directors had not drawn their fees for the quarter ending December 31, 1891, and have not drawn any since that time; therefore, at the 31st December last, the total amount of fees due to the Directors was £1,250. In view, however, of the present struggling position of the Company, the Directors have agreed to return to the Company half of the fees due, and have also agreed to accept only half fees for the present year, and they have also gone further and agreed to postpone their claim to the half fees due, together with those for this year, until the accounts have been presented to the shareholders in 1894. An agreement embodying this arrangement has been prepared and signed by all the Directors, and I am sure you will all agree with me that the Directors have acted in a most generous manner with regard to this. As regards the depreciation fund account (No. VII.), you will notice the Directors have not thought it necessary to provide for depreciation, as they are advised that the charges in the revenue account under the head of repairs and maintenance are sufficient for the purpose; and I would add that the mains and machinery are kept in such a thorough state of efficiency that it certainly does not appear to the Board to necessitate, at any rate at present, any special provision for this being made. I do not think there is anything in the general balance-sheet requiring comment. The last account is the statement of electricity generated, sold, &c., and I think the only figures requiring any special explanation in this statement are those appearing under the head of "Quantity not accounted for." Of the 13,061 units said to be absorbed by the batteries, I think it might be fairer to charge the batteries with only 9,000 units, the balance being debited to losses in meters, and the difference between the current at 101 volts we actually give consumers and the current at 100 volts that we charge to them. The 2,268 units lost in the mains represent the amount of energy expended in overcoming the resistance of the mains. The actual quantity not accounted for is, therefore, only 61 units, and I do not think any other company in London can show such a satisfactory result. During the year we have made several extensions of the mains, but by far the principal one was the extension to the Phillimore district, and it was with the special object in view of making this extension that the ordinary preference shares were issued; but before finally deciding to extend to this part of the area, the Directors took great care to ascertain the amount of support likely to be received in the neighbourhood, and on finding that there was every likelihood of obtaining a satisfactory return on the capital outlay, it was decided to carry out the work, and the Directors are pleased to find that their estimate was correct, as we have already a good number of houses connected on the mains of this extension. It was at one time thought that it would be necessary to have a battery station to supply this district, but I am glad to tell you that it was found possible to supply the current required without the aid of this, and we therefore saved a large capital outlay in that direction. Since the end of last year the Company has made a further extension to Observatory-gardens and Observatory-avenue, but in this instance, and in the case of several other small extensions carried out last year, the Directors have obtained advances from those interested at least equal to the bare cost of the work done, to be repaid by not charging the consumers on the extensions for any current consumed until the loan has been paid off, and we find that this plan acts very well. The item of £485. 5s. 7d. in No. VIII. account, debtor side, shows the deposits made in such cases to cover the guarantees. These are only repayable by our not charging the consumers for current till the loan is paid off, so you see the Company does not run any risk with these minor extensions. The guarantees vary in terms according to the necessities of the case, and several have already run off. I think I may say that these few cases are the only ones in which there are any charges on the Company. The cost

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of the Phillimore extension has been about £6,500. The number of houses on the extension already wired and lighted is 17, and the number of lamps reduced to a uniform 16-candle unit is 1,351. The estimated revenue from this extension is £500 in the current year, and £600 in the year 1894. As you are aware, the Directors obtained the sanction of the shareholders in May last to issue the balance of the ordinary shares, amounting to £29,980. in the form of ordinary preference shares, bearing a cumulative dividend of 6 per cent. These shares were in the first place offered to the shareholders of the Company in proportion to their holdings, and up to the 31st December last 796 shares were taken up, representing £7,960, and since that date the Directors have allotted 20 in addition. I think practically the whole of the capital received from the issue of these shares has been spent in making extensions of the mains and in the purchase of additional machinery required owing to the increased area supplied. No money is now owing to Messrs. Crompton and Co., the contractors, for construction though an arrangement was made that the money could have been borrowed in the event of the preference issue not having been successful. Our property, with the trifling exception of the extensions made with private money, as already mentioned, is quite free, being saddled with no mortgages, no debentures, and no charges. When I had the pleasure of addressing you at the general meeting last year we had 77 houses connected to the mains representing 6,056 8 c.p. lamps, which by the end of December last had been increased to 124 houses representing 9,438 8 c.p. lamps, or an increase of 47 houses and 3,382 lights, and I am very pleased to be able to say that so far as the present year has gone the increase in the number of houses in proportion to the whole of last year has been slightly larger, so that if the steady increase is maintained (as we have reason to expect will be the case) we may expect to be very shortly in an extremely sound position and yielding to the shareholders a substantial return on their investments. The present number of lamps on our mains is 9,854, bringing in an estimated revenue of about £3,500 per annum, but by the end of 1893 we may reasonably expect the increase of lamps to be such as to raise the yearly revenue to about £4,000. I am very pleased to say that during the year the mains and machinery have done their work in a most efficient and satisfactory manner, and with the exception of three instances during the winter, when some of the mains were flooded owing to the bursting of the water mains, no accident of any kind has occurred. In each case the flooding of the culverts happened in frosty weather, and the escaping water undermined that particular part of the roadway and filled the culvert with water, consequently making a connection between the strip and causing a loss of 240 units. In the places, however, where these accidents happened the Directors have thought it advisable to specially drain the culverts, and they are also making representations to the London County Council with a view of preventing a re-occurrence of the nuisance, as it appears the real cause of the trouble is the blowing out of the fire plugs, which are old-fashioned wooden ones, and ought to be replaced by something of more modern type. There was, I think, only one other thing which occurred during the year to trouble us, and that was a considerable leakage of water into the basement of the central station which was likely to damage the foundations, and it took us a considerable time to ascertain the source from which this came, but I am glad to say that it was at last discovered, and by constructing some drains just outside the station the leakage has been stopped. There is one thing which has, I regret to say, not quite reached our expectations, that is the yield per lamp per annum. The estimate I gave last year was 10s. per lamp, and from the results obtained by other London companies there was every reason to believe that we should exceed this sum. We find, on going into details, that the actual revenue per lamp per annum is only 7s. It is difficult to account for this difference. Possibly it is owing to Notting Hill being of a higher elevation than that of the surrounding areas, and consequently benefiting more by daylight, and also being less affected by foggy weather. It is also noticed that, as confidence in the stability of the light grows, customers wire their houses and fit up more lamps than they intend to use ordinarily. At first the tendency is only to put lamps where they are wanted almost nightly. Afterwards, when the bugbear of increased expense is found to be a negligeable item, consumers go to the opposite extreme and when they are wiring their houses put up lamps where they are merely decorative, or are only likely to be used on special occasions of balls and receptions. It is with the object of increasing the amount of revenue per lamp that we have instituted a scale of rebates, which, however, consumers do not participate in until their revenue per lamp for the year has reached the standard price of 10s., when a rebate of 5 per cent. is allowed, the highest reduction being 25 per cent., in cases where the average yield per lamp reaches the large amount of 30s.; and when we consider that the average yield per lamp on the whole of the system only reaches 7s. per annum, you can well understand that cases in which the full rebate can be claimed are few and far between. There are 19 consumers who will, according to last year's statistics, benefit by the rebates. One would get a reduction of 25 per cent, one 20 per cent., three 15 per cent., four 10 per cent., and ten would get a rebate of 5 per cent. The total amount of these reductions would be about £75. The Board are now considering a scheme for cutting down the expenditure to the lowest point of safety. I have already dealt with the question of their own remuneration. The other savings that they see their way to, would amount to somewhere about £500 a year, and include giving up the City office, the shop, the stables, &c. As all these reductions will not commence at once, not more than £400 will be saved this year. I have much pleasure in announcing another saving which we shall also get the benefit of next year. Our auditors have, as already stated in the report, reduced their fee from £31. 10s. to £15. 15s. We are now contemplating extending our work westward, and so filling up the remainder of our district. But before going on we are waiting to hear what support we can secure. The contemplated expense will be, with a battery station for the Melbury Road district only, about £16.000. But with the complete installation of boilers, engines, dynamos, batteries, &c., the cost will be about £36,000, as stated in our report for 1891. It will be useless to spend thousands for a revenue which will not even pay the expenses of maintenance of cables, let alone the supply of current. The basis that the Directors go on is that the *gross* revenue should be on such a scale as to repay the actual extra capital expenditure required in from 4 to 5 years. This would mean that (without any increase) they might get 5 per cent. for their *extra* capital at the end of 5 years. If we asked for less than this the business of the Company would be too speculative. Such procedure was unavoidable at the outset when there were no data to go on, but now it would be very wrong not to secure our way as we go along. In conclusion, I would draw the shareholders' attention to the fact that in view of the steady and continued increase in the Company's business, the future prospects of the Company appear very bright, and I hope that on the next occasion when I have the pleasure of addressing you, I shall have to propose a resolution which I regret this year it is impossible to do, namely, the declaration of a dividend, and I now beg to propose :—

"*That the report of the Directors and the accounts to December 31, 1892, submitted to this meeting be, and the same are hereby, approved and adopted.*"

Mr. SIDNEY WATERS, in seconding the motion, said that it was quite evident that the rate of progress in a company of this kind to a very large extent depended on the general commercial prosperity of the country. The Company was just started after the great Baring failure, and since then there had been a period of general depression which had weighed very heavily on the commercial world and the prosperity of England. That period was they hoped now passing away, and with the revival of trade and better times a company of this kind would be the first to benefit. During times of depression people felt reluctant to go to the expense of wiring their houses and incurring any extra expenditure. Now, however, that there were hopes that the depression was disappearing, they hoped that the number of houses that would come on their system would be materially increased.

The resolution was carried *nem. con.*

Mr. J. T. JERVIS proposed and Mr. DUTTON seconded the re-election of the retiring Directors, Prof. Crookes and Mr. S. Waters.

The motion was carried unanimously.

The CHAIRMAN having briefly expressed his acknowledgments on behalf of Mr. Waters and himself,

Mr. BENSON moved the reappointment of the auditors, Messrs. Deloitte, Dever, Griffiths and Co., at a renumeration of 15 guineas.

Mr. ASTON WEBB seconded the motion which was also carried *nem. con.*

Mr. BENSON, in proposing a vote of thanks to the Chairman and Directors for their services during the year, said that these gentlemen had behaved very liberally to the shareholders in remitting a large portion of their fees, without any urgent request from the latter. They had not only done so, but they had postponed the payment of what was legally due to them, for which the shareholders were very much indebted to them. He trusted that the hopes of the Board would be realised, and that they might soon see a dividend on their capital.

Mr. MATTERSON seconded the motion, which was cordially carried.

The CHAIRMAN, in returning thanks for himself and his colleagues, remarked that he did not believe that there was a harder working Board in London, and that it was by reason of their exertions that the Company had been brought into, he would not say such a flourishing condition, but into one so full of promise for the future.

The proceedings then terminated.

Anglo-Portuguese Telephone Company (Limited).

The following report of the Directors of this Company was presented at the sixth ordinary general meeting, held at the offices of the Company on Tuesday last :—

The amount to the credit of profit and loss account, after making all deductions, and including the balance brought from last year, is £6,099. 16s. 3d. The Directors recommend that of this amount £2,500 be applied to the payment of a dividend at the rate of 5 per cent. per annum ; that £2,000 be placed to reserve fund, and that the balance, £1,599. 16s. 3d., be carried forward to the current year's accounts. Acting upon the instructions of the auditors, the assets and liabilities in Portugal have been made up at the exchange ruling on December 31st last.

The expenditure on capital account for the year amounted to £3,256. 4s. 9d.

The number of paying subscribers at December 31st last was—

In Lisbon, 1,066, of a gross annual value of	£7,870	
„ Oporto, 1,125, „ „ „	6,140	
		£14,010

showing a total increase in subscribers of 40 and in value of £274, over the preceding year.

The shareholders will be pleased to learn that a decree was issued in December last by the Portuguese Government dealing with unauthorised lines, and regulating the powers of municipalities where the working of the telephone is concerned, which your Directors hope will have a beneficial effect upon the Company's operations.

The Directors have to record with feelings of deep regret the death, in September last, of their esteemed colleague, Mr. Richard Van Zeller.

At the meeting the dividend referred to in the report was approved, and the report was adopted. Sir Alex. Armstrong and Senhor E. Pinto-Basto were re-elected as Directors, and the auditors, Messrs. Deloitte, Dever, Griffiths and Co., were re-appointed.

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The Consolidated Telephone Construction and Maintenance Company (Limited).

An extraordinary general meeting of the members of the Consolidated Telephone Construction and Maintenance Company (Limited) was held at Winchester house, Old Broad-street, London, on Tuesday, Mr. C. L. W. Fitzgerald presiding.

The SECRETARY (Mr. Chas. Curtoys) having read the notice convening the meeting,

The CHAIRMAN said that they had met simply to confirm the resolution passed at the last meeting. It was a mere matter of form. He would simply say in a few words how that resolution came about. It was because they had received a considerable sum of money from the sale of the Austrian securities which the Consolidated Company held. He need not detain them, and he would merely move the confirmation of the following resolution :—

"*That the capital of the Company be reduced from £207,545, divided into 75,000 Preference shares of £1 each, 75,150 Ordinary shares of £1 each, and 224,850 Ordinary shares of 1/s. each, to £234,938, divided into 47,363 Preference shares of £1 each, and 75,150 Ordinary shares of £1 each, and 224,850 Ordinary shares of 10s. each ; and that such reduction be effected by returning the amount of £1 per share credited as paid upon each of the 27,637 issued Preference shares of the Company to the holders thereof, and thereupon cancelling such shares, and by returning 2s. per share to each of the holders of the 224,850 issued Ordinary shares of the Company, and by writing off each of the said 224,850 Ordinary shares the sum of 2s. per share as being capital unrepresented by available assets.*"

Sir ALEXANDER ARMSTRONG, K.C.B., seconded the resolution.

The CHAIRMAN, in reply to Mr. E. O. Walker, said that the Directors had taken the best legal advice in Vienna on their position. He himself and two of the other Directors went out there, and after ascertaining how matters stood, they decided to take what money they could get rather than risk the uncertainties of the law. They lost nothing in money. They took shares from the Austrian Company for the concessions, therefore they did not lose the money, but did not make so much as they hoped to do. The preference shareholders were paid off because they had a priority of claim.

The resolution was carried, and the proceedings ended.

Chatham, Rochester and District Electric Lighting Company (Limited).

An ordinary meeting of the shareholders of this Company was held at the Sun Hotel, Chatham, on the 21st inst., Mr. H. Jasper in the chair.

The CHAIRMAN, in moving the adoption of the report and balance sheet, said doubtless they would all be surprised, and it was very possible that they would be disappointed, especially having regard to the fact that although the Company had been at work so many years without attempting to declare a dividend, that there was none that year. He must say that he felt very justified on the information he received from the secretary, not only to hope, but to feel assured they would have been in the position to declare a dividend of 2½ per cent. at least. He was sorry that was not the position that day—they were not able to get the figures out at that time accurately. He was basing his figures upon the actual working expenses of the time as they thought they were. Coal, however, and other expenses had been heavier than they thought, and they would see they had only been able to make a profit of £62. When he told them that that profit was made in the last quarter of the year, they would readily understand that it was very difficult to be able to say what amount of profit would be made in this year. They were deceived in regard to the consumption of coal and other expenses, but he was happy to say that their position that day was due entirely to the fact that they had in their Managing Director a gentleman that thoroughly understood the science in which their money was invested. Seeing there was only a profit of £65. 5s. 5d., it was useless to think of dividing that small sum. Their estimate for the year was at the rate of 4½d. per trade unit. An important question arose here—they would ask why was it they were not making a profit; but if they made a profit at 4½d. per unit, it meant that their customers would have to pay more. They found that although their output of electricity was considerable they were getting a small percentage per uuit because of the enormous waste. They had a large number of customers who were consuming more than the Company contracted to supply them. They had also had the assurance of a customer who had put in one of the new meters, that he found that the amount he had to pay by the meter was smaller than he anticipated, and according to what he consumed now he would be paying less with the meter than when under contract, thus the contract was not the most favourable terms for the Company. A considerable number of those meters, the very best and the only meter that was passed by the Board of Trade, would be put in as quickly as possible, to the mutual advantage of the Company and the consumer. They could look forward with confidence to be in a position to declare an interim dividend in June next. He did not suppose it would be more than 2½ per cent. In regard to depreciation, they would have to consider that in the meantime.

A lengthy discussion took place as to the Chairman's having undertaken the responsibility of carrying out the contract for the underground mains, it being contended by some shareholders that his terms were hard upon the Company, as they said he had taken shares to the amount of £8,315 in return for advancing £4,150. It was, however, shown that the secretary had been unsuccessful in his appeals to several capitalists to advance the Company the necessary money at 6 per cent., and as his co-Directors were equally unwilling to assume or share the responsibility for the contract, the Chairman had undertaken it himself in order to save the Company from losing their Provisional Order, which would be the case if underground mains were not substituted for the overhead cables very shortly.

The report was ultimately adopted, and the meeting separated with a vote of thanks to the Chairman and Directors.

The report and balance-sheet contained the following :—

"Your Directors have much pleasure in presenting their fifth annual balance-sheet made up to December 31, 1892, and in calling attention to the fact of their having made a profit upon the actual generation of the electric light of £62. 5s. 5½d. Your Directors were very much in hopes of being able to delare a dividend on the past half-year, but as the profit has only been made upon the last quarter it is not sufficient. They are, however, of opinion that they will be able to declare an interim dividend in June next. This is practically owing to their having secured the services of an eminently qualified electrical engineer in the person of Mr. Mark Henry Hurrell, M.I.E.E., who has been appointed Managing Director, as the profit that has been made has been effected during the latter part of the year since Mr. Hurrell's appointment. Several new customers have been connected up during the past year, and many more are waiting to be supplied as soon as the underground system of mains has been completed. In consequence of the severe frost and heavy rains the main circuits have been delayed, but they are now rapidly approaching completion. A great part of the new machinery is in course of erection at the central station, and the sub-stations are ready to receive the transformers which are now lying at the works ready to be placed in position. Your Directors desire to inform the shareholders that a communication has been received from the Mayor and Corporation of Chatham, inquiring if the Company are disposed to sell the undertaking to the Corporation, and on what terms. In the interest of the shareholders your Directors considered it was inadvisable to enter into negotiations at present, and have informed the Corporation that when the works in progress are completed they will be willing to receive a deputation to inspect same and to confer further upon the subject."

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

THOMAS HOLCROFT AND SONS (LIMITED).—Capital £120,000 in 11,900 shares of £10 each and 1,000 shares of £1 each, electrical, mechanical and general engineers, suppliers of electricity and of light, heat and motive-power generally, &c.

E. C. AND J. KEAY (LIMITED).—Capital £50,000, in £10 shares. Electrical, mechanical and general engineers, at the Cyclops Iron Works, West Bromwich, Staffs. ; the James Bridge Works, Darlaston, Staffs. ; and Princes-chambers, Corporation-street, Manchester.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—The annual return of this Company, made up to March 8, 1893, has been filed. The whole nominal capital of £300,000, divided into 100 founders' and 59,900 ordinary shares of £5 each, has been taken up, the full amount called, and all calls (£300,000) paid.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend for the quarter ending March 31st of 12s. 6d. per cent. on the ordinary stock, and 25s. per cent. on the preferred stock (less income tax), payable on May 1st to the stockholders registered on the books of the Company on March 31st.

BELL TELEPHONE COMPANY (OF AMERICA).—This Company has increased its capital by a further two and a-half million dollars.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended March 26th were £859, as against £818 for the corresponding period of last year, being an increase of £41. The total receipts for half-year amount to £11,270 against £10,222 in the corresponding period of 1892, being an increase of £1,048.

COMPAGNIE FRANCAISE DES TELEGRAPHES SOUS-MARINS.—It is reported that this Company is about to issue 1,500,000fr. of debentures, in order to secure the annual subvention of 200,000fr. to be paid by the French Government on the laying of a cable between New Caledonia and Australia.

COMPANIA GENERAL MADRILENA DI ELECTRICIDAD.—This Company made a net profit last year of £15,600, and a dividend of 6½ per cent. has been declared.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Directors of this Company have resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income tax, being at the rate of 3½ per cent. per annum, for the quarter ended March 31st ; the dividend to be payable on and after April 24th.

GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).—An interim dividend of 2s. 3d. per share has been declared by the Board, payable on the 18th proximo.

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HOBART TRAMWAY COMPANY (LIMITED).—An extraordinary general meeting of this Company is to be held at College Hill-chambers, E.C., on April 6th for the purpose of considering a proposal to change the name of the Company to the Hobart Electric Tramway Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended March 24, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,348.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Mar. 22.	Price Tuesday, Mar. 28.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 28. Highest	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	17/6	Anglo-American	52½ 53½	52½ 53½	5 2 10	Jan., Apr., July, Oct.	.. ..	.. ..
£2,876,140	Stock	35/0	Do. Preferred	92½ 93½	93 94	5 17 0	" "	93½	92½
£2,876,140	Stock	5/0	Do. Deferred	13 13½	13 13½	..	" "	13¼	13
£250,000	100	4%	African Direct, Telegraph 4% Debentures	101 104	101 104	3 16 11	January and July	.. ..	.. ..
130,000	£10	3/0	Brazilian Submarine	11⅞ 12¼	11⅞ 12¼	5 6 1	Mar., June, Oct., Dec.	11⅞	..
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July	.. ..	.. ..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	105 109	105 109	4 11 9	June and December	.. ..	.. ..
$7.716,000	$100	$1¾	Commercial Cable Capital Stock	178 182	178 182	3 16 11	Jan., Apr., July, Oct.	.. ..	.. ..
16,000	10	8/0	Cuba Submarine	11½ 12½	11½ 12½	6 8 0	February and August	12 1/16	11⅞
6,000	10	10%	Do. Preference 10%	18 19	18 19	5 5 3	" "	.. ..	.. ..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2½ 3½	4 11 5	April and October	.. ..	.. ..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	.. ..	.. ..
60,710	20	3/6	Direct United States	11⅝ 11⅞	11⅜ 12	5 16 8	Jan., Apr., July, Oct.	12	11⅞
400,000	10	2/6	Eastern	14⅞ 15⅛	14⅞ 15⅛	4 5 11	" "	15⅛	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	15⅞ 16¼	15⅞ 16¼	3 13 10	" "	16 1/16	16
£1,594,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113 116	113 116	3 9 0	May and November	115	114¾
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	.. ..	.. ..
250,000	10	2/6	Eastern Extension	15¼ 15½	15¼ 15½	4 10 4	Jan., Apr., July, Oct.	15½	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	111 114	112 115	3 9 7	February & August	115¾	113½
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103 106	103 106	4 14 4	January and July	.. ..	.. ..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102 105	102 105	4 15 3	" "	103½	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101 104	101 104	3 16 11	February & August	.. ..	.. ..
180,227	10	1/3	Globe Telegraph and Trust	9⅜ 10	9⅜ 10	4 12 6	Jan., Apr., July, Oct.	10	9 13/16
180,042	10	6%	Do. 6 per Cent. Preference	15½ 15½	15½ 15½	3 17 5	" "	15½	15 7/16
150,000	10	5/0	Great Northern	19½ 19⅝	19½ 19⅝	4 6 1	Jan., April, and July	19¼	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104 107	104 107	4 13 6	March & September	.. ..	.. ..
17,000	25	12/6	Indo-European	44 46	44 46	5 8 8	May and November	45¼	..
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	.. ..	.. ..
£100,000	100	6%	Do. 6 per Cent. Debentures	106 109	106 109	5 10 1	March & September	.. ..	.. ..
10,802	8	4/0	Reuter's	7 8	7 8	..	April and October	.. ..	.. ..
3,381	£100 Cert.	30/0	Submarine Cables Trust 6%	118 123	118 123	4 17 7	" "	.. ..	.. ..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July	.. ..	.. ..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	102	101½
30,000	10	2/0	West Coast of America	2½ 3½	2½ 3½	..	January and July	.. ..	.. ..
£150,000	100	8%	Do. Debentures 8% 1902	105 109	105 109	7 6 10	June and December	.. ..	.. ..
88,321	10	6d.	West India and Panama	1⅜ 1¾	1⅜ 1¾	..	" "	.. ..	.. ..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10⅜ 11¼	11¼ 11⅜	5 2 2	May and November	11⅜	11⅛
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9 10	9 10	6 0 0	" "	.. ..	.. ..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	107 110	108 111	4 10 1	June and December	109½	..
64,242	15	3/0	Western and Brazilian	7⅜ 8½	7⅜ 8½	5 9 1	May and November	.. ..	.. ..
33,129	7½	3,0	Do 5 per Cent. Cumulative Preferred	5⅜ 6½	5⅜ 6¼	6 0 1	" "	6	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2 2½	2 2½	..	" "	.. ..	.. ..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	105 108	5 11 1	February & August	.. ..	.. ..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	105 108	5 11 1	" "	106⅞	..
$1.336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	.. ..	.. ..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	101 104	101 104	5 15 5	March & September	.. ..	.. ..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone (fully paid) .....xd and rights	3 4	3 4	..	..	.. ..	.. ..
22,500	14/0	1½d.	Consolidated Telephone Const. & Maintenance	¼ ⅜	¼ ⅜	1 13 4	May and November	.. ..	.. ..
20,000	£1	4¾d.	Oriental (11s. paid)	⅛ ¼	⅛ ¼	7 18 2	Yearly	.. ..	.. ..
454,747	5	2/6	National	5⅛ 5⅜	5¼ 5⅜	5 9 1	June and December	5⅜	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½ 15½	15 15½	3 17 6	" "	.. ..	.. ..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	14 14½	14½ 14⅝	4 1 4	" "	14½	14⅜
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	5⅜ 5⅝	5⅜ 5⅜	..	..	5⅜	5½
726 477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	113 116	113 116	3 17 7	January and July	114¾	114½
48,000	£10	..	New Telephone, Limited (£4 paid)	.. ..	.. ..	..	..	.. ..	.. ..
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July	.. ..	.. ..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	.. ..	.. ..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	12¼ 12⅝	12 12½	.	—	12 1/16	..
20,000	£10	..	Do. 6 per Cent. Preference	10¼ 10⅝	10¼ 10⅝	2 4 7	..	10⅝	10 5/16
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..	5 5½	..	—	..	—
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	—	..	—
8,332	£5	..	House to House Electric	..	1½ 2½	..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully pd.) xd	..	5⅝ 5⅝	..	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid) .....xd	..	6 6½	..	January and July	..	—
30,000	£5	3/4 '92	Liverpool Electric Supply (£3 10s. paid)	4⅛ 4⅜	4⅛ 4⅜	..	March	..	—
10,000	£5	5/0 '92	Do. (fully paid)	5 1/16 5⅛	5 1/16 5 3/16	..	March	..	—
111,000	5	..	London Electric Supply	⅜ 1⅛	1 1¼	..	—	..	—
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 6⅝	6⅝ 7	..	—	6⅝	6⅜
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5⅛ 6⅛	5⅛ 6⅛	—	—	..	..
18,680	£5	9½%	St. James' and Pall Mall	8¼ 8⅜	8¼ 8⅜	..	—	8 5/8	8¼
7,900	£5	7%	Do. 7% Preference	8 8½	8 8½	4 2 4	—	8 7/8	..
12,853	5	2/0	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 18 4	—	5 13/16	5 11/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/6	Brush Electrical Engineering	3 3½	3 3½	..	—	3¼	3⅛
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2⅛ 2⅜	5 1 1	—	2 3/16	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	103 105	103 105	4 5 9	..	105¼	104½
20,000	5	5/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼ 5⅜	5¼ 5⅜	6 1 9	January and July	.. ..	.. ..
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	—	.. ..	.. ..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..	1⅜ 2¼	..	—	.. ..	.. ..
45,000	10	12/0	Electric Construction	2⅜ 3¼	2½ 3	..	—	2¾	..
70,000	2	10/0	Elmore's Patent Copper Depositing	⅛ ⅜	⅛ ⅜	—	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1½ 2½	1½ 2½	..	—	.. ..	.. ..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	22½ 23½	22½ 23½	5 6 5	February & August	23¾	22¾
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	104 106	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	.. ..	.. ..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	.. ..	.. ..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0 6/0	5/0 6/0	..	..	.. ..	.. ..
78,949	5	4/2½	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	3⅛	..
37,350	12	24/0	Telegraph Construction and Maintenance	34 37	34 37	4 17 3	March and July	34¾	34½
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July	.. ..	.. ..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	—	—	.. ..	.. ..
..	£5	..	Do. Preference (fully paid)	..	..	—	—	.. ..	.. ..
			RAILWAYS AND TRAMWAYS.						
,000	£10	..	City and South London Railway	.. ..	.. ..	..	—	.. ..	.. ..
,000	Stock	5%	Do. Stock	37 39	37 39	2 17 8	May and November	.. ..	.. ..

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EVERED & CO., Ltd.

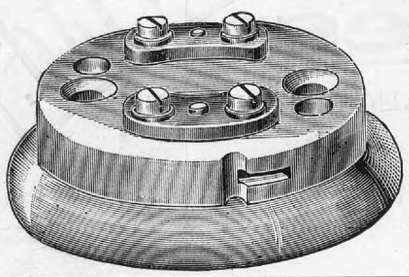
Drury Lane, LONDON, W.C.
AND
Barnet Works, BIRMINGHAM

MANUFACTURERS OF **ELECTRIC LIGHTING ACCESSORIES,**

AND (UNDER LICENCE) OF

LAMP HOLDERS.

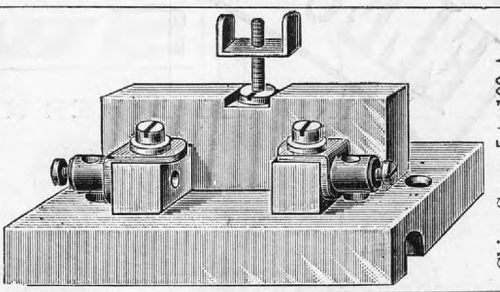
5 AMP. CUT-OUT.



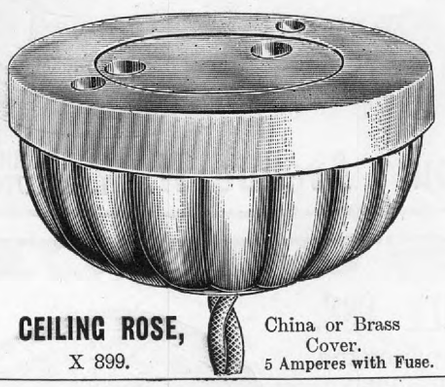
X 896.—Plain or Fluted Brass Dome.

REGISTERED TRADE MARKS EVERED

OBLONG CUT-OUTS.



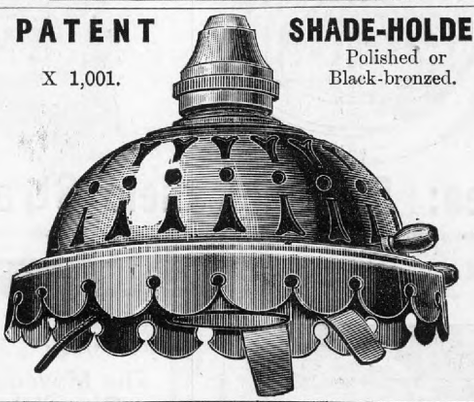
China Cover, 5 to 100 Amp.



CEILING ROSE, X 899. China or Brass Cover. 5 Amperes with Fuse.

PATENT SHADE-HOLDER.

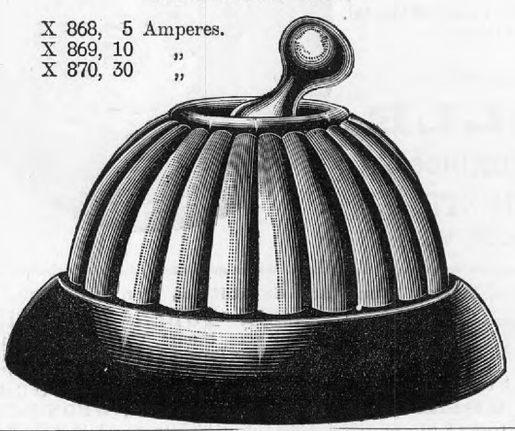
X 1,001. Polished or Black-bronzed.



TUMBLER SWITCH.

Polished Brass Cover.

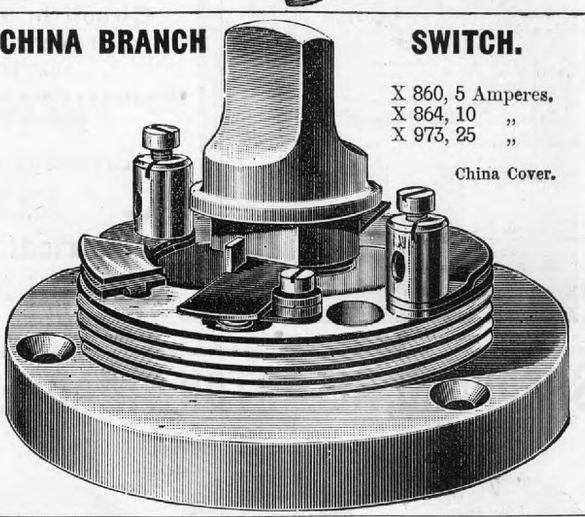
X 868, 5 Amperes.
X 869, 10 „
X 870, 30 „



CHINA BRANCH SWITCH.

X 860, 5 Amperes.
X 864, 10 „
X 973, 25 „

China Cover.

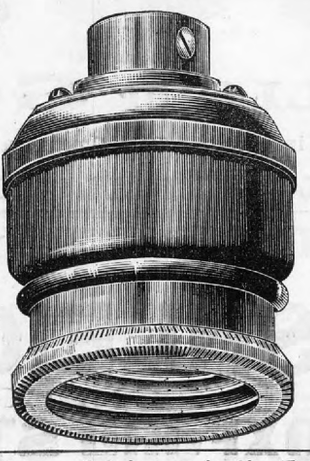


LAMP-HOLDERS FOR BAYONET JOINT LAMPS.

X 900.—Plain holder.
X 901.—With shade-carrier.
X 902.—With cord-grip and shade-carrier.
X 903.—As X 902, but no shade-carrier.
X 906. — Switch-holder.

SPECIAL TERMS TO LICENCEES.

LAMP-HOLDERS FOR EDISON SCREW TERMINAL LAMPS.



X 905. As shown.

X 910.—With key switch.

Showrooms—49 & 50, HOLBORN VIADUCT, LONDON, E.C. Catalogues to the Trade only.

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THE

Contractors to Her Majesty's Government

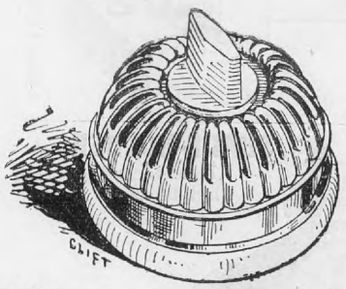
and the Principal Electric Light Companies.

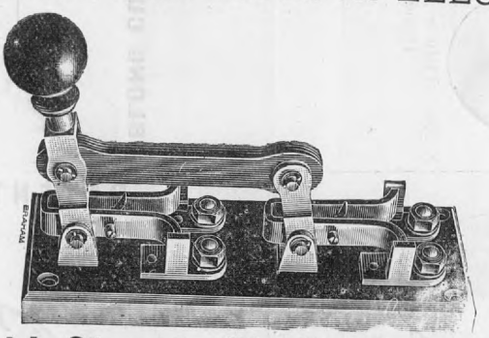
ELECTRICAL ACCESSORIES CO., Ltd.

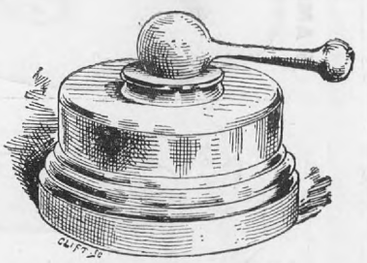
MANUFACTURERS OF

Switches

AND ALL OTHER REQUISITES for ELECTRIC LIGHT.







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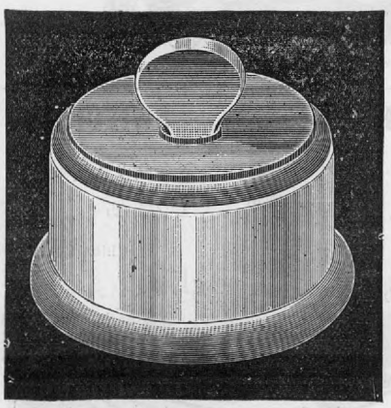

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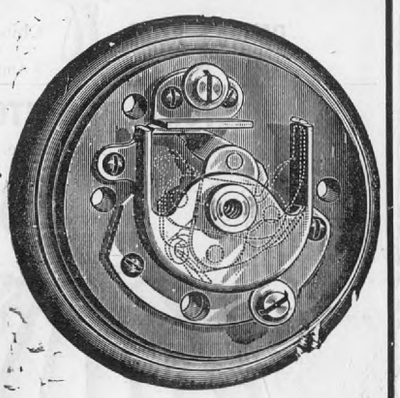

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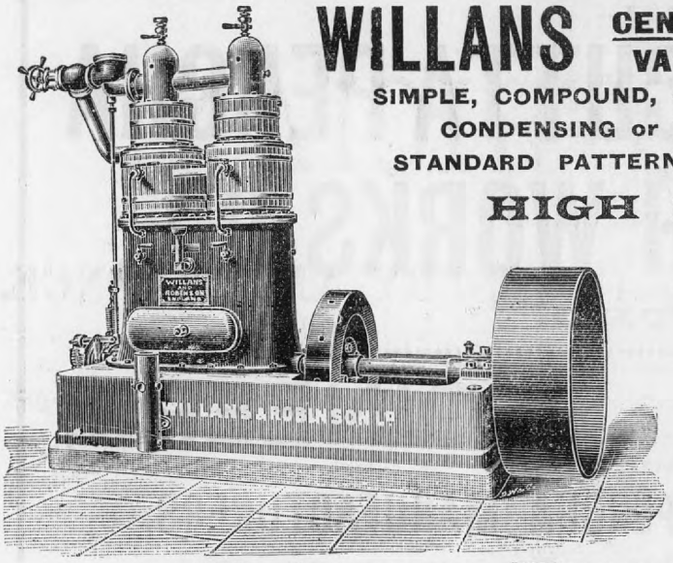

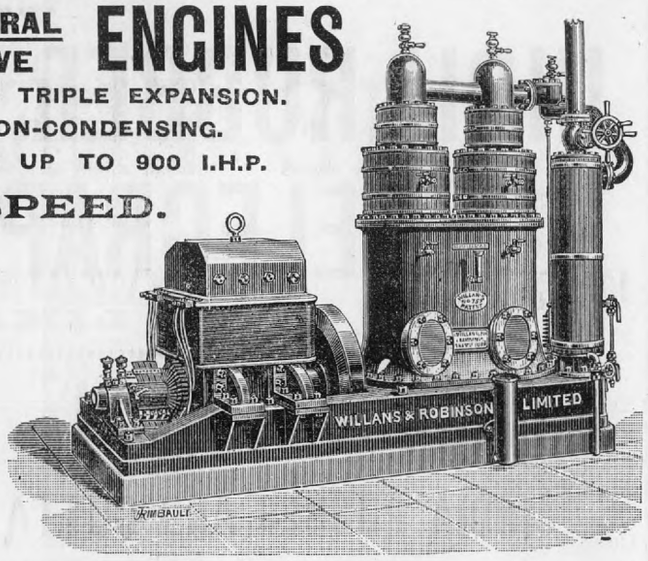

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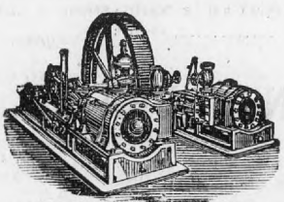

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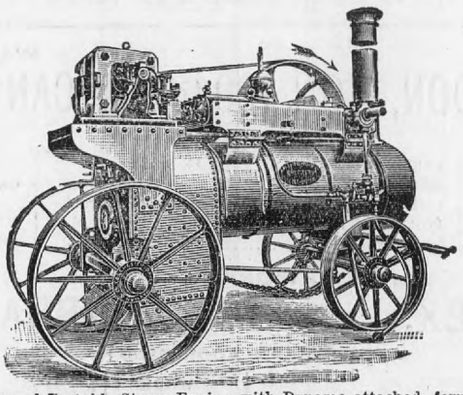

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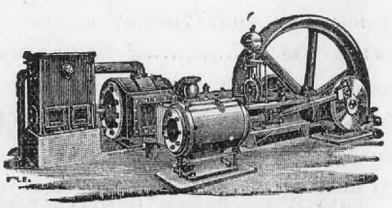

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NOTES.

The accounts of the City of London Electric Lighting Company, referring as they do to a concern still in the preliminary stage, do not present many points of general interest. The capital expenditure up to date is close on £450,000 out of a total received of £480,000. Lands and buildings account for £59,000 in round figures, and machinery of all sorts for £160,000; whilst the main laying operations of the past twelve months and more have cost over £127,000. A large and unique item is that of £57,782 9s. 6d. expended on "Conduits for Telephonic purposes." The Report states that eighteen transformer sub-station sites have been secured; these sub-stations are scarcely of Swinburnian dimensions, each one being of 20,000-light capacity.

As will be seen in another column the Coventry Town Council and Mr. Graff Baker have at last come to an agreement with regard to the electrical equipment of the tramway system of that ancient city, and we may anticipate that by the end of the present year the inhabitants of Coventry will be enjoying the full blessedness of the latest thing in tramways. We can only hope that "in the interests of the beautiful" the unredeemed ugliness of the trolley will be mitigated as far as may be.

Accustomed as are our local authorities to the respectful, not to say humble, tone of aboriginal electrical promoters, Mr. Graff Baker's *brusquerie* must have been a novel experience. The Works Committee wanted to know. They catechised Mr. Graff Baker, and ended up by requesting proof that he had paid £6,000 for the tramways, and that £35,000 had actually been expended on the lines. Now a mere Britisher would in all probability have immediately complied with this not unreasonable demand. Not so the purchaser of the Coventry Tramways. The Works Committee were berated as follows:—"The question of my having paid a certain sum for the line was settled when I stated, either verbally or in writing, that such was the fact, and a request for further proof borders on the insulting, more especially when the confirmation of anything I may have said in connection with this matter could easily be ascertained by any member of the Committee; and generally, the frivolous and trivial points that are raised are not worthy of consideration." However, "all's well that ends well," the "frivolous and trivial points" were considered and conceded and it was found possible to arrive at a satisfactory *modus vivendi*.

The effect of the earth currents due to the absence of an insulated return conductor on the City and South London Railway, to which we called attention a fortnight ago, seemed to be sufficiently serious, but we were quite prepared to learn that it was altogether eclipsed by American experience. The state of affairs in Cambridge, Mass., is recorded in our Notes. More remarkable, perhaps, than the five to ten volts between gas and water pipes on the same premises, is the complacency with which galvanised iron, rustless iron, brass, and lead pipes for the water supply were all tried in vain, the pipes lasting only from one to three months, and then giving way from electrolytic corrosion. The tramway company were notified that their return wires were not sufficiently large; though that, of course, was not so much the cause as that they were not insulated. The result was an overhead return wire. In another Note we record the electrolytic corrosion of water mains in Sault Ste. Marie (Mich.).

A full description of M. Blondel's arc standard of light, to which we referred last week, will be found in another column. Before it can be accepted either as a primary or as a secondary standard, some quantitative information should be given as to the effect of different kinds of carbon. It is not sufficient to learn that the values of the brilliancy sensibly agree. Before a negative result can be accepted, it is necessary, as Prof. Oliver Lodge recently pointed out in a short correspondence in *The Electrician*, to know something of the degree of accuracy with which the observations have been made. Photometry being, perhaps, the least accurate of all physical measurements, the so-called "probable error" is large—the expression, indeed, is a bad one, since the quantity is not probable and it is not an error. In the first place, then, we must learn the magnitude of the probable error in a number of comparisons of an arc with a certain kind of carbon, and these must be compared with the probable error of the whole series of observations. M. Blondel refers only to the general "experimental error." He alludes to it, however, only in connection with experiments with the Le Chatelier pyrophotometer, and we do not learn that any comparison has been made between different kinds of carbon used as arc-standards in the apparatus. For reasons into which we need not at present enter, we are inclined to doubt whether conclusions as to the photometric value of a naked arc can be drawn from results of observations with the Le Chatelier apparatus. The form of photometer shown in the illustration, the most elementary form of Bunsen photometer does not favourably impress us, but it is possible that the

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representation is diagrammatic, though at the same time thoroughly realistic.

While anxious to hear both sides of controverted questions, and unwilling to suppress any author's views, even when they appear to be directly opposed to modern practice, we can, in some cases, only give him a hearing when, at the same time, we criticise or, at all events, call in question some of his contentions. The author may, then, well ask why his contribution should be printed if it fails to meet with approval; but in the case of the article by Mr. Sydney F. Walker which will be found in another column, the writer prefers that his views should be published as they stand, and he is ready to support them. The points which we cannot allow to pass without comment, are the assumptions that casing (or grooved boarding, as Mr. Walker calls it,) may be, and sometimes is, erected in a state in which it can readily absorb water, and that this will "undoubtedly destroy the insulation." In the first place, soft wood moulding is to be deprecated. The best class of work is always done with so-called white wood, and this should be well primed, or should have a thorough coating of knotting. Mr. Walker suggests the use of shellac. Not only is this expensive, but the thorough drying of the wood and the "filling of the pores" with this insulating material is more than can be expected from most contractors. Mr. Walker, in fact, admits that this "may not be the best substance to use on all conditions." What sort of insulation is this that will undoubtedly be destroyed by water? Surely wood casing is only intended for mechanical protection. If a little moisture is likely to do harm, and is to be rigidly excluded, why not go back to the old-fashioned impregnated jute covering? This is all right if moisture *is* excluded. Why should thousands of pounds be spent on high-class vulcanised rubber?

We fail to understand Mr. Walker's remarks about the earthing of an alternate-current circuit. He appears to imply that this cannot be done, because neither conductor "can be at zero when each is in turn positive and negative." We cannot understand his contention or his mode of reasoning, since in practice alternate currents may be, and are, deliberately earthed, and with most useful results. The old bugbear of bad joints in damp places is revived by Mr. Walker, and is adduced as an argument against concentric wiring. We believe that the author has experience in mining work, and in such cases, of course, special precautions are absolutely necessary; but in dealing, as he does, with the general question, it is sufficient to say that in the best systems of wiring, joints, as known in the old days, are the exception—at all events in house work—wires and the main cables themselves branching from distributing fuse boards.

University College, Bristol.—Courses on Civil, Mining, and Electrical Engineering will be held at this College during the Third Term, commencing April 25th.

Guildford.—The Urban Sanitary Authority has decided not to undertake an electric lighting scheme itself, but to allow a company to do so upon the usual terms as to purchase, &c.

Cable Interruptions and Repair—

Cables.	Date of Interruption.	Date of Repair.
Gibraltar-Tangier	February 18th.	March 31st.
Para-Maranham	March 20th.	—

Electrical Bills in Parliament.—On Thursday, the 30th ult., the Hampstead, St. Pancras, and Charing-cross Railway Bill was read a third time in the House of Commons.

The Proposed London University.—A scheme for the organisation of the proposed University for London was adopted at a general meeting of the Association for Promoting a Professional University for London on March 23rd, and has been submitted to the University Commissioners.

Gilbert's "De Magnete."—The following is a transatlantic review of Mr. Mottelay's translation:—"This work is valuable mainly on account of its history, and no doubt those who obtain a copy will derive a great deal of interest in reading its pages. It is bound in white cloth."

Copper Plating.—A method of coating steel with copper is now being developed in New York by Mr. W. B. Hollingshead. The copper is deposited on a sheet of steel by electrolysis, and the sheet is then rolled; after this a second coat of copper is deposited and the sheet rolled again. The deposit thus obtained is said to be firmly adherent.

Birkenhead.—At the monthly meeting of the Town Council the special Sub-Committee stated that it had fully inquired into the matter of electric lighting, and had come to the conclusion that the Corporation themselves should take steps, under the Birkenhead Electric Lighting Order, 1890, and proceed without delay to provide that light within the borough. The minutes of the Committee were confirmed.

The Electrical Utilisation of Water Power.—Next July the water-power station at Sémur, which will then be able to develop some 300 h.-p., will commence to supply current on the high-pressure alternating system to Saulieu, seventeen miles distant, Précy, nine miles distant, and Montbard, eleven miles distant. About 3,000 lamps will be connected. During the daytime current for power purposes will be supplied to the numerous tanneries surrounding Saulieu.

Copper.— Copper consumption has kept well ahead of supply in March, the "actual" deliveries in England and France amounting to 9,190 tons, and the arrivals to 6,591 tons. The quantities advised as afloat at the end of March are slightly in excess of those at the beginning of the month, so that the visible stock has only been reduced by 2,151 tons. This brings the stock down to about the figure at which it stood a year ago, when copper was worth £1 a ton more.

Kingston.—A Local Government Board inquiry into the application of the Kingston Town Council to borrow £16,000 for the purpose of lighting the borough by electricity was held on Wednesday last. The Town Clerk explained that the Corporation had entered into a provisional arrangement with the Surrey County Council to light their new buildings at Kingston with electricity by September next. It was proposed at present to provide 5,000 private incandescent lamps and 40 arc lamps for street lighting. There was very little opposition.

Snowstorms and Electric Tramways.—It is the custom just now to reduce as many things as possible to horse-power and cost, and the two following statements may, perhaps, serve as first approximations of the horse-power and cost of an American snowstorm:—A big storm in Ottawa recently required the electric railway to use 1,000 H.P. to keep the equipment in motion. The 250 miles of track operated by the Twin City Rapid Transit Company were buried under from 2ft. to 10ft. of solidly-packed snow during a storm in February last. The storm cost the Company about $10,000.

H.M.S. "Raleigh" Struck by Lightning.—The cruiser "Raleigh," flag-ship of Rear-Admiral Bedford, on the Cape of Good Hope station, has arrived at Simon's Town after an exciting experience at sea. The "Raleigh" had been on a cruise to the various ports around the West Coast, and after leaving Lagos for Fernandez Po, encountered a tornado. For

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a time there was a continuous blaze of lightning overhead, and the rain fell in sheets. On the following day (Sunday) there was a renewal of the storm, and while the chaplain was conducting Divine service the ship was struck by lightning. It was afterwards discovered that the lightning had affected the ship's compasses.

Telephone Poles.—At a meeting of the Broughty Ferry Police Commission on Monday night last, a lengthy letter from the National Telephone Company was read, setting forth what they had done in the Ferry, and drawing attention to the great inconvenience that would result should the Company be compelled, in consequence of the Commissioners' demands, to close their Exchange. The Commissioners were obdurate, and resolved that the Clerk should be instructed to simply acknowledge receipt of the letter, and refer the Company to the notice ordering the removal of the poles in three months. The Committee appointed by the Commissioners had, it seems, suggested that the Company should give £2 per pole for each pole on the public streets, and 2s. per wire per annum. The Company would not entertain the idea of paying these sums.

Electrolytic Erosion of Water Mains.—The electrolysis of water mains by grounded circuits has been causing some trouble in Sault Ste. Marie, Mich. Dr. F. M. Taylor states in the *Engineering Record* that when the matter was discovered the Department of Public Works was much puzzled as to the cause, but having read that similar phenomena due to electricity had been noticed in other cities, he has become certain that the electric current was the cause of the leaks. The pipes were directly under the railway, and at a depth of about 6ft. The erosion was diffuse and irregular, the holes generally approximating an oval or elongated oval, with the longer axis parallel to the axis of the pipe. The eroded surface was very irregular, pitted, and bright as a new silver coin. The holes were at distances varying from a foot to 2½ft. apart, and on the upper surface. The deeper holes were directly under the rails on each side of the track.

"Installation."—"In the course of an interesting article on electrical nomenclature, brought out by the approaching World's Electrical Congress, *The Electrician* of London," says the *Western Electrician*, "takes occasion to express its disapproval of the word 'installation,' which it styles an 'affected and pompous term.' 'Plant,' 'job,' and 'work,' are mentioned as preferable words for the expression of this idea. We fail to see the force of our contemporary's objection. Even if the proposed substitutes were exact synonyms, which they are not, the only possible criticism of 'installation' would be the unimportant one that it is a polysyllabic word. Webster mentions 'to give a place to' as one of the definitions of the verb 'to install.' That is precisely what is done when an electrical plant is put in or installed, and it is entirely correct to refer to it thereafter as 'installation.' 'Plant' is driven to death, 'work' is awkward, and 'job' is inexpressive, so that 'installation' has an important and useful place."

Electric Traction at Coventry.—At the meeting of the Coventry Town Council on Thursday last week, the General Works Committee presented the following report:—"Your Committee herewith present the agreement which has been arrived at with Mr. Graff Baker with respect to the electrical equipment of the tramways, and beg to recommend that it be approved and sealed." The Mayor, in proposing the adoption of the report, said he thought it dealt finally with a long-standing dispute, and he ventured to say that it dealt with it very satisfactorily. The Council now saw the advantage of having postponed the matter from the last meeting of the Council, because they had had one or two alterations made which would be of advantage to the city. Although some of the members might not think this system the best they could have on account of its appearance, still he thought they had so modified its appearance that they could put up with it until something better presented itself. In that event a provision was made by which they could have an alteration. The report was then adopted.

Trade Advertisement at Technical Societies.—We never know, says *Industries*, quite how far the straightforward system of advertisement adopted in America is to be commended or condemned. For instance, we have just received a copy of a paper read before the American Institute of Electrical Engineers on "Micanite." It is a trade prospectus pure and simple, and is followed by a discussion. Recently, again, there was a paper on the Thomson joulemeter, or watt-meter as it is termed in the United States. In this country we have trade circulars too; but we frequently "assume a virtue when we have it not," and disguise the circular under a thin veil before bringing it before a scientific or technical society. When an English firm desires to push a new insulating material, made, say of mica and cement, or a meter which is devoid of any scientific originality whatever, one of its members reads a paper on "The Dielectric Properties of the Earth Silicates," or "Electrodynamical Means of Integrating Electrical Power," and their goods are thus advertised successfully. The American method is at least more straightforward, though perhaps less dignified.

Electrical Experiences in Minnesota.—Prof. G. D. Shepardson, of the University of Minnesota, gives an account of the electric condition of the atmosphere in Minnesota in the cold, dry weather. His bedroom, he says, has an ingrain carpet, from which he gets marked electrical shocks. On a cold morning he can hardly take a step without being strongly electrified. By shuffling across the carpet, taking only two steps, he has many times drawn a spark one-eighth of an inch long. By taking a dozen shuffling steps and touching the water faucet, he has several times drawn a spark nearly one-half of an inch long. "Indeed it is so common and so excessive that it is quite uncomfortable." It should be stated that this high degree of electrification is not an everyday experience, but it is very common when the thermometer in the room goes below 50 or 40 degrees Fah. A similar experience, says Prof. Shepardson, is very common when putting on a fur overcoat or one simply with a fur collar. The simple rubbing of the fur in putting on the coat will so electrify it that the wearer gets a prickly sensation from the charge from the collar when it is turned up against the neck.

The Birmingham Hydraulic Supply.—At a recent meeting of the Mason College Engineering Society, a Paper on "The Birmingham Hydraulic Supply Station" was read by Mr. Henry Lea. After a brief sketch of the history of modern water-pressure machinery, the author proceeded to describe the Birmingham Corporation Supply Station, which was engineered by Mr. J. W. Gray and Messrs. Henry Lea and Thornbery in conjunction. The station was opened in 1891, and the motive power is derived from Crossley gas engines. Mr. Lea described an arrangement of counters from which interesting figures were obtained, showing that although there is necessarily, at present, much idle running during which the machinery is not actually pumping into the accumulators, the efficiency of the plant is very high, the pumps delivering energy equal to about 60 per cent. of the indicated horse-power of the engines. When pumping continuously the efficiency is as high as 81 per cent. In the use of the high-pressure water for lifting purposes, the cost per ton lifted varies with the quantity of water used per quarter of a year, a sliding scale of charges being adopted; thus about 12 cwt. or eight persons can be raised 40 feet for 1d. when the minimum quantity per quarter is used, and about 3 tons, or, say, 40 persons to the same height when the maximum quantity is used.

Electric Traction and the Earth Return.—The *Street Railway Review* recently circularised the street railways companies of the United States with a view of ascertaining the general drift of opinion on the "ground return" question. The following statements are worthy of notice:—Mr. Charles H. Morse, superintendent of the fire alarm and police telegraph systems of Cambridge, Mass., has found that in various parts of Cambridge the currents of the West End Railway Company, escaping to the water and gas pipes, have prematurely corroded these pipes. Accordingly in April last he notified the West End Company that its return wires were not sufficiently large, and the Company then began to put in overhead return wires upon its principal lines. About two months ago water pipes near the Company's power house in East Cambridge began

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to show leaks. The matter was investigated, and the pipes showed electrolytic action. It appeared that galvanised iron, rustless iron, brass, and even lead pipes had all been tried in vain. Pipes would last only from one to three months, irrespective of the kind. Since then chip-stone and drain pipe have been successfully used to protect the metal pipes from the action of the currents. Mr. Morse states further that he made some surprising discoveries. For example, a number of tests showed a difference of potential of over 40 volts between water pipes in East Cambridge and Cambridgeport. In some parts of the city, water and gas pipes on the same premises showed from 5 to 10 volts difference in voltage. Workmen relaying pipes have seen arcs formed at the joints, and in some instances the current has actually set fire to the hemp packing used in the joints.

Electric Signalling from Captive Balloons.—At a recent meeting of the Royal United Service Institution Mr. Eric S. Bruce delivered a lecture on "Electric Balloon Signalling." The lecturer observed that to obtain altitude for signalling was a decided advantage. Some few years ago it occurred to him to so apply electric flash signalling to a captive balloon that the operator and most of the apparatus might remain on the ground. Several incandescent electric lamps were placed in the interior of the balloon made of a material that was translucent and filled with pure hydrogen or coal gas. By varying the duration of the flashes signalling could take place according to the Morse or any other code. Concerning the chances of a balloon being hit by the enemy, he stated that experiments which took place at Lydd and in Germany had shown that it was almost impossible to hit a balloon until its distance and height were known, while with regard to small-arms fire the damage done by occasional bullets could easily be repaired. Wind was usually considered the bugbear of captive balloons, but his experience with these balloons was that even in our breezy island they could ascend successfully and usefully on a large average of days in the year. The lights in the balloon could, if desired, be turned on continuously, and this continuous illumination had its uses. It would be valuable as a preconcerted signal or as a point light to concentrate troops at night to a given place. Observations and criticisms upon the invention were afterwards made by Lieutenant Baden-Powell, Admiral Colomb, Commander Lionel de L. Wells, Colonel Thackeray, Colonel Keyser (Inspector of Army Signalling), Admiral Sir William Dowell, and others.

Mr. Preece on Lightning Protection.—The editor of *Nature* has been good enough to forward us an advance proof of the following letter:—

In the recent Presidential address to the Institution of Electrical Engineers by Mr. Preece I find the following reference to myself: "Prof. Oliver Lodge has . . . endeavoured to modify our views as to the behaviour of lightning discharges, and as to the form of protectors, but without much success. His views have not received general acceptance, for they are contrary to fact and to experience." I was quite prepared to laugh at this with the rest, but I find that the general and semi-scientific public are apt to take Mr. Preece's little jokes, of which there are many towards the end of this address, as serious and authoritative statements of scientific fact. And it has been represented to me that unless I take some notice of the above, it may be assumed that I wish silently to withdraw from an untenable position without acknowledging having made a mistake. Indeed, I have already been questioned by a scientific worker as to whether I accepted the above statement as in any sense corresponding to truth. My reply is, that so far was I from that attitude that I did not suppose that the statement was either meant or would be taken seriously. The broad question of scientific fact is this:—Given an electrostatic charge at high potential, can the potential be reduced to zero most quietly and safely by a good conductor or by a bad one? The old lightning-rod doctrine (or drain-pipe) theory said, by an extravagantly good one. I say, by a reasonably bad one. If you employ too good a conductor the mean square of current is appallingly strong, and all manner of dangerous oscillations are set up; whereas in a bad conductor the discharge can be more nearly dead-beat. These oscillations have been experimentally and mathematically demonstrated in a great variety of ways, the unexpected and distinct effects they are able to produce have been displayed, and Messrs. Whittaker have published for me a large book about them. Some critics have sensibly objected that the book is too big, but I am not aware of any scientific authority who controverts my position. If Mr. Preece only means that these views regarding lightning and its dangers are not yet practically accepted by the great British Telegraphic Department, that is, I admit, perfectly true.—OLIVER LODGE.

Electricity on Warships.—In a recent Paper on "The Transmission and Distribution of Power in Modern Ships," Signor Nabor Soliani, of the Italian Admiralty, discusses the pros and cons of electric power. He points out that the erection of electrical circuits offers but little difficulty, the wires being easily bent as desired, easily passed through anywhere, and easily joined again in case they should break. Electric motors neither radiate heat nor leak hot water, and the manipulation of a switch is sufficient to start, accelerate, slacken, or stop the movement of the motor. On the other hand the disadvantage of the high speed of motors which either greatly limits their utilisation or involves cumbersome gearing is insisted on, as is also the difficulty of locating faults in electric circuits Electric circuits are moreover very liable to suffer from inrushes of water. Finally, electric-motors are not very well adapted for machinery designed to operate, for instance, the rudder, the anchor, &c., in which the resistance to be overcome might suddenly change, resulting in an enormous rush of current, damaging alike to generator, motor, and conductor. Signor Soliani is, therefore, inclined to think that, upon the whole, the area of electrical applications on board ship is not so extensive as it might at first sight appear, and that great improvements must be made before electricity can supersede those other means which are now used for the transmission and distribution of power. He further points out that at present a very low potential of only 65 volts is used, which, for electric lighting, is suitable; but would no longer be adequate in the case of a general system of transmission and distribution, on account of the enormous current which it would be necessary to transmit.

The Elevated Electric Railway at the Chicago Exhibition.—The general public, as well as railway men and members of the electrical fraternity, are much interested, says the *Western Electrician*, in the elevated electric railway now nearing completion at the World's Fair grounds. The line is being constructed by the Western Dummy Railroad Company, which is merely an offshoot of the General Electric Company. The line is three and one-tenth miles long, double tracked, with loop terminals. The foundations for the structure are generally concrete, 7ft. by 7ft, and one foot deep, placed about 4ft. below the surface of the ground. The spans are generally 25ft. The lowest part of the structure allows 12ft. head room, and in the highest 27ft. The gradients have been designed as far as possible to allow an ascending gradient approaching each station. The heaviest gradient is 1½ per cent. The boiler house contains 10 300-H.P. Babcock and Wilcox boilers. Oil will be burned as fuel. The engine room contains a 2,000-H.P. Reynolds-Corliss cross compound condensing engine, coupled direct to a 1,500-kilowatt Thomson-Houston multipolar generator. This dynamo is the largest on the World's Fair grounds. The armature shaft alone weighs 65 tons. It is of solid steel, 24in. in diameter. At one end of the building is a 750-H.P. Reynolds cross compound engine coupled direct to a 500-kilowatt Thomson-Houston multipolar generator with an over-hung armature. Midway between this engine and the largest engine is located a 750-H.P. Hammond-Williams compound, condensing, vertical engine, coupled direct to a 500-kilowatt Thomson-Houston multipolar generator. At the other end of the engine room there is a 750-H.P. tandem cross compound condensing Greene engine, belted direct to a 500-kilowatt Thomson-Houston multipolar generator. Between the Greene engine and the Allis engine is placed a 400-H.P. tandem compound condensing engine, coupled direct to a 200-kilowatt Thomson-Houston multipolar generator. The rolling stock will consist of about eighteen trains, each consisting of four cars, the first car in each train being equipped with four motors. The motors have a nominal horse power of about 133 each, making a total of 532 to each train. The cars are to be controlled on the series-parallel principle, the motors being placed in series at the start and gradually thrown into parallel. The cars are equipped with air brakes of the latest design, they are 47ft. long, and will seat 96 people. The conductor for carrying current from the power station to the trains consists of a 60-pound steel T rail, mounted on insulated blocks and placed outside the track. The current is carried from this rail to the car by means of a sliding copper shoe, which rests on the top of the rail and is held in contact with it by a spring. The current is returned through the iron structure.

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ELECTROMAGNETIC THEORY.—XLVII.

BY OLIVER HEAVISIDE.

(*Continued from page 594.*)

§ 193. Coming now to the effects produced on electromagnetic waves by a small amount of conductivity, to be afterwards increased, we shall adopt a particular device for simplifying the treatment. Imagine, first, the dielectric medium to possess a uniformly-distributed small conductivity. Evidently, the action of the conductivity on a wave is a continuous and cumulative one. Next, localise the conductance in parallel sheets—that is, substitute for the uniform conductivity a great number of parallel plane conducting sheets, between which the medium is non-conducting. If we increase their number sufficiently, their action on a wave whose plane is parallel to that of the sheets will approximate, in the gross, to the effect of the uniform conductivity which the conductance of the sheets replaces. We have, therefore, to examine the influence of a single very thin conducting sheet upon a wave. This is not difficult.

Imagine, then, a simple plane electromagnetic sheet to be running through the ether at the speed of light. This is the natural state of things; and, in the absence of conductivity or other disturbing causes, there will be no change. Now insert a plane conducting sheet in the path of the wave. It should be so thin that the retarding effect of diffusion within it is quite insensible. Let the wave strike it flush. The theory shows that it is immediately split into two similar waves, one of which is transmitted beyond the plate, whilst the other is reflected. The transmitted wave differs from the incident in no respect except strength. It is attenuated in a certain ratio depending upon the conductance of the sheet, being greatly attenuated when the conductance is large, and slightly attenuated when it is small. The formulæ are reserved. This transmitted wave moves on just as the incident wave did, and nothing further happens to it. The reflected wave, on the other hand, having its direction of motion opposite to that of the incident and transmitted waves, travels back the way it came, and nothing further happens to it.

The direction of the magnetic force in the three waves is the same. This is one general property, irrespective of the amount of conductance. But a much more striking one connects the intensity of the magnetic force in the three waves. The sum of the intensities in the reflected and transmitted waves equals the intensity in the original incident wave. That is, the conductance, with dissipation of energy, has had no effect whatever on the total induction. It has merely redistributed it, by splitting it into two parts, which then separate from one another. The "number of tubes" in the reflected wave may be made to bear any ratio we please to the number in the transmitted wave by altering the conductance of the plate; but their sum is always exactly the number of tubes in the incident wave. This property exemplifies, in a manner which may be readily understood, the persistence of induction, in spite of conduction and waste of energy.

But as regards the displacement, the case is quite different. From the fact that the reflected wave runs back, whilst its magnetic force preserves its original direction, we see that the electric force must be reversed. On the other hand, it is unchanged in the transmitted wave. If, then, their sum equalled the electric force in the incident wave, it would imply that the transmitted wave was of greater amplitude than the incident. But it is smaller, invariably. So there is a loss of displacement. Thus, if H in the incident becomes $(1-n)$H in the transmitted wave, where n is some proper fraction, it becomes nH in the reflected wave. At the same time E in the incident becomes $(1-n)$E in the transmitted, and $-n$E in the reflected wave. The loss of E is, therefore, $2n$E, or the loss of displacement is $2n$D. By the loss we mean the excess of the displacement in the incident over the sum of the displacements in the two resulting waves, transmitted and reflected. This loss occurs at the very moment the incident wave coincides with the plate. The plate itself may be regarded as a dielectric homogeneous with the ether outside, or perhaps of different permittivity, but with the conducting and dissipating property superposed. When thin enough, the permittance of the plate is of insensible influence, and may be disregarded. But strictly, a conducting dielectric is a dielectric which cannot support displacement without wasting it, so that a continuous supply of fresh displacement is needed to keep it up. The rate of waste of energy is proportional to the electric stress.

But it should be carefully noted that the loss of energy and the loss of displacement are entirely distinct things, which are not proportional; and that the loss of displacement itself may sometimes require to be understood in a somewhat artificial sense. For the loss may be greater than what there is to lose. It must then be understood vectorially. This occurs when n is greater than $\frac{1}{2}$. When $n=\frac{1}{2}$, the reflected and transmitted waves are equally strong, and only differ in the direction of the displacement. The loss of displacement is, therefore, complete. The loss of energy in the plate is simultaneously at its maximum, being equal to one-half of the energy of the original wave. If we reduce the conductance of the plate, we increase the transmitted wave, and reduce the waste of energy in it and the loss of displacement. The amount of the latter still remains positive, therefore, assuming it to be positive in the incident wave. The extreme is reached when the plate has no conductance. Then the incident wave goes right through without any splitting and reflection, and therefore without attenuation, and there is no waste of energy. On the other hand, if we increase the conductance above the critical value making $n=\frac{1}{2}$, we reduce the transmitted wave and increase the reflected, whilst we simultaneously reduce the waste of energy in the plate and increase the loss of displacement. The extreme is reached when the plate is a perfect conductor. There is then no transmitted wave and no loss of energy, whilst the reflected wave is of full size, but with the displacement reversed as compared with the incident, so that the loss of displacement, in the sense described, is the greatest possible, viz., 2D.

It will be seen from these details that whilst the absorption or dissolving of induction by conductance is a myth, the idea of an absorption of displacement is not without its inconveniences when the conductance is great, and that this becomes extreme when there is really no loss of energy in the plate, when, in fact, the incident wave does nothing in it, but is wholly rejected with its displacement reversed. It seems, then, more natural to consider the waste of energy from the field caused by the plate as loss. This takes place equally from the electric and magnetic energies, since they are necessarily equal in every one of the three waves. But in the application made later, the plate is to have very slight conductance (in the limit an infinitely small amount), so that the total displacement cannot change sign, but merely suffers a slight loss. Then the idea of loss of displacement by conductance becomes useful again.

The loss of energy takes place as the incident wave is traversing the plate. Its successive layers each cause a minute attenuation of the wave passing, and this applies equally to the induction and displacement, so that the transmitted wave emerges from the plate a pure electromagnetic wave, a reduced copy of the incident. The successive layers, too, each cast back a minute portion of the wave traversing them, with unchanged sign of the induction, but with displacement reversed; and these rejected fluxes make up the reflected wave. There are evidently residual effects due to the internal reflections of minute portions of the main reflected wave, but these residuals tend to vanish when the plate is thin enough.

If the plate be a magnetic instead of an electric conductor, the theory is quite similar. The transmitted wave is an attenuated continuation of the incident. The reflected wave is also a copy of the incident, also reduced. But it is now the induction that suffers loss, because its direction in the reflected wave is opposite to that in the incident and transmitted. On the other hand, the displacement now fully persists, being merely split into two parts by the plate.

Notice that if the plate be both an electric and a magnetic conductor, its attenuating effect from these two causes on the transmitted wave will be additive, so that it will emerge a pure wave with extra attenuation. But as regards the reflected wave, we have a peculiar result. The action of the magnetic

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conductance is to reverse the induction whilst keeping the displacement straight; whilst that of the electric conductance is to reverse the displacement and keep the induction straight. The result is that the reflected wave is reduced in magnitude by the addition of magnetic conductance to previously existent electric conductance. With a proper proportioning of the two conductances, the reflected wave may be brought nearly to evanescence from a plate of finite conductance. In the limit the compensation is perfect, and the incident wave goes right through without reflection, though it suffers extra attenuation. This is the explanation of the distortionless propagation of waves in a dielectric medium possessing duplex conductivity, electric and magnetic. Whilst there is no reflection in transit, there is a continuous loss both of displacement and of induction.

§ 194. Now return to the case of electric conductivity alone, and, as described, let it be locally condensed into the conductance of any number of parallel plates. We know that the effect of any one of them on a thin electromagnetic sheet is to split it, as previously described. If we like, therefore, we can follow each of the resulting waves, and observe how they are, in their turn, split by the first plates they meet, giving rise to four waves, to be a little later split into eight, and so on. This process may seem cumbrous, but it is also an instructive one.

Thus, consider what happens to the total induction. We know that it persists in amount and direction when a single split occurs. Now the same property applies to every successive split a wave suffers in our dielectric medium containing parallel conducting plates. So the total induction remains constant. It is redistributed and spreads out both ways, but without the least loss. There is a small loss of energy at every split, but this does not affect the total induction. This applies when we start from a single pure electromagnetic sheet moving either way. It therefore applies when the initial state consists of any number of such sheets, of any strengths, forming a perfectly arbitrary initial distribution of induction and displacement in parallel plane layers. There is still persistence of the induction. Finally, the same applies when we split up the conducting plates themselves into plates of smaller conductance, and spread them out at uniform distances. The ultimate limit of this process is reached when the conductance is quite uniformly spread, so that we have a perfectly homogeneous medium under consideration. It is, fundamentally, a dielectric propagating disturbances at speed v; but it is, in addition, a conductor as well and distorts the waves and dissipates their energy. The speed v is $(\mu c)^{-\frac{1}{2}}$, with the proper values of μ and c. The conductivity does not interfere with this property of propagation at finite speed. But observe that if we choose to ignore the displacement, then the corresponding speed is infinitely great. We conclude from the above that plane sheets of induction in electric conductors always preserve the total induction constant in amount, irrespective of the amount of elastic displacement, or whether there is any at all. That is, induction cannot be destroyed by conductance.

If then, it suffers destruction, this must be due to some other cause. It may be merely a cancellation by the union of oppositely-directed inductions. This may be termed a vectorial cancellation. It may occur, of course, with plane strata of induction. Thus if, in an infinitely large conductor, the total induction be initially zero, which does not require the induction density to be zero, the final effect will be a complete annihilation of the induction by mutual cancellations. Should, however, the total induction be not zero, it will persist. The induction density will tend to zero, but that will be merely on account of its attenuation by spreading, not because there is any destruction by the conductance or resistance when either of them is finite. To prevent the attenuation to zero we may interpose infinitely conducting barriers, one on each side, in planes parallel to the sheets of induction. Then the final result will be that the induction will spread itself out uniformly between the barriers and maintain a finite density.

To illustrate this property in a somewhat less abstract manner, consider a large ring, say of copper, though iron will do equally well except as regards some complications connected with its magnetisation. Let it be inductised by an enveloping coil-current so that the induction goes along the core in a complete circuit. When it is steadily set up, if we remove the coil-current (and the coil too, preferably for our present purpose) the induction in the core will, in time, all come out of it. But if we clap an infinitely-conducting skin upon the core, it will not come out. Then we have a certain flux of induction locked up, as it were, in a conducting material, which has no effect upon it. It can neither be destroyed by the conductance of the core nor can it get through the perfectly-obstructive skin. If the skin is clapped on after the induction has partially escaped (which escape begins on the outside, before the interior is sensibly affected), there is a redistribution of induction, which continues until a new state of equilibrium is reached. During this process there is electric current in the core and some waste of energy. But there is no waste of the induction. The final induction is the mean value of the original induction across the section of the core.

In further illustration, let the core be hollow and be inductised circularly—instead of along its length—by means of two currents on its boundaries, inner and outer, oppositely directed, following the length of the core. When this is done, remove the currents and clap on perfectly conducting skins internally and externally. There will be a similar persistence of the induction, although its tubes now go round the inner boundary circularly. There may be an initial settling down, but the outer skin will not let the induction expand outwardly, and the inner skin will not let it contract inwardly. If the latter could happen we might have cancellation. To get this effect remove the inner skin. Then, whether we fill up the hollow with finitely conducting matter or leave it nonconducting, we allow the induction to spread internally and permit cancellation. The induction will now wholly disappear, in spite of the external skin. That is to say, there will be a continuous passage of the induction out of the initially inductised region, accompanied by electric current therein, which will continue until the whole of the magnetic energy is wasted as heat in the core.

The same property is exemplified, though in a less easily understandable manner, with a single closed line or circuit of infinite conductance. If it embrace a certain amount of induction it will always do so, in the absence of impressed force to alter the amount. The induction is locked in and cannot pass through the infinitely-conducting circuit to dissipate itself. If the conductance of the circuit be finite, then it can get through. The time-constant varies as the conductance. The disappearance of the induction is manifested by the waste of energy in the circuit, the electric current in which is supported by the voltage of the decreasing induction through it. But the current is there all the same (measured magnetically) when the conductance is infinite. The induction is steady, and there is no voltage in the circuit. But none is needed.

On the other hand, if there is initially no induction through the circuit, there will continue to be none when the magnetic field is created in its neighbourhood. But although the tubes of induction cannot cut through the infinitely conducting circuit so as to make the induction through it be a finite quantity, yet they do pass through a surface bounded by the circuit, as much positively as negatively. The resulting induction distribution is to be got by superimposing the external induction and that due to a current in the circuit of such strength as to make the total induction through it be zero. The property is a general one, for if the circuit be moved about in a magnetic field, there will always, in virtue of its impermeability to the magnetic flux, be zero total induction through it if its conductance be infinite; whilst if it be finite but great, there is an approximation to this result so long as the motion is kept up, or the external field be kept varying. At the same time, the least amount of resistance in the circuit will be sufficient, if time enough be given, to allow the external induction, when due to a steady cause, to get past it to the full extent, when of course the current in the circuit will cease.

In a similar manner, displacement can be locked up by a circuit of perfect magnetic conductance. There is also persistence of displacement in spite of a finite degree of magnetic conductivity in a continuous medium, unless it be electrically conducting as well.

(To be continued.)

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ALTERNATING CURRENTS AND ROTARY FIELDS.

BY ALEX. RUSSELL.

As the recent improvements in alternate-current motors ensures for them a large and increasing use in the near future, it is important that engineers should have a good working knowledge of the action of alternating currents of electricity. To obtain this an elementary knowledge of trigonometry and mechanics is quite sufficient.

An alternating electric current is one that flows for a small fraction of a second in one direction, and then, for an equal time, in the opposite direction, these changes in the direction of the flow taking place many times in a second.

A good way of picturing to the mind the instantaneous values of an alternating current is to consider a point P (Fig. 1) revolving round a circle whose centre is O, and whose radius O P is the maximum value of the current which we shall denote by I. Then, if we draw a perpendicular P N on a fixed diameter A A′ of the circle, we can represent the current by the line O N, the current being positive when N is to the right of O and negative when N is to the left. If the point P goes n times round the circle in a second, then the *frequency* of the alternating current is n. The *period* of the alternating current is the time P takes to make one revolution. It evidently is equal to $1/n$.

The *phase* of the current O N is the angle P O A, or it may be defined as the fraction of the whole period that has elapsed since the current last had its maximum positive value.

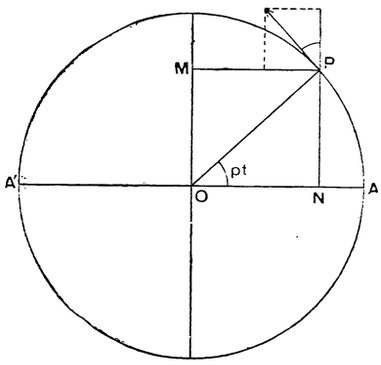

FIG. 1.—As P rotates round the Circle, O N represents the Instantaneous Value of the Current.

In general, the speed of P varies in one revolution and depends on the phase of the current, but we can arrive at approximate and very useful results by considering the speed of P to be constant and equal to its mean speed. Since the circumference of the circle is 2π I, the mean speed of P is $2\pi n$ I, remembering that speed is measured by the number of units of space described per second. If i represent O N, the instantaneous value of the current at the time t, then $i = \mathrm{I}\cos$ P O N. Now the circular measure of the angle P O N is $\frac{\text{arc}}{\text{radius}} = \frac{2\pi n \mathrm{I} t}{\mathrm{I}} = 2\pi n t = p t$ (say). Hence $i = \mathrm{I}\cos p t$.

If we measure the current by an alternating current ammeter, what we measure is the square root of the mean square of the current. We shall first consider what is the value of the mean square of the current. By a well-known formula in trigonometry,

$$\mathrm{I}^2\cos^2 p t = \tfrac{1}{2}\mathrm{I}^2 - \tfrac{1}{2}\mathrm{I}^2\cos 2 p t.$$

Now, for a complete period the mean value of $\frac{1}{2}\mathrm{I}^2$ is $\frac{1}{2}\mathrm{I}^2$, since I does not vary with t, and the mean value of $\frac{1}{2}\mathrm{I}^2\cos 2 p t$ is zero, since there are as many negative as positive values. Therefore the mean value of i^2 is $\frac{1}{2}\mathrm{I}^2$. If A be the direct current which would give the same reading on the ammeter, then $\mathrm{A} = \sqrt{(\frac{1}{2}\mathrm{I}^2)} = 0{\cdot}707\,\mathrm{I}$. A may be called the effective value of the current.

In a circuit a direct current does not instantaneously rise to its maximum value, owing to the self-induction of the circuit. The effect of self-induction is to bring into existence a counter E.M.F., whose magnitude is directly proportional to the rate at which the current O N changes. In other words, this E.M.F. equals some constant multiplied by the rate of change of O N. This constant is defined to be the coefficient of self-induction of the circuit. We shall denote it by L.

Then E.M.F. of S.I. $= \mathrm{L} \times$ rate of change of O N,
$= \mathrm{L} \times$ velocity of N,
$= \mathrm{L} \times$ horizontal component of vel. of P,
$= \mathrm{L} \times 2\pi n \mathrm{I} \sin$ P O N,
$= \mathrm{L} p \mathrm{I} \sin p t.$

As the current is diminishing this E.M.F. is positive. If e be the applied E.M.F. and R the resistance of the circuit, we obviously have, by Ohm's law,

$$\mathrm{I}\cos p t = \frac{e + \mathrm{L} p \mathrm{I} \sin p t}{\mathrm{R}};$$

$$\therefore e = \mathrm{R}\,\mathrm{I}\cos p t - \mathrm{L} p \mathrm{I} \sin p t,$$

$$= \sqrt{\mathrm{R}^2 + \mathrm{L}^2 p^2}\,.\mathrm{I}\left\{\cos p t.\frac{\mathrm{R}}{\sqrt{\mathrm{R}^2 + \mathrm{L}^2 p^2}} - \sin p t.\frac{\mathrm{L} p}{\sqrt{\mathrm{R}^2 + \mathrm{L}^2 p^2}}\right\}$$

$$= \sqrt{\mathrm{R}^2 + \mathrm{L}^2 p^2}\,\mathrm{I}\cos(p t + \alpha),$$

where $\tan\alpha = \mathrm{L} p/\mathrm{R}$.

Thus the phase of the E.M.F. is in advance of the phase of the current. The effect of self-induction is, therefore, to make the phase of the current lag behind the phase of the E.M.F. by an angle whose tangent is $\mathrm{L} p/\mathrm{R}$. We shall now consider what happens when a condenser C is put in the circuit. If Q be the quantity of electricity in the condenser at any instant, then we know by the definition of current that the rate at which Q is stored up in the condenser is equal to $\mathrm{I}\cos p t$. But from the figure the rate at which $\mathrm{I}\sin p t$ (O M) increases with t is equal to the vertical velocity of P is equal to $p\,\mathrm{I}\cos p t$. Hence the rate at which $\mathrm{I}/p \sin p t$ increases with t is equal to $\mathrm{I}\cos p t$. Therefore, $\mathrm{Q} = \mathrm{I}/p \sin p t +$ some constant. If $\mathrm{Q} = 0$ when $t = 0$, $\mathrm{Q} = \mathrm{C}\,\mathrm{E}' = \mathrm{I}/p \sin p t$, where E′ is the potential difference between the terminals of the condenser. Thus, $\mathrm{E}' = \mathrm{I}/c p \sin p t$.

Hence, if we have a circuit having self-induction and capacit in series,

$$\mathrm{I}\cos p t = \frac{e + \mathrm{L} p \mathrm{I}\sin p t - \mathrm{I}/c p \sin p t}{\mathrm{R}},$$

$$\therefore e = \mathrm{I}\{\mathrm{R}\cos p t - (\mathrm{L} - 1/c p^2)\, p \sin p t\},$$

$$= \mathrm{I}\sqrt{\mathrm{R}^2 + (\mathrm{L} - 1/c p^2)^2 p^2}\cos(p t + \beta),$$

where $\tan\beta = \dfrac{(\mathrm{L} - 1/c p^2) p}{\mathrm{R}}$.

The form of this result shows us that the presence of the condenser is the same as if we had a resistance coil whose resistance was zero and coefficient of self-induction $-1/c p^2$. If we put both R and L equal to zero in the last formula, we see that the phase of the current is in advance of the phase of the E.M.F. If we had n condensers, $c_1\, c_2 \ldots \mathrm{C}_n$, in series, they would act like a resistance coil $[0, -1/c_1 p^2 - 1/c_2 p^2 - \ldots]$. It follows that the n condensers act like a single condenser whose capacity is C, where

$$1/\mathrm{C} = 1/c_1 + 1/c_2 + \ldots + 1/c_n;$$

a well-known theorem in statical electricity.

We have still to show how alternating currents of the same period combine.

Let O L, O M (Fig. 2), represent instantaneous values of two currents, whose phase difference is the angle A O B, O A and O B being the maximum values of the currents. Describe a parallelogram on O A and O B as adjacent sides, and let O R be its diagonal; then, if we draw R N at right angles to O X,

$$\mathrm{O\,N} = \mathrm{O\,L} + \mathrm{L\,N} = \mathrm{O\,L} + \mathrm{A\,K} = \mathrm{O\,L} + \mathrm{O\,M}.$$

Hence O N, which is equal to the sum of the currents O L and O M, is their resultant, and the maximum value of this resultant current is O R. If there had been a third current O C, the resultant of the three would be determined by the diagonal of the parallelogram described on O R and O C as adjacent sides, and so on for any number of currents. Since the effective values of the alternating currents are proportional

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to their maximum values, their resultant is found in the same way. For example, suppose the effective values of the currents in a divided circuit are A′ and A″, and their difference of phase is α. Construct a parallelogram, the lengths of the adjacent sides being A′ and A″, and α being the angle between them; then the length A of the diagonal of this parallelogram gives us the effective value of the main current, and the phase differences between the currents are given by the angles between the sides and diagonal of this paralellogram. Conversely, if we are given the main current and the phase differences, we can find the branch currents by this parallelogram construction.

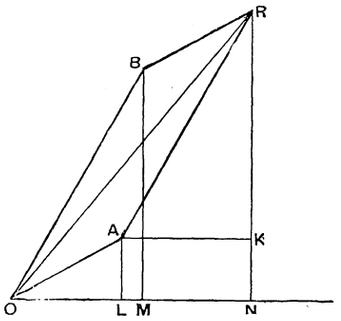

FIG. 2.—Method of Compounding Alternating Currents.

When a direct current A′ and an alternating current i are superposed, the instantaneous value of the current is $A'+i$. To get the reading on an ammeter in the circuit, we have to consider the mean value of $(A'+i)^2$ for a period. Now, $(A'+i)^2 = A'^2 + 2A'i + i^2$, and the mean value of this expression is $A'^2 + A^2$, for $2A'i$ has as many positive as negative values. Hence, the reading on the ammeter is $\sqrt{A^2 + A'^2}$, A being the effective value of the alternating current.

The reading on the ammeter would be the same, if, instead of a direct current A′ and an alternating current A, we had two alternating currents A and A′, whose phase difference was 90deg.

Exactly similar theorems hold for compounding alternating E.M.F.s. If an alternating E.M.F. has a maximum value E, then the effective value $V = 1/\sqrt{2}\,E = 0{\cdot}707\,E$; and if the potential difference between the terminals of an electrostatic voltmeter be $V' + E\cos(pt+\alpha)$, then the reading on the voltmeter is $\sqrt{V^2 + V'^2}$.

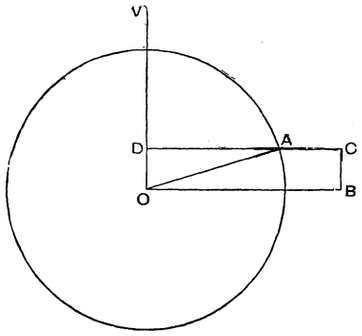

FIG. 3.—The area of O B C D measures the Watts in the Circuit.

To measure the power expended in an alternating-current circuit is not a simple matter, since the phases of the E.M.F. and current are different.

If the current is $I\cos pt$ we have seen that the E.M.F. is of the form $E\cos(pt+\alpha)$.

At any instant, therefore, the watts expended on the circuit

$$= E\,I\cos pt\cos(pt+\alpha),$$
$$= \tfrac{1}{2}E\,I\,\{\cos\alpha + \cos(2pt+\alpha)\},$$
$$= \tfrac{1}{2}E\,I\cos\alpha + \tfrac{1}{2}E\,I\cos(2pt+\alpha).$$

The mean value of this for a complete period is $\frac{1}{2}E\,I\cos\alpha$, for the mean value of $\frac{1}{2}E\,I\cos(2pt+\alpha)$ is zero. The watts being expended on the circuit are therefore $V\,A\cos\alpha$, where V and A are the readings on the voltmeter and ammeter respectively. Graphically, if O V (Fig. 3) = V, the angle V O A = α, O A = A, and we draw O B at right angles to O V and = V, the work done is equal to the area of the rectangle O B C A D. From the diagram we can see that a given error in measuring α produces a larger percentage error in our determination of the power, the greater the angle α is.

The production of rotary fields by means of ordinary alternating currents is a problem of great practical utility. A rotary field for experimental purposes when we have an alternating current supply can be made very simply. Take a few thin strips of sheet iron and bend them into a circular

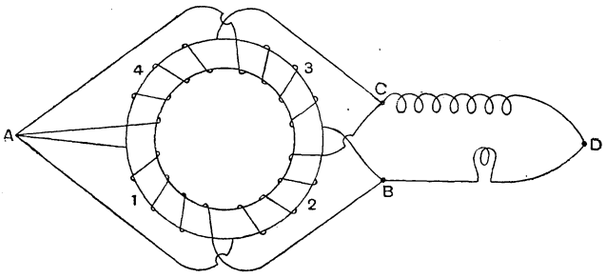

FIG. 4.—Experimental Rotary Field.

hoop. Now coil wires round this hoop as in Fig. 4. Connect C to a choking coil, and B to an incandescent lamp, the currents in each being equal. If we now connect A and D to the supply mains we get a rotary field inside the ring. Compass needles and discs of iron pivoted on pins placed inside this ring will revolve with great rapidity. To reverse the direction of rotation we connect the choking coil on to B and the lamp on to C the rotating bodies inside the ring will now rotate in the opposite direction. The reason of this can easily be seen graphically by drawing the magnetic state of the ring at various instants due to the magnetising currents round it.

The current that flows through the lamp is nearly in the same phase with the applied E.M.F., because the self-induction

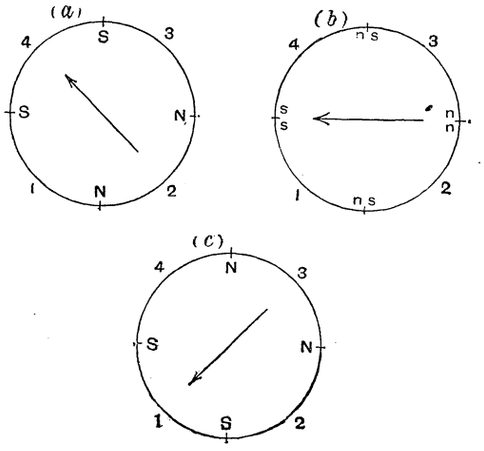

FIG. 5.—Magnetic State of a Rotary Field, at times differing by an eighth of a Period.

of this circuit is small compared with its resistance. The current that flows through the choking coil lags in phase nearly 90deg. behind the phase of the applied E.M.F. Hence (Fig. 4) the phase of the currents in (2) and (4) lags nearly 90deg. behind the phase of the currents in (1) and (3). When the currents in (1) and (3) have their maximum value the currents in (2) and (4) are nearly zero. The magnetic state that these currents tend to induce in the ring at this moment is shown in Fig. 5 (*a*), the arrow head denoting the direction of the lines of force. An eighth of a period later the magnetic state of the ring is as in (*b*), and after a quarter period as in (*c*). Hence the field is rotating in the direction 1, 2, 3, 4. It is an instructive exercise to draw diagrams as in Fig. 5, to show the direction of rotation when B and C (Fig. 4) are inter-

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changed. In constructing a motor on this principle, the great object to be aimed at is to reduce the magnetic resistance of the air gap as much as possible. This has been very effectively done in the motors invented by Mr. C. E. L. Brown, and described in *The Electrician*, Jan. 27, 1893.

If we have n mains, the potential of each main differing in phase from the potential of the main next it by $360/n$deg., and if the final point of each main is joined to the final point of each neighbouring main by means of n equal intermediate wires which are wound consecutively round a soft iron ring, then, from symmetry, the currents in the intermediate wires would differ in phase by $360/n$deg. That is, all the currents in the wires would take their maximum values one after another, and a rotary field would be produced. It is to be noted that by winding a coil left-handedly instead of right-handedly the phase of its magnetising force is reversed. Hence four phases were got from the two-phased currents in Fig. 4.

It is not difficult, by splitting an alternating current into branch circuits which have different inductances, to produce currents which differ from one another in phase by $180/n$deg., then by winding the wires left-handedly and right-handedly on the ring to produce the same field as with polyphase currents. The method of measuring the power supplied by polyphase currents leads to some very pretty theorems in trigonometry, but at present they are likely to remain nothing more. The only real point of superiority of polyphase currents over alternating currents was in the ease with which they could be applied to work motors.

PHYSICAL SOCIETY.

At an ordinary meeting of this Society on March 24, 1893, Prof. A. W. Rücker, F.R.S., President, in the chair, several excellent photographs of flying bullets, and of the air waves produced by vibrating hammers, were exhibited, the originals of which had been taken by Prof. Mach. A Paper on

"The Differential Equation of Electric Flow,"

was read by Mr. T. H. Blakesley, M.A. The object of the Paper is to show that the ordinary mathematical expressions for electric flow fail to explain all known facts, and to point out that in order to interpret these facts, certain properties of matter not usually recognised must be admitted. The subject is treated both algebraically and geometrically in the latter case, the magnitudes being represented by the projections of the sides of a triangle revolving in its own plane on a fixed line in that plane. Taking the ordinary differential equation for a simple circuit having resistance and self-induction, viz., $V - L\,dc/dt = R\,C$, it is shown that this takes no account of any energy except that spent in heating the conductor, and that where radiation into space is concerned, it is necessary to introduce another term λC, where λ is a quantity of the nature of resistance. It is further pointed out that if work be done outside the circuit, the line which geometrically represents the induced E.M.F. cannot be perpendicular to that indicating the current and "effective" E.M.F., the latter term being defined to mean the value of the quantity which is numerically equal to the product of the current into the resistance. A magnetic phase-lag must, therefore, exist. The author also shows that a magnetic field induced in phase with the magnetic induction, would not result in a loss of energy and no hysteresis could exist. Under the same circumstances there could be no radiation of energy from an alternating magnet.

A Leyden jar, discharging through a circuit having self-induction is next considered. Taking the ordinary premises, it is shown that no provision is there made for energy radiated into space, and that magnetic lag is necessary for the existence of such phenomena. The differential equations for the variables in condenser discharges, according to ordinary assumptions, are shown to be of the same forms, and the variables can be represented by the projection of the sides of a triangle which is simultaneously undergoing uniform rotation and linear logarithmic shrinking. The rate of shrinking is the same as that of the radius vector of an equiangular spiral of characteristic angle β, where $\cos\beta = \sqrt{K/L} = R/2$; K, L, and R representing capacity, self-induction, and resistance respectively. The equations and their consequences are considered at some length, and several important properties brought out. To allow for radiated energy, R must be virtually increased from R to $R+\lambda$, and the total energy is divided between the circuit and the field in the ratio of R to λ. If, therefore, the circumstances be such that λ is large compared with R, say by having high frequency, the heating of the circuit may only be a small part of the total energy. In this direction the author thinks the true explanation of some of Tesla's experiments is to be found, the energy being expended chiefly in radiation and not in current through the experimenter's body. When obtaining photographs of rapidly-moving objects, Prof. Boys had used discharges of high frequency, but since several sparks of nearly equal intensity were obtained, the decay of amplitude was not very rapid, and the angle β of the logarithmic spiral representing the magnitudes would be nearly 90deg. For the most rapid discharge $\beta = 45°$, and the ratio of successive maxima was $e^{\pi}:1$, *i.e.*, 23·14 to 1.

DISCUSSION.

Prof. PERRY thought the C^2R term would not represent the heating of the wire when the oscillations were rapid, owing to the distribution of current not being uniform over the section of the conductor. Maxwell had shown that certain throttling terms had to be considered. In condenser discharges the complete equation would have many terms.

Prof. O. J. LODGE said the best definition of R in such cases was that derived from Joule's law rather than that of Ohm. Frequency was very important in the radiation of energy, but even at ordinary frequencies of alternators some energy was radiated. Referring to Tesla's experiments, he said the reason why no serious consequences followed was that there was not much energy behind them. High frequency might be instrumental in preventing injury, but this he thought remained to be proved.

Dr. SUMPNER pointed out that losses other than C^2R (R being the ordinary resistance of the conductor) had to be taken into account. In some cases, such as transformers on open circuit, the effective resistance might be 1,000 times that of the coil. To discuss completely the problem taken up by Mr. Blakesley, it would be necessary to take account of non-uniform distribution of current, both across and along the conductor, as well as the character of the magnetic and electric fields surrounding the circuit.

Mr. SWINBURNE thought there was a tendency to overestimate the rate of high-frequency currents, for unless the coils of transformers were assumed geometrically coincident, calculations were difficult. Errors of hundreds per cent. were quite possible. In Tesla's experiments no great power was involved, for the transformer could not give out any large power.

Mr. BLAKESLEY, in reply, said the term R was such that C^2R represented the whole waste loss in the conductor, whilst λ included everything wasted outside the conductor.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, April 7th.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at St. James's Hall Restaurant.

MONDAY, April 10th.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting. Paper to be read on "The Cleaning of Tramway and other Rails," by H. Conradi.

TUESDAY, April 11th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion: "Steam-Engine Trials," by the late P. W. Willans, M.Inst.C.E. At this meeting the monthly ballot for members will be taken.

WEDNESDAY, April 12th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Construction of Locks and Safes," by Harry W. Chubb.

THURSDAY, April 13th.

ROYAL INSTITUTION.

3 p.m. Afternoon Discourse: "The Atmosphere," by Prof. Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Distribution of Power by Alternate-Current Motors," by Albion T. Snell, M. Inst. E.E.

FRIDAY, April 14th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "The Manufacture and Efficiency of Armour-Plates," by D. Carnegie, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Seals," by Sir W. H. Flower F.R.S.

SATURDAY, April 15th.

ROYAL INSTITUTION.

3 p.m. Tyndall Lecture: "Some Applications of Electricity to Chemistry," by James Swinburne, M.Inst.E.E.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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EVAPORATIVE OR AIR CONDENSERS FOR STEAM-ENGINES.

Coal consumption is in one sense a comparatively unimportant item in the expenses of an electric-supply company, since it is only about one-fifth of the whole instead of about three-fifths, as in the case of isolated plants ; and it is for the most part proportional to the output. Salaries and other expenses of management, and the interest on plant, run on whether the load be heavy or light. Expensive plant for securing high economy is a burden to the capital account already loaded with copper mains and buildings. One of the accessories to the generating machinery which is often shirked by designers of supply stations is the condensing apparatus. Where there is a scanty supply of water it has been proposed in some cases to sink a well and to put down a pump ; but it may be objected, on the other hand, that nearly as much coal will be spent in pumping as will be saved by the vacuum. Some engineers, indeed, maintain that the friction of, and work done by, the air-pump is a serious proportion of the work gained. Again, when water is to be obtained, there is a difficulty about disposing of it, especially in stations hemmed in by streets. The cooling pond is a familiar adjunct to a factory in a manufacturing district, and it is not generally known that the Trafalgar-square fountains are the cooling ponds of the Government Waterworks at the back of the National Gallery. As fountains they have been derided, but if electric lighting is to be thoroughly municipalised the ingenious expedient may be repeated elsewhere, and more or less ornamental fountains may become common features in our squares and public places.

The chimney of the St. Pancras station carries a series of iron roof-like structures, roofing in nothing in particular and serving, in fact, as cooling screens over which the heated condensing water trickles. Somewhat analogous to this, but in principle to be preferred, is the air condenser or evaporative condenser, which is recommended often enough but seldom seen. SIR FREDERICK BRAMWELL and Mr. E. A. COWPER are well-known advocates of such a condenser, and we are glad to find some details of the apparatus in last week's *Industries*, in an article by Mr. MICHAEL LONGRIDGE. The condenser consists merely of a stack of pipes, through

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which the exhaust steam passes, and over which the cooling water is allowed to trickle. They may be arranged in any convenient manner; the example described and illustrated in our contemporary consists of two horizontal cast iron pipes, into which are fitted a number of pairs of vertical pipes. A trough above the pipes distributes the cooling water, and part being evaporated, the rest falls into a tank and is pumped back again to the trough. A horizontal arrangement of pipes, on the other hand, would allow the principle of cooling to be used which is largely adopted in brewing and refrigerating plant. Here the fluid to be cooled ascends zigzaging up the stack of pipes, while the water trickles down; the result is that there is a fairly uniform difference in temperature between the interior and the exterior of the pipe at any part, and the work goes on more regularly. The principle is not quite so important in the case of steam, and whatever arrangement be adopted, the pipes must be sufficiently large to avoid any back pressure.

Mr. Longridge points out that, while the cooling surface of condensers in steamships is about one square foot per indicated horse-power, and for land engines in the tropics about two and a-half square feet, a much larger allowance, up to even ten square feet per indicated horse-power, is necessary for evaporative condensers. In surface condensers a large quantity of cooling water is used, and Mr. Longridge gives as an example a rise of temperature from 60° to 110°, each pound of water taking up fifty thermal units. The weight of the cooling water will be about twenty times the weight of the feed. With the evaporative condenser, on the other hand, while the surface over which it passes is greatly increased, the quantity is reduced until it becomes equal to, or even less in quantity than, the feed. Advocates of evaporative condensers assert, indeed, that not only is shortness of water no excuse for not condensing, but that such condensers will actually save water. The water cools the steam, not only by becoming warm, as in a surface condenser, but by turning into vapour; the air also becoming laden with vapour assists in carrying away a good deal of heat. Mr. Longridge gives the result of a test made with an evaporative condenser, in which a circulation of water was kept up and maintained by a supplementary supply of cold water from the town mains. A more complete test over a prolonged period would be of interest.

One drawback to this excellent system is the "washing day" effect of clouds of steam which are necessarily given off freely into the air. It is one thing to discharge exhaust steam up a properly constructed shaft at a considerable height above the neighbouring houses, and another thing to generate it on the roof of the station. Mr. Crompton has, we believe, contemplated housing an evaporative condenser under a roof, and allowing the steam to escape out of something of the nature of a shaft. But free access of cool air is essential to the efficient working of a condenser of this kind, and any check to its operation simply means an increase in the prime cost, since a larger condenser would be needed to do the work. The nuisance, however, would probably be more apparent than real, and the shades of night must necessarily fall before the time of full load comes on, and what would then be out of sight would probably be out of mind. But it is by no means necessary to provide a condensing plant capable of dealing with the exhaust of full-load working. It was pointed out by Mr. Willans that such condensers might with great advantage be employed on light loads. The construction of an evaporative condenser is extremely simple, and its use is burdened with no patents. No change need be made in the existing plant or in its working, unless, indeed, the lavish lubrication of the cylinders which is to be seen in some stations might interfere with the continuous circulation of the feed water.

PARALLEL DISTRIBUTION.

BY FRANCIS JEHL.

In the parallel system of distributing electricity, there are several methods that have been suggested, and which can be classified as follows:—Firstly, the direct system (Fig. 1); secondly, the feeder system (Fig. 2); thirdly, the loop system (Fig. 3); and fourthly, the double-loop system (Fig. 4). In the direct system the current is supplied directly to the points of consumption, and if we assume that the current density is the same throughout the metal used per square centimetre, and that the current is supplied at an equal rate per unit of length, we see that in the direct system the mains gradually taper off. In the feeder system we see that the principal mains or feeders must have the same cross-section throughout,

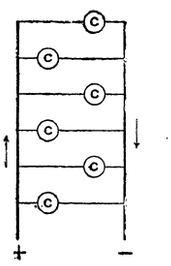

Fig. 1.

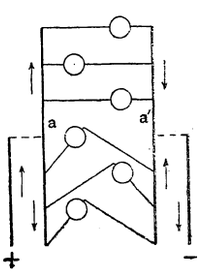

Fig. 2.

and that the secondary mains can be tapered off from the points at which they are fed a, a' in Fig. 2. In the single-loop system we have one main, a, Fig. 3, which gradually tapers off as in the direct system in Fig. 1, while the main, a', is of constant cross-section up to the point, b, and then tapers off downward. In the double-loop system, we have both mains, a, a', gradually tapering off, but at a lesser rate per unit of length than in the other systems. The above-mentioned systems form the elements of parallel distribution, and, of course, permit of further modifications, as per example, by taking two such systems as shown in Fig. 1. and connecting them in series and, using only one main in the centre, we have the principle of the Edison-Hopkinson three wire system, and which is extensively used in conjunction with the feeder system, also due to Edison. Now the principal

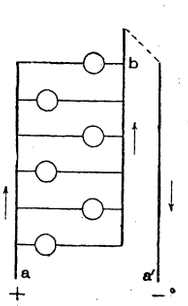

Fig. 3.

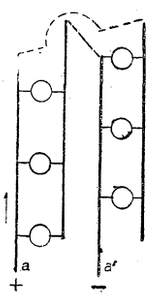

Fig. 4.

object to attain in the distributing of electrical energy is: (1) Economy, which is given by Lord Kelvin's law. (2) Safety, that is, having the necessary cross-section to prevent excessive heating. (3) Regulation, that is, to prevent too great a variation of potential along the leads. Let us now examine the four elementary systems shown above, and determine approximately the relative weight of metal used in each of them, assuming as before, a constant current density per square unit, and that the current is taken off equally per unit of length. The question of metal forms one of the principal items of the capital required in the distribution of electricity from central stations, and is therefore an important question to consider, in deciding upon which system we shall take. It is also clear that if the current density is the same throughout per square unit, the system having the most metal, will not only require a larger capital, but the yearly interest and redemption upon the same will be larger; and, also, the yearly costs of power wasted in the

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mains will also be greater than in another system having less metal. Now in Fig. 1 we have six equidistant points, from which branches issue, and each branch consuming a constant quantity of current c. Taking the scale shown in the figure as reference to units of length, we see that up to the first unit of length, the main must have the necessary metal to carry six times the quantity of current c, and if we denote p as the necessary weight of metal to carry a unit of current per unit of length, we must have an amount of metal equal to $6\,p\,c$, for the second unit of length our amount would be $5\,p\,c$, for the third it would be $4\,p\,c$, and so on. Writing these amounts in a series, we get

$$6\,p\,c+5\,p\,c+4\,p\,c+3\,p\,c+2\,p\,c+p\,c$$
$$=p\,c\,[1+2+3+4+5+6]=21\,p\,c.$$

Thus $21\,cp$ is the amount of metal required for one main, in which the current density is constant. Double this amount, that is $42\,c\,p$ is the amount required for the system under consideration. This shows, that in the direct system, if the current decreases regularly per unit of length, and the density is to be constant, the quantity of metal required for the mains, is an amount which can be expressed by the sum of an arithmetical progression. Similarly we can calculate the weight of metal required for the other systems, noting from unit length to unit length the current in that part, and, multiplied by $p\,c$, summing up the parts will give the required amounts.

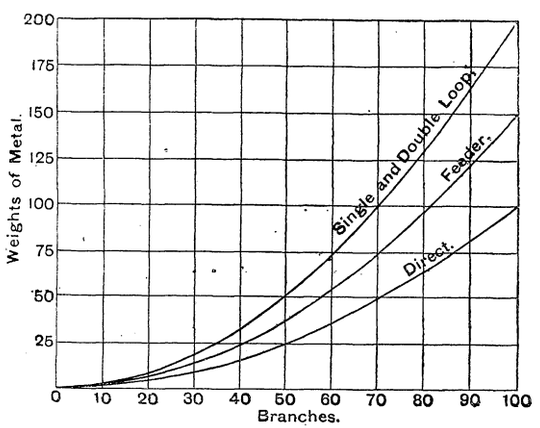

FIG. 5.

We will now give general formulæ to calculate the weight in any of the four elementary systems, assuming as before stated, that the quantity of current decreases regularly per unit of length. Let n denote the number of branches each taking c amount of current, and p the weight of metal per unit current and length. Let W equal the total weight of metal. We have then for the direct system

$$W_d=n\,(n+1)\,p\,c \quad . \quad . \quad . \quad . \quad . \quad (a),$$

for the feeder system,

$$W_f=[n\,(n/2+1)+n^2]\,p\,c \quad . \quad . \quad . \quad . \quad (b),$$

for the single-loop system,

$$W_l=(n\,(n+1)+n^2)\,p\,c \quad . \quad . \quad . \quad . \quad (c),$$

and for the double-loop system,

$$W_m=(2n\,(n+1)-n)\,p\,c \quad . \quad . \quad . \quad . \quad (d).$$

A further assumption is embedded in the above formulæ, b, c and d, and that is, that the relative lengths of the four systems is as 2 for the direct, 3 for the feeder and loop, and 4 for the double loop. The feeder always supplies the current in the middle, so that the total length of both is always equal to n units of length. Also in the loop system the one main carrying the whole current to b is equal to n unit of length.

In order to have a fair comparison between the four systems, n must be an even number and greater than two. Putting $n=$ successively 4, 6, 8, 10 we obtain the following figures, supposing c and p are each equal to unity. These figures show that the direct system is the one requiring the least amount of metal, and, therefore, absorbing the least amount of energy in the mains. From the formulæ a, b, c, and d we can construct curves, showing the *relative weight* of metal used in each system with a given number of branches, as shown in Fig. 5. The curves also show how the *relative difference* of weight between the different systems vary, as the number of branches increase, &c.

n =	Direct system.	Feeder system.	Single-loop system.	Double-loop system.
4	20	28	36	36
6	42	60	78	78
8	72	104	136	136
10	110	160	210	210

There is, however, another consideration to be noticed, and that is the question of regulation. It is now necessary to find which of the four systems will have the least variation of pressure between the first and last point of consumption. Theoretically, it is impossible to maintain a constant difference of potential between the various points, yet practice has shown us what limits are allowable, and which system admits of the best regulation, when the load varies from point to point. It was once claimed that in the loop systems, the pressure is always equalized, but this, will be shown later on, is not true. It is reasonable to suppose that whatever holds for an element of a system, will generally hold for the entire system. Now, in order to facilitate our calculations regarding the difference of pressure along the mains, we will assume that we have a given quantity of metal, from which our mains are to be made: further, that they are of constant cross-section, and therefore equal resistance per unit of length for each system. The direct system will evidently have the largest cross-section, while the double loop system the least. Let L_d equal the total length of the direct system's mains, S_d, the cross-section and δ the density of the metal employed. Then we have as the weight, W, of the whole mains $W=L_dS_d\delta$ (1) and by similar notations for the other systems.

$$W=L_fS_f\delta \ . \ . \ (2) \qquad =L_lS_l\delta \ . \ . \ (3) \qquad =L_mS_m\delta \ . \ . \ (4)$$

where L_f, L_l, L_m and S_f, S_l, S_m denote the lengths and cross-sections respectively of the feeder, loop, and double loop systems. These equations show that the ratio of their cross-sections are equal to the universe ratio of their length. Now the resistance of the direct system mains considered in one continuous length is $R_d=(L_d\,\rho)/S_d$ where ρ is the specific resistance of the metal. We have by substituting this value of S_d, namely $(L_d\,\rho)/R_d$, in the equation (1) and similarly for (2), (3) and (4) the following the following equations, each expressing the given amount of metal, W, used in our assumption

$$W=(L^2{}_d\,\delta\,\rho)/R_d \ . \ . \ (5) \qquad =(L^2{}_f\,\delta\,\rho)/R_f \ . \ . \ (6)$$
$$=(L^2{}_l\,\delta\,\rho)/R_l \ . \ . \ (7) \qquad =(L^2{}_m\,\delta\,\rho)/R_m \ . \ (8)$$

We may also suppose that the relative lengths of the conductors of the four elementary systems (each considered in one direct length) are $L_d=2$, $L_f=3$, $L_l=3$ and $L_m=4$. The assumption for L_d, L_l and L_m is correct, but in the case of the feeder, L_f, we have taken an average value. These values substituted in (5), (6), (7), and (8) give us

$$W=(4\,\delta\,\rho)/R_d \ . \ . \ (9) \qquad =(9\,\delta\,\rho)/R_f \ . \ . \ (10)$$
$$=(9\,\delta\,\rho/)R_l \ . \ . \ (11) \qquad =(16\,\delta\,\rho)/R_m \ . \ (12)$$

Now in Fig. 1 it can be easily verified, that, by calculating the fall of pressure from point to point along the mains, the loss in volts between the first and last parallel is

$$E_d=\frac{C}{2}\,(R_d) \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

C is the total current, and R_d as before the resistance of the leads. Of course, it is assumed that the current is taken off equally per unit of length. In the feeder system it is evident that the greatest difference is between the point of supply and the end parallels, and that we get

$$E_f=\tfrac{1}{2}\cdot\frac{C}{2}\cdot\tfrac{2}{3}\,R_f\,\tfrac{1}{2}=\frac{CR_f}{12} \quad . \quad . \quad . \quad . \quad (14)$$

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It must here be noticed that the whole current C divides itself into two paths, as shown by the arrows in Fig. 2, and that we must therefore only take $\frac{1}{2}$ of C/2. The resistance R_f is that of the whole main feeders and secondary considered as one direct length, and as $\frac{2}{3}$ of this resistance is in the secondary, which at the same time is taken in multiple arc, we must take $\frac{1}{2}$ of $\frac{2}{3}$ in our formula. Now, taking the value of R_f from equations (9) and (10), we get $R_f = \frac{9}{4}.R_d$ and substituting this value in (14) we get

$$E_f = \frac{CR_f}{12} = \frac{C}{12}\frac{9}{4}R_d = \frac{3}{16}CR \quad . \quad . \quad . \quad (15)$$

Comparing equations 13 and 15 we see what an advantage is derived from the feeder system over the direct system. We have the same weight of metal in both systems, but in one we have about 2·6 times better regulation, that is, less variation of pressure.

(To be continued.)

THE INSULATION RESISTANCE OF PRIVATE-HOUSE CIRCUITS.

BY E. TREMLETT CARTER.

There seems to be some considerable diversity of opinion among the "authorities" as to what should be the standard of insulation resistance of a private-house lamp circuit. As a matter of fact, this diversity is really not confined to this particular case; for there is much difference of opinion regarding the insulation of street mains and of dynamos. But attention has been the more emphatically directed to private-house circuits by the number of carefully drawn up "rules" for the guidance of the contractor, and by the hopelessness of the task of trying to reconcile them. In the majority of cases these rules follow the logarithmic law, and it is natural and simple that they should do so; but it is not so much in the law of their variation as in the coefficients used that any reflection on their value is cast by their conflicting character. The single exception which we have been able to find to the hyperbolic law is that of the London Electric Supply Corporation Rule, which specifies an insulation resistance which is constant between definite limits, and which falls considerably as each limit is passed. But as this stepped system has a logarithmic decrement in the rate of fall from each successive step to the next, the rule is but an approximate hyperbolic law. All the rules, then, more or less closely follow the law which may be expressed thus: $r = k/n^2$; or, $R = k/n$, where r is the insulation resistance per lamp, and R is the insulation resistance for all the lamps, k being being the constant of resistance, or the number of megohms which the circuit should have if only one lamp were on the circuit.

Now it is in the numerical value of this constant, k, that the difference lies; and the extent of the diversity can be seen, either by a glance at the following table or by comparison of the curves given in the accompanying figure.

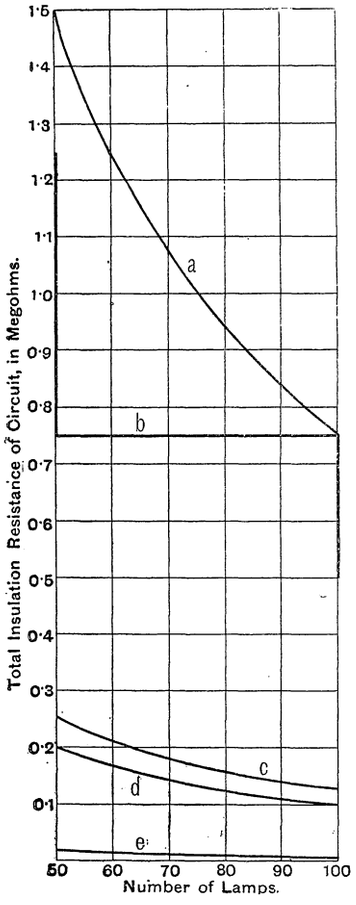
Authority.	Value of k.
London Electric Supply Corporation (maximum) ...	75 megohms,
" " " (minimum) ...	2 "
Phœnix Fire Office	12·5 "
Bradford Corporation	10·0 "
Prof. Jamieson	10·0 "
Institution of Electrical Engineers	0·87 "
Kempe	75 "

Turning to the curves, that marked *a* shows the values according to Kempe; the stepped values, constant between 50 and 100 lamps, are shown by *b*; *c* shows the Phœnix Fire Office rule; *d* the rules of the Bradford Corporation and of Prof. Jamieson; while the diminutive curve, *e*, represents the modest requirements of the Institution of Electrical Engineers in this matter. The stepped curve of the London Electric Corporation is better explained by the following details:—

From	1	to	25	lamps	R = 2
"	26	"	50	"	1·25
"	51	"	100	"	0·75
"	101	"	150	"	0·50

From which table it will be seen that this company demands a higher standard of insulation for large circuits than for small ones.

It might be thought that these diverse rules are the cause of the great difference which lies between the zenith and the nadir of almost every list of tenders in electric lighting work. Why is it that Messrs. A. and Co. can supply for £19,865 4s. 1¼d. what the highly respectable firm of Messrs. B. and Sons cannot undertake for less than the round sum of £50,000? Is it that the constant, k, of the former firm is only 0·87, while that of the latter is 75? But on looking into the matter, this solution proves of no avail; for one sees that a very wide range in actual insulation resistance is productive of only a trifling variation in the cost of materials.



Curve *a*, Kempe; *b*, London Electric Supply Corporation; *c*, Phœnix Fire Office; *d*, Bradford Corporation, and Prof. Jamieson; *e*, Institution of Electrical Engineers.

To wire a house with 1,000 megohms per mile does not cost three times the cost of wiring it with 300 megohms, even when the cost of wire alone is considered; while it does not cost 10 per cent. more when the percentage is taken on the total cost. This point has been recently brought out very fully by Prof. Ayrton, who shows that the actual cost of the best quality insulation is negligibly different from that of rubbish. The reason why the rubbish is used is not so much that it is cheaper in itself as that, where cheap and nasty work is done, there is absolutely no advantage to be gained by using good material; while the rubbish is a trifle easier to handle, and the work can be got over faster. The highly-respectable firms tender high prices, not because it costs them so much more to put in good material, but because they have a monopoly of first-class workmanship and can command their price.

Royal Institution.—On Saturday, April 15th, Mr. James Swinburne will begin a course of three lectures on "Some Applications of Electricity to Chemistry."

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CONCENTRIC WIRING.

BY SYDNEY F. WALKER.

With much that Mr. Sam Mavor states in his article of February 17, 1893, the present writer fully agrees. Porcelain, though very pretty and a good insulator, is a very troublesome material to work with. Grooved boarding also, though excellent for the purpose for which it was originally designed, viz., to protect the insulation of the cables from mechanical injury, has the objectionable feature that its pores hold water, which will undoubtedly destroy the insulation, or at any rate will assist to. Further, connections to branches are not easily made in grooved boarding without, on the double-wire system, bringing the two joints dangerously near together, and sometimes straining the insulation of both main and branch cables. And these failings are not the sum total of the offences of the double-wire system with grooved boarding. But while on the one hand it is very doubtful whether concentric wiring will cure the ills referred to, on the other hand it is quite certain that the whole of them can be very much reduced, if not entirely got rid of, by care and thought both in designing and in constructing. Electrical engineers are far too apt to follow one another like sheep do their bell wether. Now they all declare that one form or one type of apparatus is, *par excellence*, the best that could possibly be designed, and a short while hence they are equally as enthusiastic over some totally different type, presenting just the opposite qualities. In neither case have they taken much trouble to examine for themselves whether the apparatus is really adapted for the work it will be called upon to do, and whether it can stand the trials to which it will be subject.

This or that eminent man has declared for the apparatus, possibly under very different conditions to those in which it is now intended to be used, and that is sufficient. For instance, if it be acknowledged that grooved boarding is good, provided it harmonises with the decorations in private houses and does not hold water, would it not be worth inquiry whether it may not be possible to prevent its holding water? If the pores of the wood be filled with an insulating and waterproof substance, the boarding should not hold water so long as this is present. But here again care and thought, or their absence, will make all the difference between obtaining any advantage from this and the reverse. Filling the pores of the wood with shellac, for instance, or with any substance that is an insulator and that will withstand moisture and the other conditions that may be present, gets rid of the difficulty at once; but the pores should be filled, the wood being thoroughly dried first and before the wires are laid in the grooves, not merely a coat or two given afterwards without any thought as to whether moisture may not be already present. Shellac, too, may not be the best substance to use under all conditions.

It will be considered a truism to say that care in making the joints and in placing them will reduce the troubles Mr. Mavor refers to, yet it is well known that careless jointing is at the bottom of a great many of those troubles, and would be equally present with concentric wiring.

But, now, as to concentric wiring as the panacea. The writer's first objection to this is that it infringes a rule which he believes to be necessary for the duration of cables used for electric lighting, viz., that there shall be no metallic conductor outside the insulating envelope. He believes, and his experience has borne out his belief, that the act of putting on the outer conductor necessarily strains and often damages the insulating envelope. Though the fault is often not detected, even by very careful tests, it leads to the breakdown of the cable later on, and considerably shortens its life. The writer's second objection is the necessity advanced by Mr. Mavor of earthing the outer conductor. He most strongly objects to "earth," as it is called, being connected to any electric lighting system at all, and for the reason, among others, that when you have secured good "earth" you have introduced into your lighting system a mass of conductors over which you have no control, and in which, and to and from which, you will have currents passing over which you have also no control, and which will invariably lead to trouble. A little consideration will show that the idea that by connecting to "earth" you are making one conductor of absolute zero potential is a mistake. With alternating currents, for instance, how can either conductor be at zero when each in turn is positive and negative? And with direct currents there can be no zero of potential, though there may be two or more points at the same potential; but these points, from the very nature of the case, cannot be points in the same conductor.

It is, perhaps, hardly necessary to refer to the case of the troubles in connection with the St. James's Company's mains, though those troubles afford a striking illustration of the points the writer has been endeavouring to enforce. The known disturbance to ship's compasses, not only from the leads but from the return through the body of the ship, is also another striking illustration of the point. In fact, wherever you connect a source of electricity to a conductor, you communicate the electrical condition existing at the point of junction to that point only. The electrical condition of every other part of the conductor must differ from that at the point of junction. Mr. Mavor is also mistaken in supposing that a concentric cable cannot create a fire.

The writer has in his possession a piece of a cable, virtually a concentric cable, though the outer wires were of iron, which set fire to a cotton cargo by means of a spark which passed between the inner and outer conductors. One of the latter was fused. In this case Mr. Mavor's rule had been rigidly observed. The outer conductor was in contact with the body of the ship everywhere, and one side of the dynamo was connected directly to the ship. The writer's view of the question is that where damp is or may be present, it should be excluded from the insulation of the cable proper, and that in damp places the insulation should only be broken where it is absolutely necessary. He prefers to use double the length of cable or more, if by so doing he can avoid a joint where damp may be present.

Another rule of the writers's is, when you are obliged to make a connection in places where damp may penetrate, make the connection where and by such means as will enable it to be always in sight. Never hide your connections in damp places; make them as large as you possibly can, and repair the work the damp has accomplished as frequently as possible.

A SECONDARY STANDARD FOR ARC-LIGHT PHOTOMETRY.

At the meeting of the Société Internationale des Electriciens on March 1st, M. Blondel made some interesting suggestions with regard to a secondary standard for arc-light photometry. The following is a verbatim translation of M. Blondel's remarks as reported in the *Bulletin* of the Société Internationale:—

As to material standards the only one I wish to refer to is the photometric standard, for which as a secondary standard the American Institute of Electrical Engineers propose the Hefner-Alteneck amyl-acetate lamp, arranged so as to exactly reproduce the *bougie-décimale*. This proposal does not appear to me to be a very happy one. First of all, the unit definitely chosen by the Congress of 1889 being the Violle platinum standard, the secondary standard adopted in each country or in each laboratory for lights of the same tint is a matter of little importance provided it is sufficiently constant and that its value as a function of the unit is known and can be easily verified. There is an especial reason for not abandoning the *carcel* in France, where it has been used so long, since it is almost exactly half a *violle*. Complete freedom of action ought to be retained in this matter, and it should only be recommended to standardising laboratories to employ the Violle portable apparatus as arranged by its inventor. Secondly, all lamps or candles, and even the Violle standard, possess this serious and well-known defect, namely, that owing to the composition of their light, they do not lend themselves to a comparison with the light of arc lamps. Now the amyl-acetate standard is precisely the most red of any at present in use, and this fact must be added to those cited above to prevent its employment being prescribed. Arc-light

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photometry is, in fact, the only class which can necessitate the choice of a special secondary standard. This matter is so important from this point of view that I ask permission to show you a little piece of apparatus which I have recently had made for this very purpose, and to refer briefly to the considerations which justify its adoption as a secondary standard.

At present it is extremely difficult to measure, even roughly, the photometric intensity of an arc lamp for the following reasons:—Everyone who has carried out arc-light measurements knows how hard it is to equalise the sensation produced by this light and by the standards of light now in use. The relative value of these sensations depends in a large measure upon the conformation of the eye of the observer and the dimensions and illumination of the areas under observation. Many people rest content with a very rough approximation. Others get out of the difficulty by interposing a red or green glass, or both successively, often without making clear the exact meaning of the results so obtained. Others again, to a small extent, have recourse to the photometry of differently-coloured lights, the learned flavour of the method concealing its frail and, at times, inaccurately-laid foundations. In any case there is complication, with its consequent doubtful results.

Even admitting that by some means or other two differently-coloured lights have been balanced for a given objective value of the illumination, the balance will be upset when the objective value is changed in virtue of the Purkinje phenomenon.

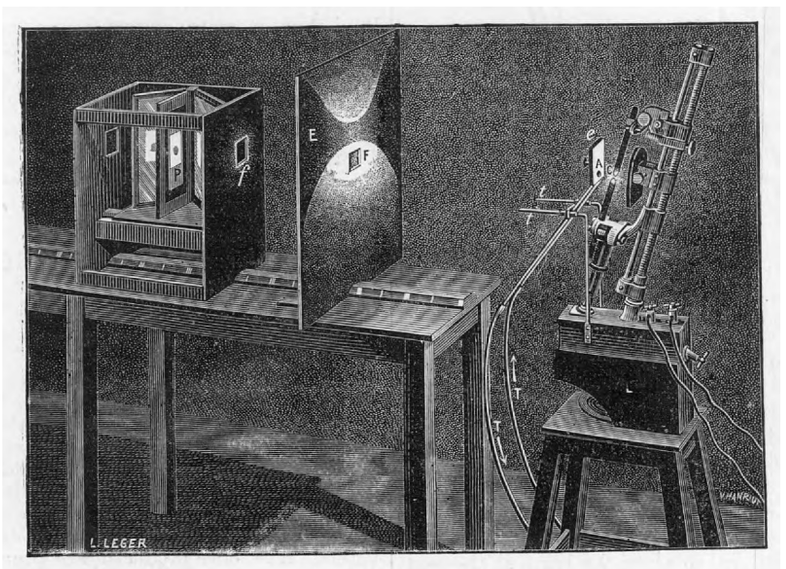

FIG. 1.—General View of Photometric Arrangement.

L, Sautter-Harlé lamp. C, positive crater. *e*, screen, cooled by a stream of water. *t t*, rods. T T, water-tubes. E, screen. F, aperture in screen. P, photometer. *f*, photometer slit.

Finally, if two illuminations are balanced by a comparison of two diffusing surfaces they will not be so from the point of view of visual perceptivity, that is to say, for reading purposes or clear distinction of detail.

It is, therefore, impossible to satisfactorily define the light of an arc lamp as a function of existing standards, and this can only be done by means of a standard of the same tint, having as its source the electric arc. The principle underlyi ngthe method I employ for this purpose, which is, as we shall see, the isolation on the positive crater of the arc of a given light-emitting surface, requires some preliminary explanation.

MM. Abney* and Violle have in turn demonstrated the constancy of the spectral composition of the light of the crater, and, consequently, the constancy of the temperature apart from the current strength. This constancy of the temperature had, indeed, already been proved by M. Rossetti, and Prof. Silvanus Thompson had discovered the cause* of it in the volatilisation of the carbon at the point of passage, a volatilisation which requires a constant expenditure of energy, and is carried out at a fixed temperature. But it has not been shown up to the present that the intrinsic brilliancy of the surface of the crater is independent of the density and the molecular structure of the carbons employed. In fact, it is not enough to get a constant temperature if we wish to have a constant brilliancy; the emissivity must be independent of the molecular structure, and, as we know, this condition is far from being fulfilled in incandescent lamps.

As experiment alone was capable of giving an answer on these points, in conjunction with M. Le Chatelier, and by the aid of the ingenious pyrometer devised by him, I carried out a series of determinations of the intrinsic brilliancy under the most varied conditions of voltage and current, and with carbons of very different nature and composition supplied by various firms, but chiefly by the Société Le Carbone, to whom I must express my thanks. The samples sent by this Company comprised the most widely different types—hard and soft, homogeneous, and without cores, for high and low voltages. Contrary to our expectations, all the values of the brilliancy obtained by us sensibly agreed; the deviations were always irregular and did not exceed the limits of experimental error, limits which are unfortunately somewhat wide in pyrophotometry. For the degree of accuracy which we were able to attain it may be concluded that provided the carbon used is sufficiently pure—that is to say, with the exception of the core, free from mineral substances likely to lower its point of volatilisation—the intrinsic brilliancy of the zone of maximum brilliancy in the positive crater is practically constant, and is not only independent of the current but also of the molecular state and density of the carbons used.†

Such being the case, the crater possesses the principal properties necessary for a standard of light, upon the sole condition that we isolate a given emitting surface in the zone of maximum brilliancy. Moreover, thanks to the fact that incandescent carbon follows Lambert's law of emission, it is not necessary that emission should occur normally to the incandescent surface.

I have devised, I think the first, an apparatus fulfilling the requirements of a practical standard, and capable of being

* In a letter which he was good enough to send me on this matter, Prof. Silvanus Thompson informs me that Captain Abney in a report to the English Secretary of State for War showed a few years ago, for the first time, the constancy of the spectral composition of the light emitted by the positive crater and, moreover, employed, with a view of constructing a standard spectrum, a method analogous to that which I now make use of for obtaining a standard of light. Although the report referred to has never been published, and that, as far as I know, there has been no allusion to this subject in photometric treatises previous to this communication, I think it my duty to call attention to the priority of Captain Abney in this matter, remarking merely that my point of view is decidedly different, as is also the law which serves as my point of departure.

* "Arc Lamps and their Mechanisms." By Prof. S. P. Thompson. A Paper read before the Society of Arts, March 6, 1889.

† If more accurate experiments show that there are appreciable differences in the emissivity, the difficulty can be got over by always working with the same carbon after having standardised against a Violle standard.

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manipulated with as much ease as an ordinary standard. This apparatus, which I have the honour to exhibit before the Society, comprises essentially a lamp with oblique carbons, a luminous point which can be regulated and a vertical screen with a variable diaphragm (Fig. 1).*

The lamp I employed is one which lends itself very readily to the purpose in hand; it was a projector lamp lent me by MM. Sautter et Harlé. The carbons are both inclined at an angle of about 20deg. to the vertical. Owing to this inclination, the positive crater on the upper carbon presents a surface which is inclined about 50deg. to 60deg. to the vertical, and it is easy to disengage it completely from the lower carbon by displacing the arc 4 to 5 mm.† The opaque screen (Fig. 2), formed by a little flat box bent in the middle, and continually cooled internally by a current of water‡ can be moved in a horizontal direction in front of the arc along two rods acting as sliders and fixed to the base of the lamp. The screen is pierced at the bend by a small conical hole, behind which revolves a disc provided with a number of apertures of known dimensions. An area of one square millimetre seems particularly appropriate to arc-lamp investigations, in which it is usually advantageous to employ a standard more powerful than ordinary standards. The aperture in the diaphragm is placed on a level with the centre of the crater and at

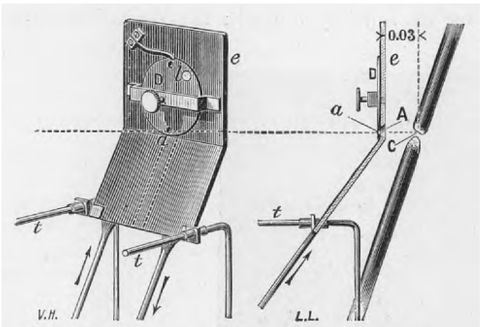

FIG. 2.—Details of the Apparatus. Perspective View and Vertical Section. D, pierced disc. A, conical aperture. *a*, square millimetre aperture. *l*, lens.

a very short distance (two to three centimetres) from it. In this way a conical and divergent beam of light is obtained, having as its centre the base of the crater and the small aperture; its horizontal intensity is equal to the intrinsic brilliancy of the corresponding portion of the crater multiplied by the area of the aperture employed.

The standard thus constructed and which we may call the *arc standard* is employed in the same way as any other photometric standard. It is sufficient to place the lamp at the end of a photometer bench and arrange the hole in the diaphragm at the same height as the centre of the photometer screen, which may be of any type, Bunsen, Foucault, Mascart, &c. The sole, but indispensable, condition to be fulfilled is that the horizontal rays impinging upon the photometer shall come well from that portion of the crater which has the maximum brilliancy, which is the only portion giving a constant light. With this view two precautions have to be taken.

(I.) A fairly large, regular, uniform crater must be obtained. This is arrived at by employing a sufficient voltage to ensure complete stability, that is to say, we must have at least 70 to 75 volts at the lamp terminals, including the rheostat, and in addition a current density of at least 0·2 ampere per square millimetre.§‖

(II.) It is necessary to make sure before each reading that the light received by the photometer really does come from the most brilliant part of the crater. This is easily done by bringing a little lens, the focal length of which has been chosen so that the crater is at its focus, behind the opening in the screen. A highly-magnified and sharply-defined image of the arc is then thrown on a vertical screen placed in front of or behind the photometer, and we can see in what part of the image the aperture is. The image of the positive carbon is projected in the shape of a very clear elliptical surface, the length of which may attain several metres, the upper edge standing out clearly on a black ground. When the lamp works well, this edge is almost the brightest, and it is within this portion of the image that the photometer aperture ought to be.* Adjustment is carried out very easily by placing the lamp in the proper direction and then raising the arc by means of the lever provided for that purpose. As soon as the adjustment is correct, an aperture of known size is brought into action, and the reading is taken.

The average illumination at the photometer is constant, but small rapid variations from the mean occur, which are due either to variations in the phenomenon of volatilisation or to the flame which rises up in front of the crater. This flame can be easily blown away and the arc concentrated more decidedly on the edge of the crater by suitably arranging a fairly powerful directing magnet. These variations do not allow us to make an absolute standard of this apparatus in the same sense as the Violle standard is absolute. But for measuring the candle-power of arc lamps, the light of which is of the same kind though more powerful, and which constantly undergoes, moreover, considerable variations from the average intensity, the use of the *arc-standard* cannot give rise to any objections on this score. I think, moreover, that I have shown that the manipulation and the adjustment are very simple.†

* We are indebted to *L'Industrie Electrique* for these *clichés*.—[Ed. *E.*]

† One could also employ, though it would be less convenient, a lamp with vertical carbons, and use an oblique screen, adding a mirror to reflect the ray horizontally. It would be necessary then to take into account the coefficient of reflection of the mirror.

‡ If water cooling is found somewhat of a nuisance, the metallic screen may be replaced by a similar one made of some refractory porcelain.

§ For instance, good results are obtained with 15mm. carbons, 75 volts, 40 amperes and a 5mm. arc, although 10mm. carbons (provided they are of good quality) and 25 amperes will do. If the arc is constantly moving the crater no longer remains uniformly brilliant, and either the conditions of supply or the type of carbons employed should be altered.

‖ 0·2 ampere per sq. mm. = 129 amperes per sq. in.—[Ed. *E.*]

ON THE KATHODE RAYS IN GASES AT THE PRESSURE OF THE ATMOSPHERE AND IN THE HIGHEST VACUUM.‡

BY DR. PHILIPP LENARD.

The rays producing phosphorescence, which are projected from the kathode of a Geissler tube, are, according to Hertz, transmitted by thin metal plates. If it were possible to find a metallic plate of a thickness sufficient to resist the external atmospheric pressure without losing its transparency, we should be able, by closing a hole in the discharge tube by this plate, to allow these rays to enter the air outside. This idea is realised in the experiments a short description of which I lay before the Academy. It is shown by these that the kathode rays, once produced, are propagated through a space filled with air; this fact offers greater facilities for their observation, and it is thus made possible to choose and vary the conditions of observation independently of those of production.

Apparatus.—The figure shows a section of a convenient form of the apparatus. E E is the glass discharge tube, K the kathode, an aluminium disc 12 mm. in diameter, A the anode, which is preferably made with a large surface. Opposite the kathode the tube is closed by a strong metal plate *m m*, perforated at F to a diameter of 1·7 mm. Over this perforation cemented from the outside is a plate of beaten aluminium 0·003mm. thick. This covering, which is transparent to kathode rays, but totally bars the passage of light and air, I call the window, and the space to the left of it, the observing space. The distance between the kathode and the window is 12cm.; the latter is shut off from the discharge by the screen V, and is thus protected from being acted on. On the outside, the large metal screen S S is attached to the window support, and to this the tin cover G G is fixed. The latter, as well as the screen S S, the anode, and the positive pole of a large induction coil, are conducted to earth, the negative pole being connected to the kathode. The arrangement chosen leaves the observing space almost perfectly free from light and the forces of the electric discharge. The best exhaustion in the discharge tube is reached when the difference of potential between the electrodes corresponds

* Cored carbons may be used upon the sole condition that the dark image of the core is not thrown on the photometer.

† These experiments were carried out at the Central Laboratory of the Société Internationale des Électriciens, which is always so hospitably opened to all investigations of the kind, with the assistance of MM. Guilbert and Guiard.

‡ Communicated to the Royal Prussian Academy of Sciences by Prof. von Helmholtz.

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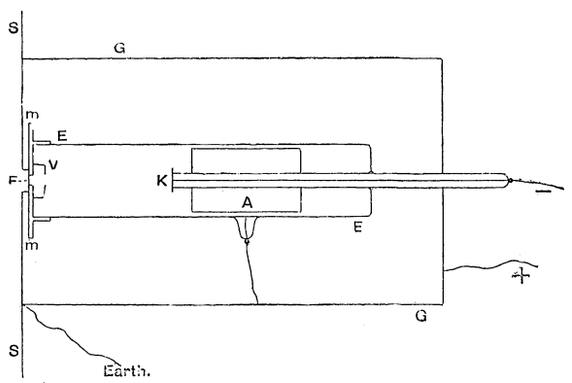
to a length of spark of 3cm. between tubes in air. As regards the phenomena seen in the observing space, I have been able to ascertain the following, besides some less important things.

Kathode Rays in the Open Air.

The kathode rays produce a slight luminosity in the air. A bluish light surrounds the window, which is somewhat bright at its surface only. A strong smell of ozone is noticed.

Phosphorescent bodies held near the window shine on the side turned towards it brightly with the light peculiar to them. With increase of distance from the window the phenomenon diminishes rapidly in intensity, disappearing at a distance of about 6cm. It is only the distance which determines the brightness of the luminosity. The direction is without influence, which is not surprising, since kathode rays pass diffusively through aluminium. Phosphides of the alkalies, common and uranium glass, calcspar, fluorspar, and other minerals, pentadecylparatolylketone and asaron, all glow with the same colour and relative brightness as they do in vacuum tubes within the range of the kathode rays. The luminosity is particularly great in the phosphides of the alkaline earths and the carbon compounds mentioned. Among liquids, a drop of petroleum showed its blue fluorescence. Metals, quartz, mica, and eosine-gelatine, which is strongly affected by light, remained non-luminous, as in vacuum tubes; also aqueous solutions of eosine and fluorescein, and the ether solution of chlorophyll. All phenomena of phosphorescence in the observing space cease as soon as a magnet attached to the discharge-tube prevents the kathode rays from reaching the inner surface of the window.



A quartz plate, 0·5mm. thick and not too small, introduced anywhere between the window and a phosporescent body, stops its luminosity. An ordinary gold, copper, or aluminium leaf leaves it almost undiminished. Whether, however, a substance is transparent or not depends entirely upon the thickness of the layer employed. I have not found a solid body perceptibly transparent with the thickness of a fifth of a millimetre or more, whereas thin layers of all bodies were partially transparent, such as stout writing paper, collodium films, aluminium foil up to 0·03mm. thick, thin blown glass, very thin split mica. Almost perfectly transparent are, besides the metal foils already mentioned, tissue paper and soap films showing colours below the sixth order.

The atmosphere is a turbid medium for kathode rays. They are not propagated in straight lines, but diffused. The phosphorescence effects penetrate into the shadow of an opaque body projected from the window, and it is not possible to cut off sharply defined rays 1cm. long by means of diaphragms. If a metal plate with a sharp-edged opening about 1mm. wide is placed in the way of the kathode rays, a sharp, bright image of the opening is only obtained immediately behind it. At the distance of 3mm. the image is already enlarged five times and diffused, and at 12mm. the screen is equally illuminated almost all over.

Kathode Rays in a Vacuum.

It is a fundamental question concerning the nature of kathode rays, whether their propagation is conditioned by the presence of matter, or whether they also pass through empty space. The impossibility of generating kathode rays in a perfect vacuum has up to the present stood in the way of an answer to this question. It is now possible to overcome this impediment. We produce the rays as before, but surround the observing space with glass walls and exhaust it. As the exhaustion proceeds, the distances within which phosphorescence phenomena are observed increases, and the rays cut off by a diaphragm are better defined. When the degree of exhaustion is reached at which the kathode rays are usually studied, the phosphorescence of the glass wall of the observing space, besides an increased intensity, indicates rectilinear propagation in all directions from the window. The length of the rays, pretty sharply defined, was carried to 30cm., and was only limited by the walls. From this degree of exhaustion up to extreme exhaustion there is little change. The rays only appear a little sharper, the glass phosphorescence somewhat brighter. With this extreme exhaustion, at which the mercury pump ceases to act—the most sensitive test for a gaseous residuum—the electric charge fails. It is no longer possible to produce a discharge between two aluminium plates fixed within the observing space. Discharge takes place along the outer surface of the glass, although the electrodes are 20cm. apart. We can hardly ascribe sensible effects to such imperceptible traces of matter. Granting this, our experiment proves that kathode rays are processes in the ether. If they were material processes the highly vacuous space ought to have been practically impenetrable to them. To these experiments may be added the fact that in the case of all degrees of exhaustion permitting something like a distinct formation of rays, a strong deflection of these rays by the magnet was observed.

Kathode Rays in Various Gases.

Different gases are turbid media to very different degrees; greater definition is accompanied by greater transparency. On letting coal gas escape between the window and the phosphorescent screen, a considerable increase of brightness is noticed on the screen. On filling the observing space with hydrogen at ordinary pressure enclosed in glass, the phosphorescence phenomena extend as far as 20cm. from the window, or more than three times as far as in air at equal pressure. It is also possible to cut off rays by means of a diaphragm which give pretty sharp patches up to a distance of 3cm. These rays in hydrogen at ordinary pressures are strongly deflected by the magnet. Oxygen is just perceptibly less transparent than air, and just about as turbid. Carbonic acid is much less transparent, all the phenomena in this gas being confined to distances up to 4cm. from the window. Rays, even of a few millimetres, cannot be obtained.

From these phenomena we may argue that very small dimensions affect the kathode rays. Even for light of the smallest known wave-length, matter behaves as if filling space continuously; here, on the contrary, the behaviour of elementary gases even is that of a non-homogeneous medium, each individual molecule acting as a separate impediment. The number of molecules upon which the kathode rays impinge in equal volumes of different gases is always the same; we may, therefore, say that hydrogen molecules render the ether much less turbid than oxygen molecules, and the latter less than carbonic acid molecules.

NOTES ON CERTAIN PROPOSALS FOR PATENT LAW REFORM.*

BY W. LLOYD WISE, FELLOW OF THE CHARTERED INSTITUTE OF PATENT AGENTS.

Amongst the matters that will be considered shortly by the Associated Chambers of Commerce are certain proposals for Patent Law reform. Hence, seeing that there is an agitation for alteration in the Patent Laws that, in various forms, have done so much to promote the advancement of the industrial arts in the United Kingdom, it becomes important to watch closely the suggestions put forward. This is the more necessary because many persons who dabble in matters of this kind are possessed (in regard to the matter in hand) of that most dangerous of things, a little knowledge.

Although the Government fees have recently been largely reduced, so that they now amount to only £99 for fourteen years, there is a widespread feeling in favour of further reduction, and it has been suggested that the fees for a fourteen years' patent should be brought down to £25. It seems reasonable to give the present scale a fair trial before rushing into a further reduction. But the principle appears sound, that as patentees are liable to the payment of income-tax like other persons, they should not be exceptionally taxed, in respect of their inventions, to an extent beyond that which is necessary to support the Patent Office and carry out its work on a thoroughly efficient basis.

Another suggestion is that patent applications should be officially examined, and when granted should be "absolute." Such a system appears to be utterly impracticable. At any rate, since, under the new German law, it is provided that proceedings for declaration of nullity shall not be allowable if instituted after the expiration of five years from the date on which the publication of the grant was effected, the least that can be judiciously done is to wait and see how that system is found to work, before attempting in this country such a dangerous experiment as is proposed.

* From the *Chamber of Commerce Journal.*

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There is a wide-spread belief amongst Germans and others having special and extensive experience in patent matters, that the attempt to make patents indefeasible will prove a failure; because, on the one hand, it is impossible by any system of examination to make sure that an invention is absolutely new, even within the country for which the patent is demanded, and, on the other hand, it must be grossly unjust, and may prove disastrous, to deny to any one charged with infringement of a patent the right to show, in self-defence, that the patent in question ought never to have been granted. It is quite contrary to English ideas to arbitrarily take from any one any freedom he may have legitimately enjoyed, and this to enable others to enjoy a monopoly at the expense of their fellow-men.

The suggestion that patents, when granted, should be absolute surely cannot have been the result of mature consideration on the part of persons having large experience of patent matters in general, and of the practical working of preliminary examination systems in particular. Those who propose absolute patents also make another suggestion, a very superficial consideration of which will (if regard be had to the history of progress in the industrial arts, due to successive improvements) at once show how impolitic, not to say impracticable, such a scheme must be. There is a suggestion, that will be presently dealt with, to the effect that an impracticable or unworkable patent should not invalidate a later though similar workable patent. Here at once is implied an admission that no system of examination will suffice to prevent the granting of patents for impracticable and unworkable inventions. Could anything be more illogical than to grant an absolute patent for an impracticable or unworkable idea, thus entitling the grantee to levy blackmail from those who may subsequently produce a practicable and workable thing? The policy of the Patent Law is, and should be, to grant to those who devote themselves to the improvement and advancement of the manufacturing arts a reward, in the form of an exclusive privilege of limited duration, in return for the benefit conferred upon the community by the disclosure of some new and useful invention, which, on the expiration of the term of exclusive privilege, the public at large will be at liberty to freely exercise and enjoy. This consideration, and every other consideration, would be utterly wanting in the case of an exclusive privilege granted in respect of an impracticable or unworkable idea. But this is not all. The grave responsibility cast upon those charged with the administration of the law when determining whether or no Letters Patent should be granted in a given case, must inevitably result in a practice of granting patents very sparingly. The effect would unquestionably be to damp the progress of invention by refusal of patents for improvements which, from an examination of the mere specification, might appear unimportant, but which, if allowed to go forth as the subject matter of Letters Patent granted to the applicant at his own risk and without Government guarantee, and to be commercially introduced, might be productive of the most beneficial results. When it is remembered that in cases of litigation experts of eminence constantly differ, when on oath, as to whether two things are practically the same; as to whether one thing is an improvement on another; as to whether one thing will work and another will not, and so forth; and this after the invention forming the subject matter of the patent in dispute has been introduced into practical use, it is only natural to ask what conceivable kind of a staff of examiners could be entrusted with the investigation and decision, from documents alone, of questions of the exceedingly intricate and highly important nature necessarily involved in the determination of the question whether a given invention should or should not become absolutely and exclusively, for a term of years, the property of the person seeking that privilege.

An inventor who applies for a patent surely (as a rule) does so in the belief that his invention is new, that it is workable, and that it is valuable. He may be mistaken; sometimes the most experienced of men in a given profession or trade are mistaken. Sometimes an invention promising the most favourable result on paper, turns out, when put into practice, to be a failure, or at least to need very material modification before it will work. But if those with practical experience who have devoted special consideration to the matter are unable to perceive defects, how is it to be expected that examiners, dealing with innumerable cases involving a variety of subjects, could be relied upon to form a correct judgment? In the same connection, let it be remembered that inventions which men of experience have pronounced impracticable have sometimes proved not only practicable but exceedingly valuable. In such a case what is to compensate, not only the unfortunate inventor, but also the community, for the loss incidental to the improper refusal of a patent, and the consequent loss to the public of the benefits that would have accrued from the early introduction of the invention into the market?

And last, though not least, let it be remembered that the granting of absolute patents would render it necessary for every manufacturer to incur the anxiety and expense of at least continually employing some one (in some cases it might be quite a staff) to watch closely, and from time to time take steps that might by costly, with a view to preventing anyone getting a patent for something already used in the manufacturer's own works; because should a patent once issue, the manufacturer would be entirely at the mercy of the patentee, and might be compelled to leave off doing that which he might have been doing, even continuously and on a large scale, perhaps for years.

As an alternative, it has been suggested that it should be so arranged that Patent Office officials should carry out searches on behalf of inventors. If this means that every application for a patent should be subjected to examination as to novelty, it is quite possible that a workable system might be devised. But those who talk about the advantages of the examination systems that obtain in the United States and in Germany have yet a great deal to learn. They evidently have not any idea of the large proportion of invalid patents that are granted, notwithstanding the irritating investigations and the often unreasonable requirements of officials. They are ignorant as to the large number of patents which, after being granted, are declared invalid, both in Germany and the United States, and in the case of the United States, of whose patent system many of the uninitiated seem to be enamoured, they little dream of the enormous amount of money that is being constantly spent in litigation concerning the validity of such grants; nor do those who so urgently demand an exhaustive official examination preparatory to the grant of Letters Patent, know how often patents have been refused for meritorious inventions. We do not want in this country a system under which patents might be refused for inventions of such importance, for examples, as the Bessemer Process or the Siemens Regenerative Furnace. If the proposal under notice means that Patent Office officials should undertake to perform for inventors work now entrusted to patent agents, the way will be paved to an interesting inquiry. It will naturally be asked to what extent the principle is to be conceded of providing officials at the public expense to perform for the benefit of a class work which a number of tax-payers have specially qualified themselves to undertake, and whereby they obtain a livelihood. It is only necessary, for the moment, to add, that the attempt made under the Act of 1883 to enable inventors to dispense with professional aid has lamentably failed, as was to be expected. In a very large proportion of cases, notwithstanding the official examination, the patents taken out without professional assistance by persons ignorant of even the elementary principles of patent law and practice, have literally been worthless. Such provisions are simply misleading, and have the effect of frequently depriving the luckless inventor of the benefit he might otherwise have derived from his invention.

A further proposal is that a time limit may be fixed, beyond which an impracticable or unworkable patent should not invalidate a later though similar workable patent. It will be interesting to learn what is meant by this suggestion. If it has any meaning whatever, it rather seems to indicate that, contrary to precedent, up to a certain time an impracticable or unworkable patent *should* invalidate a later though similar workable patent. It is well recognised by our Courts that an antecedent specification ought not to be held to be an anticipation of a subsequent discovery, unless it has been ascertained that the antecedent specification discloses a practicable mode of producing the result which is the effect of the subsequent discovery. Of course, the difficulty is to determine the facts. If those responsible for the suggestion under notice are prepared to do that of which, so far, there appears no indication, namely, to unfold a feasible plan of readily determining when a patent is impracticable or unworkable and when a later, though similar, patent is workable, without all the delays, heavy costs, and uncertainty incidental to a judicial investigation with expert evidence, &c., then they will assuredly be entitled to the thanks of the whole community.

The most effectual mode of weeding out impracticable and unworkable patents is by making all patents subject to annual payments. These need not be large. A patent having been in existence for four years, if it be not impracticable or unworkable, the owner would have no difficulty in providing, say, a couple of pounds to keep it in force for another year, and so on. Even assuming, for the moment, that the fees for fourteen years were reduced to £25, then, roughly speaking, £2 per annum would be a reasonable charge for renewing the patent, year by year, after the fourth year of its term.

A further proposal is that a new class of Letters Patent be introduced at a low fee, and arranged to protect articles where the protection sought is limited to one purpose. This, like other proposals, is crude and indefinite, and, therefore, difficult to deal with; but no doubt there are certain classes of inventions that do not come strictly within the provisions of the existing law, but which might advantageously be protected for a limited time. The difficulty is to satisfactorily define inventions of this character, and to differentiate them from such as come legitimately within the purview of the Statute of Monopolies as interpreted by the Courts.

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LEGAL INTELLIGENCE.

Woodhouse and Rawson United (Limited).

Mr. Justice North has granted an order calling upon the Lord Mayor's Court Authorities to withdraw from possession of certain goods on the premises of Woodhouse and Rawson United (Limited), which were taken in execution under writs of fi. fa., a Receiver being in possession. In granting the Order his Lordship expressed the opinion that a gross contempt of Court on the part of the execution creditors had taken place, and costs of this action will have to be paid by them.

Last week at Brentford an action was brought by Mr. W. S. Sargeant, of Chiswick, against Mr. E. Edwards, for the recovery of a balance of £38 odd for work done on the steam launch "Lady Violet," and for insurance, &c. A counter claim by Mr. Edwards for £27 for services rendered in connection with the registration of patents was also tried. It appeared that Mr. Sargeant was engaged by Mr. Edwards to construct a steam launch to be worked by a specified engine, to be supplied by the defendant. After the launch was built considerable alterations had to be made, and it was to recover the cost of these alterations that Mr. Sergeant brought the present action. The defence was that the plaintiff had assigned his interest in a debt to Woodhouse and Rawson United (Limited), and to prove this the defendant was called, and stated that he had received a notice from the plaintiff to the effect stated. The defendant further stated that he had already settled with Messrs. Woodhouse and Rawson for various accounts for £65, which included the amount of the present claim. Ultimately Judge Bagshawe reserved judgment in the first action and in the cross action gave Mr. Edwards £15. 1s. 5d. and the costs of the action.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March* 24, 1893.

The Telautograph.—The private exhibition of Prof. Elisha Gray's telautograph, of which I spoke in my last letter, took place on Tuesday last simultaneously at the offices of the Gray National Telautograph Company in New York and Chicago, before numerous representatives of the press. At these exhibitions the actual distances covered were not great, as the messages were transmitted only between the various rooms of the Company in each building. Resistances, however, were introduced into the lines so as to make them as nearly equivalent as possible to a mile in length. All of the instruments were connected to a switchboard similar in all essentials to a telephone switchboard, through which they were inter-connected as desired. About one hundred representatives of the Press responded to the invitations to the New York office, and the result has been that the new invention has been well written up. The exhibition, while a success as far as it went, does not appear to satisfy the technical mind that the instrument will have a large practical use. While the reproduction was reasonably perfect, sufficiently so as to preserve the individuality of the handwriting, the transmission seemed to be slow and laborious and the action of the receiving instrument somewhat awkward. It is probably a fact that letters rapidly written cannot be faithfully reproduced, and that as far as speed is concerned there can be no comparison with the ordinary transmission by the Morse code. Since two circuits are required for the transmission of the rectilinear components of the curves, three wires are essential, which means a multiplicity of connections in the switchboard, already too complicated in telephonic installations. The impossibility of multiple transmission over the same circuits by the methods involved is another bar to its successful competition with the present methods of telegraphic communication. The expense necessarily attached to the installation of such circuits and their maintenance will prove an insurmountable obstacle to their general introduction. It has some special advantages, however, over other methods of communication, one of which is that the message is autographic and is recorded, and, where one is connected with the exchange, it may be received in his office during his absence and without the necessity of passing through the hands of a third party. It would seem, however, that its largest application would necessarily be between central offices and thence by means of a messenger to the party addressed. The instrument has been much simplified since Prof. Gray's first attempt, but, notwithstanding this, it seems to be capable of further simplification before it can become a commercial instrument, even in its most favourable field.

The Lamp Question.—The General Electric Company are continuing their crusade against infringing lamp manufacturers, as evidenced by two new applications for injunctions last week. These were against the Germania Electric Company and the Boston Incandescent Lamp Company, both of Boston, Massachusetts, to prohibit them from manufacturing incandescent lamps. It is a significant fact that the outside concerns now accept the past decisions as final, that both of these companies agreed to the issuance of injunctions, and that it should be made permanent. The Germania Company also at once made an assignment, and asked that a receiver be appointed to wind up its business.

CORRESPONDENCE.

HIGH VACUUM TUBES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read with interest Mr. Rimington's article on "A Novel Electroscope" in *The Electrician* of March 24th. I discovered the effects of a charge of electricity on a vacuum tube about eighteen months ago. I then found that when a charged body was rapidly approached to, or withdrawn from, a vacuum tube, an instantaneous flash of light was the result, too faint to be seen, however, except in total darkness; but the denser the electrification the brighter the light, which also became more visible on increasing the rapidity of motion. To produce the best effects, I therefore revolved the tube by its centre in a perpendicular position at a high speed, which seems to be Mr. Rimington's method.

I also found that the same glow of light was induced in the tube by rubbing it on silk, flannel, &c.; and that if the tube was rubbed sideways along a long rubber, the light continued in intermittent flashes for about five minutes after removing the tube from the rubber, the flashes being about five seconds apart. If the tube is discharged by drawing a conductor along it, a succession of cracks is heard accompanied by flashes of light. An electrodeless tube was used, but an ordinary Giessler tube will produce the first effect; but the continued flashes are only seen in tubes of high vacua.—Yours &c.,

Greenwich, March 28, 1893. H. L. KERDEL.

A HYSTERESIS THEORY OF BROWN'S ALTERNATING-CURRENT MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. J. A. Kingdon, in his article on "A Hysteresis Theory of Brown's Alternating-Current Motor," makes the curious assertion that the mathematical theory of alternate currents gives the current in the secondary in quadrature with the primary current. That this idea is erroneous may be simply shown thus. The differential equation to the secondary is

$$N\,dc_2/dt + M\,dc_1/dt + r_2 c_2 = 0;$$

where N is the self-induction of the secondary, M the mutual induction, r_2 the resistance of the secondary circuit; c_1 the primary and c_2 the secondary current. Assuming the currents as sine functions differing in phase, let $c_1 = C_1 \sin pt$ and $c_2 = C_2 \sin (pt+\theta)$, θ being the difference in phase between the two.

Then

$$p\,N\,C_2 \cos(pt+\theta) + p\,M\,C_1 \cos pt + C_2 r_2 \sin(pt+\theta) = 0.$$

$$C_2\{r_2 \sin(pt+\theta) + p\,N \cos(pt+\theta)\} = -p\,M\,C_1 \cos pt$$
$$= p\,M\,C_1 \sin(pt+\pi/2+\pi).$$

Hence

$$C_2 \sqrt{r_2^2 + p^2}\,N^2 \sin(pt+\theta+\phi) = C_1\,p\,M \sin(pt+\pi/2+\pi)$$

and this equation must hold for all values of t. Therefore

$$\theta + \phi = \pi + \pi/2 \text{ and } \tan\phi = pN/r_2,$$

$$\theta = \pi + (\pi/2 - \phi) \text{ and } \tan\theta = \cot\phi = r_2/pN,$$

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If p N is large compared to r_2, ϕ will be nearly equal to $\pi/2$, but always less than it. Hence θ is nearly equal to π, but always greater than it, and θ is the angle by which the secondary current is *ahead* of the primary. It would, of course, come to the same thing to say that the secondary current lagged *behind* the primary by an angle rather less than π.

Of course, if the secondary circuit is open, the E.M.F. induced in it will be in quadrature with the primary current, as will be seen by making r_2 infinite, then tan $\phi = 0$ and $\phi = 0$. Hence $\theta = \pi + \pi/2$, or the secondary E.M.F. is $\pi/2$ behind the primary current. It must be remembered that this is not the current driving E.M.F. in the secondary, but that the E.M.F. of self-induction, which differs from it in phase, has to be subtracted.

With regard to the hysteresis question, if, as Mr. Kingdon tries to prove, the repulsion produced be due to hysteresis and not to the effect of self-induction, how does he explain the repulsion of wire rings and rotation of copper discs &c. when brought near an electromagnet excited by an alternating current (Elihu Thomson's experiments), since in this case the moving parts have no iron in which hysteresis can be developed? In all probability, as was pointed out in the editorial notes, the effect of the hysteresis is very small compared to that due to the self-induction, and there seems every reason to suppose that a motor constructed on these lines without iron at all would work, though of course feebly as the magnetic induction would be weak.—Yours, &c.

E. C. Rimington.

Lynton House, The Park, Norwood, S.E.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Tenders Invited.—The Council of the Borough of Brighton require tenders for Lancashire boilers, steam and water system and piping, with feed pump; steam dynamos, and a motor-dynamo. Further particulars are given in our advertisement columns, and all information can be obtained of Mr. F. J. Tillstone, Town Clerk, Town Hall, Brighton. Tenders must be in by 10 a.m. on Monday, the 17th inst.

——— The Gas Committee of the Salford Borough Council invite tenders for the supply and erection of boilers, engines, electrical plant and mains, &c., for their electricity supply works. Some particulars appear in our advertisement columns, and full information may be obtained from Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, S.W. Tenders must be delivered to Mr. S. Brown, Town Clerk, before 5 p.m. on May 4th.

——— The Manchester Libraries Committee invite tenders for wiring and appliances for the electric lighting of the Free Reference Library, King-street, Manchester. Tenders must be in by April 15th. Further particulars appear in our advertisement columns.

——— The Corporation of Derby require tenders for the construction and laying of mains, and the supply of transformers, transformer boxes, lamps, posts, and accessories. Tenders must be in by the 17th inst.

——— Tenders will be received up to September 1st for the lighting by gas or electricity of the town of Szegedin (Hungary). Particulars can be obtained of the municipal engineer.

——— Readers are reminded that the tenders for the stock, plant, machinery and effects of an electrical and general engineering business, with patents, licences and goodwill, which has been established in the West Riding of Yorkshire for over fifteen years, and which is for disposal by Messrs. Lakeman and Oliver, must be in not later than Wednesday next, April 12th.

——— The French Direction des Postes et Télégraphes will, on the 13th inst., open tenders for creosoted telegraph poles, electric cables, tubes, curved and elbow-pieces, sleeve joints, junction pieces, and junction boxes. Information as to the schedule of prices can be obtained at the Third Bureau of the Division du Matériel et de l'Exploitation Électrique, 103, Rue de Grenelle, Paris.

Tenders Accepted.—Subject to certain deductions for simplification in the design agreed to by the Lighting Committee of the Cardiff Corporation, the tender of Messrs. W. Thomas and Co., of West Bute Dock, Cardiff, has been accepted for the construction of the chimney to be erected at the electric light works at Leckwith Common, the amount being £2,967.

——— The Electric Lighting Committee of the Whitehaven Trustees recommend the acceptance of the tender of Messrs. Siemens Brothers and Co. (Limited) for providing and laying the conductors for the Whitehaven electric lighting scheme. It is stated that a considerable saving will be effected on the contract originally entered into with the International Okonite Company (Limited), but which was rescinded a short time back.

——— The Electric Lighting Committee of the Bristol Corporation have accepted the tender of the Brush Electrical Engineering Company (Limited) for the equipment of the substations for the sum of £1,752.

Removal Notices.—The office of Elmore's German and Austro-Hungarian Metal Company (Limited) have been removed from 64, Cannon-street, E.C., to Broad-street-avenue, E.C. Mr. H. Ellis has been appointed secretary to the Company, *vice* Mr. J. Shurmer, who has resigned.

——— The Electrical Accessories Company (Limited) are removing their offices from 5, Macclesfield-street, Shaftesbury-avenue, W., to 110, Charing Cross-road, London, W.C., with works at Birmingham, as hitherto.

——— The offices of *Electricity* have been removed from Cannon-street to 29, Ludgate-hill, E.C.

Personal.—Mr. W. Farrar has resigned his position with the Corlett Electrical Engineering Company, Wigan, and has joined Messrs. Rosling and Matthews, of Trafalgar Works, Bradford.

——— Mr. C. N. Russell having resigned his position at Acton Hill, has been appointed engineer and manager to the London and Lancashire Electric and General Engineering Company, Limited, at Dalston, London, N.E.

Dissolution of Partnership.—Frank Reid and William Nichol, electrical engineers, Forth House, Bewick-street, Newcastle-upon-Tyne.

Bankruptcy.—The public examination of Edward James Bayly, electrical engineer, of 2, Selborne-street, Liverpool, lately adjudicated a bankrupt, is to take place at the Liverpool County Court on the 13th inst., at 11.——Frederick George Williams, lately trading as Kenyon and Co., electrical engineers, Crown Point, Denton, Lancs., has been granted his discharge, subject to the payment forthwith to the trustee of the sum of £193.

Lamp Shades.—Miss Overend, of Garville-avenue, Rathgar, Dublin, has recently designed a very ornamental lamp shade, particularly suitable for use with incandescent electric lamps. The shade is made up of crimped strips or ribbons of coloured paper representing floral combinations.

Messrs. Hodges and Todd.—This firm have just issued a new illustrated list of ammeters and voltmeters, battery cell testers, switch boards, resistance frames, &c.

Edison-Swan Price List.—The Edison and Swan United Electric Light Company have divided their price list into three sections, the first relating to lamps, the second to fittings, and the third to measuring instruments. Absence of competition has certainly not limited the number of varieties of lamps. Some 112 illustrations of lamps are given, most of them full size. The special lamps are sold, with but few exceptions, at the ordinary price. Among these special lamps we find some new forms of "focus lamps" for optical lanterns, from 8 c.p. to 200 c.p., the last being a formidable-looking affair. A number of flat lamps for portable reading-lamps are made. Double filament lamps for side lights of ships; lamps for chemical factories and gunpowder mills; long-necked flat lamps for exploring between the plates of a secondary battery; and a large number of fancy shapes are offered. Among a number of lamp holders of the most improved type, we find in Section II. the very earliest forms of wooden holders with spiral springs and outside terminals. That these are generally to be condemned few will deny; it is suggested in the price list that they are suitable for small, low-volt lamps. A considerable variety of switches and some complete switchboards are illustrated, and coloured plates of decorated porcelain fittings and fancy glass shades are given. Section III. contains gravity ammeters, and gravity, Cardew, and Fleming and Gimingham voltmeters, and a curious relic of bygone days, the Edison meter, to keep the wooden lampholders in company, perhaps.

An Automatic Accumulator Switch.—We illustrate below the latest form of the "Nevile" patent automatic accumulator switch, for which Messrs. Drake and Gorham are the agents for Great Britain. The switch is designed to prevent the current from a battery of accumulators from discharging itself through the dynamo when for any reason, such as a belt breaking or the gas supply of a gas engine being accidentally cut off, the E.M.F. of the

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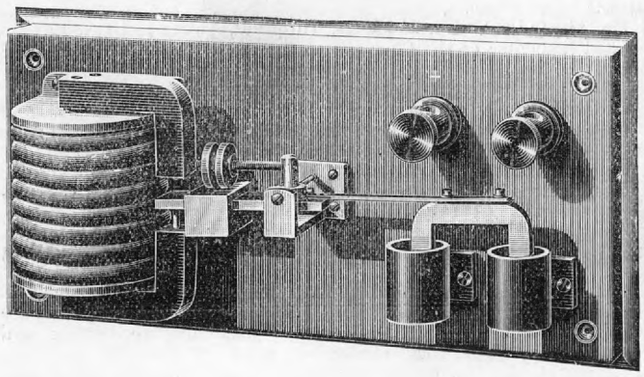
dynamo falls below that of the battery. Objection to this class of apparatus was formerly that springs were used in actuating them; or that they were so wound that during the whole time of working a small current was flowing from the battery through the instrument, causing waste and heating; or that it has generally been necessary to adjust them for one particular E.M.F., which has therefore been the highest one at which the battery was likely to be. Thus, when the apparatus was first started with the battery low it would not close the circuit until the dynamo was considerably above the battery in E.M.F., causing a jump in the lights, a



shock to the dynamo, and sometimes severing the main fuses by the large current generated. The "Nevile" apparatus is constructed somewhat on the principle of a polarised relay, and is so wound that so long as the E.M.F. of the battery is greater than that of the dynamo, the circuit is held open, but as soon as the E.M.F. of the dynamo exceeds that of the battery, the tendency of the switch is to move, a difference of 1 per cent. or 2 per cent. in the E.M.F. being sufficient to close the circuit, which is done by a copper fork dipping into two mercury cups. The opening or closing is effected when the E.M.F. on the two sides is practically the same, the current then passing being so small that, even with a switch constructed to carry 200 amperes, the spark is scarcely perceptible. The switch (printed instructions for fixing which are issued) has been considerably improved and modified lately, and can be obtained from Messrs. Drake and Gorham.

Barrow.—A Sub-Committee is to be appointed to consider and report to the County Council on the subject of applying for a Provisional Order empowering the Corporation to adopt and carry out a scheme of electric lighting for the borough.

Barry Dock.—Mr. F. J. Evans, the electrician to the Barry Railway Company, has successfully adapted the electric current to No. 12 coal tip at the Barry Dock Works, enabling 50 laden waggons to be drawn up to the tip at a time, an achievement which the old hydraulic method has never succeeded in accomplishing.

Birmingham.—The Birmingham Electric Supply Company have now reduced their rates to from 8d. per unit for supplies under 150 units down to 6d. per unit for above 600 units. These rates take the place of rebates previously allowed.

Birkenhead.—A sub-committee of the Town Council have under their consideration the question of the electric lighting of the borough, and strongly recommend the Council to carry out the provisions of their Provisional Order themselves. It was pointed out that unless the matter received the immediate attention of the Council their Provisional Order was in jeopardy, and the Board of Trade would be disposed to confer the powers upon a supply company to the exclusion of the Corporation.

Bournemouth.—The Town Council have been notified by the Board of Trade that should they decide upon lighting the gardens and pier by electricity a Provisional Order will be required. This could not be obtained this year, but a licence could probably be secured in about four months. The matter has been referred to a committee.

Cleckheaton.—A Local Government Board inquiry has been held in respect to the application for borrowing £5,540 for the Town Hall scheme, which includes a complete installation of the electric light.

Country House Lighting.—Goodrich Court, near Ross, Hereford, in the occupation of Mr. H. C. Moffatt, has recently been lighted by electricity. Two Spiel's patent oil engines, one of 10 and one of 2½ H.P., drive a 130-volt Goolden dynamo. The current is conveyed from the engine-room to Goodrich Court, a distance of 230 yards, through underground cables laid in bitumen casings up a very steep gradient, and charges a set of 54 Epstein accumulators, which store sufficient energy for from three to four days' ordinary consumption. The installation consists of about 250 incandescents, and the butler has sole charge of the controlling switches. The work has been carried out under the supervision of Mr. J. B. Cumberland, of Messrs. Rooper and Tozer.

Derry.—Notwithstanding an amendment that the matter of the electric lighting of the city should be postponed, the report of the Electric Lighting Committee was passed at the last meeting of the Corporation.

Dundalk.—The Town Commissioners have received a letter from Mr. T. M. Healy, M.P., stating that the Board of Trade are prepared to take into consideration the application for the renewal of the electric-lighting licence, which expires in July next, and which the Board had previously refused to renew. A special meeting of the Commissioners has been called to consider the subject.

Dundee.—The electric light is in considerable demand here, and an application has been made to the Works Committee to extend the lighting to the Dudhope-terrace district of the city. This would involve a further outlay of £2,000. It is probable that the Royal Infirmary will shortly adopt the electric light.

Falkirk.—A report has been presented to the Town Council by Mr. Neilson, their inspector, with reference to the proposed electric lighting scheme, in which he states that from inquiries he made he found that the engine plant at present in use for hydraulic purposes was insufficient for the electric lighting work, and he had therefore turned his attention to the utilisation of the water discharging into the Little Denny reservoir. He had consulted several engineers on the subject, and the result of his inquiries was that he had calculated that by using a turbine wheel at least 200 H.P. would be available for the purposes of electric lighting, and another turbine could be erected equal to a further 30 H.P. The estimate was rough, but he believed that the whole of the public lighting by electricity in the borough, including the public buildings, could be effected at an annual cost of about £500, including interest on capital, &c. During the past financial year they had paid for gas lighting purposes nearly £1,100. The report was remitted to the Lighting Committee for their consideration, with instructions from the Council to obtain from a firm of electrical engineers definite information on the subject.

Gartloch Asylum.—At the last meeting of the Glasgow District Lunacy Board it was decided to adopt the electric light for the new asylum which is being erected at Gartloch.

Guildford.—The Town Council have received the report of the Electric Lighting Committee regarding the proposed Provisional Order. The Committee advise the Council to withhold their consent to the granting of a Provisional Order to a private company, unless satisfactory terms can be arranged and a clause inserted arranging for the acquisition of the undertaking by the Council on reasonable terms. The Council have adopted the Committee's recommendations.

Halifax.—At a recent meeting of the Gas Works Committee of the Corporation in relation to an electric lighting scheme, the electrical engineer (Mr. Wilmshurst) reported favourably on the system of electric lighting adopted at Huddersfield, Bristol, Worcester, &c. Mr. Wilmshurst considers that the system adopted by these towns is economical, as is proved by the substantial dividends already being paid by companies working it. A warehouse recently occupied by the Salvation Army is suggested as the site for a central station; it is estimated that this building will accommodate sufficient plant and machinery for from 50,000 to 60,000 8-c.p. lamps. Mr. Wilmshurst recommends that high-pressure mains be laid throughout the main streets in the compulsory area, and that two sub-stations, one near the Town Hall and the other near the Post Office be erected. The total estimated cost of the plant recommended to be first put down is £23,600, and the ultimate cost of the scheme would be from £30,000 to £32,000.

Heckmondwike.—A public meeting was held last week for the purpose of again explaining the scheme for electric lighting here. There is to be an election of four members to the Local Board, chiefly on the electric lighting question, and the object of the meeting was to give those gentleman who are interesting themselves in bringing the matter prominently forward an opportunity of explaining their views. A resolution approving the scheme was unanimously adopted.

Hotel Lighting.—The *City Press* directs attention to the hesitancy shown by hotel keepers before adopting the electric light. One of the few hotels which now possess a complete electric lighting installation from cellar to top floor is the Cannon-street Hotel, London, E.C. This is one of the largest private lighting plants in London, and has cost nearly £5,000. The work of fitting and completing has been in progress for nearly two years. Mr. W. Durtnall has had charge of the entire installation, which, we understand, has proved completely successful. Great care has been taken to perfect every detail; the underground cables are run through glass-lined iron

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tubes, and a connection is made with Mr. Durtnall's private room by which he is apprised of any accident during his absence from the generating room. At present there are only 1,000 lamps alight, but ultimately these will number between 1,400 and 1,500. It is more than likely that the cooking for the hotel will shortly be effected by electricity, and it is intended to run the laundry by electric instead of steam power. From a financial point of view the result is highly satisfactory.

HULL.—Mr. Holder, the Chairman of the Electric Lighting Committee, in referring to numerous applications for the electric light from residents and business men outside the district at present served, stated that the testimony of those who had used the electric light, not only for its saving over gas, but also for its general usefulness, had convinced those residing outside the area of the value of the light. It has been decided to circularise the district, and it is anticipated that a considerable extension of the light will ultimately be necessary.

ILFORD.—The Ratepayers' Association do not appear to be atis-s fied with the resolution of the Local Board to shelve the question of electric lighting for the present. A requisition has been made by the Chairman of the Ratepayers' Association to inspect the report of the expert employed by the Board, and the request has been acceded to.

LECTURES.—Amongst recent lectures on Electricity we note one by Mr. N. H. Watkinson on "Electric Welding," at Glasgow; by Mr. G. Fletcher, at the Derby Municipal Technical College, and also by Mr. J. Ritchie, at Edinburgh, on "Utilisation of Water-Power."

LOANHEAD.—The Shotts Iron Company have introduced the electric light into the Burghlee section of their colleries at Loanhead. The machinery is only partly employed at present, but it is ultimately intended to light the workshops, engine-houses, and the bottoms of the various pits. The Company contemplate extending the installation to their Ramsay colliery.

MOSS SIDE.—The works in connection with the electric lighting of this district are to be begun at once, and it is anticipated that the Whalley Range district will be lighted by next winter. The township is to have a telephonic exchange, the wires to be laid underground.

REDDITCH.—In connection with the renovation of St. Stephen's Church the authorities have under consideration the introduction of the electric light. Local rumours are to the effect that a supply company is shortly to be formed to serve the district.

SCARBOROUGH.—Mr. Bernard Drake, who is advising the Corporation, recommends this body to adopt the system of laying mains in cast-iron pipes with junction boxes, and also the use of the footpaths in preference to the carriage-ways for the mains.

SHEFFIELD.—Mr. John Tasker, owing to ill health, has resigned the Chairmanship of the Sheffield Electric Light and Power Company (Limited), and Mr. George Franklin has been elected Chairman in his stead. Mr. W. S. Laycock will fill the vacancy on the Board.

TIVERTON.—A special report by Mr. J. Siddalls, surveyor to the Town Council, on the proposed electric lighting scheme for the borough has been printed and will shortly be issued.

TUNBRIDGE WELLS.—In reference to the subject of introducing the electric light at Tunbridge Wells, considerable correspondence has appeared in the local press, and reference has been made from time to time to the lighting of the City of London. Sir David Salomons, in a recent letter on the subject, points out a number of advantages which the electric light has given to the City which have not been fairly stated in the correspondence that has appeared, and he refers to a breakdown which recently occurred, and which, although it only lasted for eight minutes, was sufficiently serious. In digging the trenches for the permanent works, some of the pipes containing the cables from the pioneer station were exposed, and one of the stokers, instead of throwing the hot ashes from a boiler furnace into the usual receptacle, thought it more convenient to throw them into the open trench in which were the exposed pipes, with the result that the insulation on the cables was melted. This sufficiently explains an incident of which those opposed to the introduction of the electric light at Tunbridge Wells have made much.

WAKEFIELD.—In the estimates accompanying the plans for lighting the new offices of the County Council, provision is made for the electric light. A number of business men in the city have also the question of lighting their premises by electricity under consideration.

WEST HAM.—The Works Committee of the Town Council, in presenting their last report, state they have further considered the subject of electric lighting in the borough, and that they recommend the Council to put in force the Provisional Order obtained in June last, and proceed to carry out the scheme for lighting the principal streets of the district.

RE WOODHOUSE AND RAWSON UNITED, LIMITED.

At the moment of going to press we have received a circular signed by Sir Rawson W. Rawson and Mr. Samuel Pope, Q.C. (dated 5th April), an abstract of which we give below :—

As trustees for the Debenture Stock of this Company, we are advised that it is our duty to call a meeting of the stockholders with a view to their considering the present position, and their course of action in the future. We think it best, also, to invite the attendance of all the other creditors of the Company, whether secured or unsecured, at the meeting which we propose to call, with a view to taking their opinion also as to what should be done.

Mr. Alexander Young, of Messrs. Turquand, Young and Co., was appointed liquidator of the Company at the recent General Meeting, and Mr. F. D. Leslie, of Messrs. Robinson and Leslie, has been appointed by the Court Receiver of the Company's assets and manager of the business, as representing all the secured creditors.

Petitions have also been presented against the Company to wind it up compulsorily, one by a debenture holder for an amount of £250, and the other by a creditor for £185. and, as they will come on for hearing on the 11th April, it is important that the views of the creditors should be represented before the Court.

A meeting will, therefore, be held of all the creditors of the Company on Monday, the 10th inst., at 12 o'clock, at the Cannon-street Hotel, E.C., at which we shall shortly lay the facts before the creditors, with the object of their views being represented on the hearing of the petitions. Now that the liquidator has been appointed, the Directors have no responsibility for the further management of the Company's affairs, but are desirous of a reconstruction scheme being carried out, which will not only save some of the shareholders' money, but will enable the creditors to be paid in full. It is to the interest of all creditors to attend the meeting.

On the one hand it is suggested that a hasty and immediate realisation of the Company's assets under a compulsory winding-up will probably result in a heavy loss even to the secured creditors; and, on the other hand, it is believed by many of those interested in the Company that a reconstruction scheme may be carried through which will not only pay all the creditors in full, but leave a substantial balance for the shareholders. We cannot give details of the scheme, which is, we understand, at present before counsel, but we are able so say that the outline of the scheme is as follows :—

1. That a new Company be formed under a new Board of Directors, to be subsequently appointed by the subscribers, for the purpose of carrying on so much of the business of the old Company as promises to be profitable, and constituting a channel through which the assets may be advantageously realised.

2. That the receiver of the Company's assets will not part with any of those assets to the new Company proposed to be formed without receiving cash, or unquestionable security to the value of the assets so to be transferred to the new Company.

3. That any new money to be found as working capital for the new Company shall not be subject to the liabilities of the old Company.

4. That the sum of £25,000 be provided as working capital of the new Company, this sum to be raised either from shareholders or from other persons outside the Company, who will receive as consideration for finding this money bonds or other securities entitling them to a preferential claim upon the profits of the new Company.

5. The proceeds of the assets sold to the new Company or others will be distributed by the Receiver to the creditors of the old Company according to their priorities.

6. The new Company will assist the Receiver in realising those assets of the old Company which can be utilised in the business of the new Company by the way of fulfilling their contracts, and in the ordinary course of trade.

7. Those portions of the Company's premises which are especially suitable for the trade which will be carried on by the new Company will be leased to the new Company.

We are extremely anxious that all the creditors of the Company should attend the meeting of which we have given you the above notice, but in the event of your being unfortunately unable to do so, we shall be glad to know your views, whether favourable or adverse to a scheme of reconstruction based upon the above principles, and we shall be much obliged if you will return to us the form enclosed, signing the same, and altering it to suit your views, if you are opposed to the scheme. Fuller particulars will be given at the meeting, and later on the reconstruction scheme will be laid before you in its entirety.

COMPANIES' MEETINGS & REPORTS.

Elmore's French Patent Copper Depositing Company (Limited).

The following circular letter has been issued by the Directors of this Company, accompanying the statement of accounts referred to :—

"Herewith we beg to send you accounts made up to December 31st last. From these you will see that the total amount of working capital that the Company have had at their disposal at the date of the balance-sheet from shares and debentures, after paying for patents, has been £140,061. In addition to this, the Company have had upon second mortgage £39,353,

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and from loans the sum of £28,789, and have incurred further liabilities amounting to £21,761. This sum has been expended as follows :—(1) Cost of land, buildings, plant, furniture, stock, cash in hand and other assets, £169,458. (2) Expenses of issue of preference capital, £3,334, which would, in the ordinary course, be spread over a series of years. (3) Expenses up to May 31, 1892, connected with the establishment of the Company, the working out in the laboratory and works of the details of the process and alterations connected therewith, and in connection with the new patents taken out by the Company, £18,483, the major portion of which could be either put to capital account, or the whole extended over a series of years. (4) Administration charges in Paris and London up to May 31, 1892, which might be spread over a term of years, but which it would be more prudent to write off at once—namely, £14,416. (5) The amount paid by the Company as interest and commission, £4,165, after deducting interest received on deposits, £609, which must be written off. (6) With regard to the bonus credited, but not yet paid, to the Foreign Company, namely, £3,000, this, the Directors hope, will be waived. (7) The remaining items for rent of water-power and loss by exchange on sending money to Paris amount to £1,256. The profit and loss is taken from June 1 to December 31, 1892, which is the time that the Company has been at work regularly. It may be recollected that Sir Frederick Bramwell and Mr. Harris estimated that 12½ tons per week would pay all expenses. Owing to the small output during this period, namely, about 7 tons per week, the loss in manufacturing amounts to £5,187. Of this there is a certain amount of copper existent in the furnace bottoms, which is recoverable when these furnaces are ultimately taken up, though in the accounts treated as loss. The total administration expenses in France during this period amount to £2,972, and in London to £2,427. These charges are increased beyond the normal by incidental expenditure and professional charges, travelling expenses, &c. The amount of interest and commission comes to £4,884 for the same period, whilst the interest on debentures comes to £1,750, and the rent of water-power at Bellegarde to £1,687, The Directors consider that in normal working the administration charges in Paris and London ought be covered by £5,000 per annum, unless the business is carried on on a much larger scale than is proposed. Naturally, at the outset of the Company heavy expenses have had to be incurred under this head."

A circular has also been issued, signed "Maddisons," in which exception is taken to the "share holdings" of the Committee of Investigation recently inquiring into the affairs of this Company, consisting of Messrs. Saunders, M.P., and Storey, M.P., and Sir Thomas Farrer. Mr. Storey, in reply, states that he holds a considerable number of shares in the Company, the bulk of which cost him 2¾, and none less than 1¾, and he further states that the object of calling the recent meeting was to put a stop to the extravagant daily loss, and to secure what he could for himself and his co-shareholders. Mr. Burnside, who was selected as financial expert to assist the Committee in their investigations, has (Mr. Storey states) never bought, sold or held a share in the Company at any time.

An extraordinary general meeting of this Company was held yesterday at Winchester House, E.C., Major Jones in the chair, to consider, and if approved, pass the following extraordinary resolution :—

"*That it has been proved to the satisfaction of this meeting that the Company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the Company be wound up voluntarily.*"

The SECRETARY (Mr. J. Shurmer) having read the notice calling the meeting,

The CHAIRMAN stated that the meeting had been called in fulfilment of an undertaking given by the Directors at the recent informal meeting of certain shareholders. At that time the Board expressed their opinion, which they still held, that the shareholders, in their own interests, should unite and carry out the policy advocated by the Directors—namely, the issue of £100,000 new Debenture Stock, wherewith to pay off the existing £50,000 of Debenture Stock, and to provide the necessary capital for meeting the liabilities of the Company and carrying on its work. About £9,000 had been actually subscribed, and more had been conditionally promised ; but, unfortunately, the action taken by Messrs. Saunders and Storey had prevented their having any chance of carrying out the scheme. A petition had been filed for winding up the Company, which would come on for hearing on the 11th inst., as they ascertained on returning to the offices from the informal meeting referred to ; and since then, acting on the part of one of the largest shareholders, Mr. Wood—and, he believed, in the interest of the shareholders generally—Messrs. Maddison had put in a receiver, Mr. Duncan, who had been to Paris, where he had investigated the Company's affairs. and had interviewed the general manager, M. Sécretan. He asked Messrs. Saunders and Storey to put the meeting in possession of their views as regarded liquidation.

Mr. STOREY, M.P., stated that the meeting had been called for a specific purpose, and it was the Chairman's duty to propose the resolution, of which notice had been given.

The CHAIRMAN stated that the Directors agreed to call the present meeting, but they did not undertake to recommend voluntary liquidation.

Mr. MADDISON stated that since the last meeting the situation had greatly changed. It might be wise not to decide to go into liquidation at that meeting. He suggested that the meeting should be deferred until the 10th instant, to see whether M. Secrétan could be brought to make a definite offer to them.

Mr. J. H. DUNCAN stated that since his appointment as Receiver he had been to Paris, where he had found an exceedingly critical financial position, and there was a threat on Good Friday of a French liquidator taking possession of everything. If that were done, the position for the shareholders, and even the creditors, on this side would be a very disastrous one. As regarded the receipt of orders, as far as he could judge, there was a distinct encouragement. He had seen gentlemen in Paris who held about 5,000 shares, and he asked them particularly as to the reputation which the business enjoyed. The answer he received was that as regarded the financial position, it was extremely bad, but that nothing could be better than its industrial and commercial position. He could not contemplate how the Company could possibly be carried on without more working capital being provided than he had yet heard mentioned. He himself could not but be struck with the point that to carry on the business on a small scale meant loss, on a moderate scale it would mean just paying expenses ; while if they got up to a certain figure they would show some profits, and if they went past that figure they would begin to make large profits. Placed as he found himself in Paris, he approached M. Secrétan on the lines of the offer made by that gentleman to the Directors. If they authorised negotiations being entered into, he believed that M. Secrétan would agree to a proposal by which a French Company or firm would be formed, which would raise £80,000 or £100,000 in Paris. Out of this sum they would pay £20,000 to the English Company to get rid of their liabilities in France, amounting, he believed, to about £7,000 or £8,000 ; they would give £50,000 in obligations forming a first charge on the undertaking, bearing 5 per cent. interest, but issued at a discount so as to yield 6 per cent.; and they would also issue £60,000 of founders' shares to rank after the capital raised in Paris. He told M. Secrétan, however, that he must allow the old shareholders to come in for 10 per cent. immediately after the working capital had had 10 per cent., half of the surplus to go to the £60,000 of founders' shares belonging to the shareholders, and the remaining half to the capital raised in France. It struck him that if they had not the courage on this side to find the means to carry on the Company, their friends in France should be allowed to do so. If they could keep the Company alive and settle with their creditors on the basis of the plan shadowed out, he thought the Company could be resolved into something like a simple trust. M. Secrétan told him that out of the Committee of Control of five, two would be appointed on behalf of the English shareholders and three on behalf of the French proprietors.

Mr. STOREY, M.P., said that by the proposal outlined by Mr. Duncan all the cash which the Company would receive from France would have to be paid away to creditors, and they would then remain in debt to the extent of between £20,000 and £29,000, with no cash in hand; secondly, that the obligations offered to them would practically have to go to the debenture-holders here ; and thirdly, that of the £60,000 of founder's share, the preference shareholders' shares would be £43,000. There would thus be left for the £100,000 of ordinary shares, £17,000 of founders' shares, of no value on the market, upon which M. Secrétan might be able some day to give them something, after he and his friends had got 10 per cent. For this they would have to give up the whole of their property to M. Secrétan, and he (the speaker) was decidedly averse to any such proceeding. There was a petition filed, to be heard on the 11th, for winding up the Company compulsorily, and if they did nothing the petition would be heard and granted, and the Company would be compulsorily wound up, when no one would get anything. He had made a proposal that they should go into voluntary liquidation, under the control of the Court, so that they might stop the existing expenditure, and be in a strong position to negotiate.

Mr. F. L. RAWSON said he presumed that the object of Mr. Duncan in suggesting a postponement was that the details of the scheme might be worked out. All their difficulties, if faced, melted away.

Mr. MADDISON proposed a resolution adjourning the meeting until Monday next at the same time and place.

The motion having been seconded,

The SECRETARY said that he had received a letter from Sir Thomas Farrer. It was clear that that gentleman did not by any means endorse the reports or the recommendations emanating from Messrs. Saunders and Storey. He read the letter, in which Sir Thomas Farrer also said that his opinion had been for some time that the financial position of all the Elmore Companies needed investigation.

Mr. SAUNDERS, M.P., afterwards addressed the meeting, and moved an amendment to the effect that they should now pass the resolution for voluntarily winding up the Company under the supervision of the Court.

The CHAIRMAN intimated that the amendment was out of order.

Mr. STOREY said that he desired to protest against the Chairman's conduct at the meeting, in view of eventualities. With regard to the remarks of Mr. Rawson, he had declined, and he still declined, to enter into any communication with that gentleman about any of the Elmore Companies ; and his only hope was that before they had done with them there would be a public exposition of all the facts with regard to the financing and getting up of the Companies.

The CHAIRMAN then put the motion for adjourning the meeting, and declared it carried.

Johannesburg Lighting Company (Limited).

The second ordinary general meeting of this Company was held yesterday at Winchester House, Old Broad-street, Mr. W. Garland Soper presiding.

The SECRETARY read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, said that it would be within their recollection that the Lighting Company took over the Gas Company, the consideration being one share in this Company for two shares in the Gas Company, preference shares at par in this Company for debentures in the Gas Company, and in addition 20,000 shares in this Company, of which 7,868 shares were still unissued. The figures recording the assets in the balance-sheet agreed with the above

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purchase price of the Gas Company, but in the opinion of the Board the assets were entered below their value. He must also remind them that although the revenue account covered a period of ten months, yet lighting had not been supplied for the whole ten months. As a matter of account there appeared a loss, but as a matter of value this loss they considered more than covered—there was in their judgment more than 20s. in the £. The expenses were necessarily heavy, but as the consumption of electricity and gas increased, the relative proportion of expenses to revenue ought materially to diminish. As to the supply of electricity they might say that by the introduction of electrometers consumption was measured with economy to the Company and with satisfaction to the consumers. The demand for this light was in excess of the quantity they could supply. But the fact was that the Company was becoming unequal, as now constituted, to meet the present and increasing demands for light which were arising both for gas and electricity, and which by virtue of the concession they held they ought to be ready to furnish. In addition to the town itself there were the districts of Doornfontein and Jeppestown, which in themselves were important suburbs, and which they were under contract to at once supply with light. They, therefore, must have more capital. This money was required for the transport and erection of the second gas holder and tank and extending the mains and the supply of further plant for the electric lighting to Doornfontein and Jeppestown and other extensions of the system which were very urgent. The present indications of revenue based on actual working were these:—On gas without the products, and on the present supply by only one gasholder, a net profit of £3,600 per annum, as by a statement made by Mr. Lance under date February 24, 1893; on electricity without the present No. 3 plant (on February returns), £2,280 per annum, To meet their difficulties and cope with the growing demand for light, the Directors suggested that the shareholders and debenture holders should consent to the issue of debenture *pari passu*, but not preferent to the existing £60,000.

Mr. W. M. FARMER seconded the motion.

The CHAIRMAN, in reply to Dr. Todd, said that all the figures he had given were based on the actual working at the present moment, with their coal costing £3 per ton. Johannesburg was going ahead at a rapid pace, and the demand for artificial light had been greater than the Company had been able to supply.

The motion was then agreed to *nem. con.*

The CHAIRMAN next proposed a resolution approving the proposal of the Directors to borrow a sum not exceeding £40,000 on debentures. Whoever subscribed to these debentures would not subscribe money to defray liabilities, because there were practically no liabilities to pay, for all of which there was sufficient cash in hand. The money was required simply to supply new material and new stock.

Mr. S. HUGHES HEWITT seconded the motion, which was carried unanimously.

The retiring Director, Mr. W. Garland Soper, was, on the motion of Mr. ALFRED JONES, seconded by Mr. WILLS, unanimously re-elected to his seat at the Board.

The auditor, Mr. W. F. Turner, was also re-appointed on the motion of Mr. WALLIS, seconded by Mr. KERRISON, and a vote of thanks having been accorded to the Chairman, the proceedings ended.

Hobart Tramways Company (Limited).

An extraordinary general meeting of this Company was held yesterday at the offices, College Hill-chambers, E.C., under the presidency of Mr. Alfred Mattei, L.L.D., to consider a resolution altering the name of the Company to the Hobart Electrical Tramways Company. The Chairman said the proposed alteration was made at the request of some of the largest shareholders, and the Directors after careful inquiry had found that they were well within their powers in acceding to the proposal. They had the advantage of having present at the meeting their engineer, Mr. Harper, who had been over the line and had expressed satisfaction at the manner in which the contract had been carried out. It was a matter of regret that the line had not yet been opened for traffic, but their Tasmanian friends were doing all in their power to accelerate matters. The electrical work had been carried out by Messrs. Siemens Bros. and Co. of London. The material had been sent out from England and it had been thoroughly inspected. Sir Benjamin Baker had expressed great satisfaction with the cars, dynamos, and all he had seen. Hobart was a rising place, and the P. and O. and Orient Companies both sent their boats to the port during the fruit season. The latest news from the Mount Zeehan Silver Field on the West Coast was of a very satisfactory character. At present Hobart was the principal route for the West Coast viâ Strahan, and, therefore, this Company would also benefit by the development of those fields. In reply to a question, he stated that the Board were still in correspondence with the Tasmanian Government in reference to Sir Edward Braddon continuing to occupy the position of Chairman of the Company, because it had been brought out under his auspices, and no one could better serve the interests of the shareholders than Sir Edward, because of his great ability and local knowledge. A resolution in accordance with the object of the meeting was agreed to, and a vote of thanks to the Chairman closed the proceedings.

City of London Electric Lighting Company (Limited).

The following Directors' report is to be presented at the third ordinary general meeting of this Company, to be held at Winchester House on Thursday, the 13th inst., at 2:30 p.m.

The revenue account is for six months only, the period previous to June 30, 1892, having been occupied principally in testing under continuous running the first plant delivered by the contractors.

The expenditure on capital account up to December 31, 1892, amounted to £448,163. 12s. 9d. The greater part of this outlay is for land and for conduits and similar works which have not yet been fully utilised, but which are necessary for the proper carrying out of the Company's business as its operations extend.

The gross revenue for the six months was	£10,425	11	2
The expenditure, including the loss on the public lighting, was	9,991	4	7
Leaving a net revenue of	£434	6	7

The sums payable by the New Telephone Company (Limited) in respect of tubes agreed to be leased under the provisions of the Telegraphs Act, 1892, are not included in the accounts.

In view of the fact that the Company has not finally accepted the plant from the contractors and that all other works are still in progress, the question of depreciation does not at present arise, but the necessary provision will be made in due course.

The revenue is daily increasing, and is now being earned at the estimated rate of £35,000 per annum gross. The Directors consider this result satisfactory when it is remembered that the Company can scarcely be said to have fairly got to work.

The first section of the main engine and boiler house, with one of the large chimney shafts, at Bankside is practically complete, and the machinery is in course of erection. The second section is being actively pushed on with. Eighteen sites have been secured for transformer substations, of which four are in operation and six in course of construction. The remainder will be proceeded with during the current half-year. Each station when fully equipped will be capable of supplying energy to at least 20,000 8-c.p. lamps. The erection of machinery is being rapidly proceeded with. The plant already in position and on order, which it is expected will be erected before the end of the year, will be sufficient for 140,000 8-c.p. lamps. The arc-lighting plant installed is fully equal to all demands for public lighting. The number of units sold during the half-year was 506,400.

Street work has progressed satisfactorily. On December 31, 1892, 371 miles of "ways" had been laid in the City, and this length has since (this report is dated March 23rd) been increased to 415 miles, into which 95 miles of cables have been drawn. Sufficient "ways" have been laid down to supply an ultimate demand of 400,000 8-c.p. lamps. Future expenditure will, therefore, be chiefly confined to outlay on cables, which will only be incurred as applications for lamps are received. Work will be commenced in Southwark as soon as the Company's plans have been approved by the local authority.

On December 31, 1892, out of the equivalent of 53,000 8-c.p. lamps for which signed applications had been received, 20,250 had been connected up and service lines for 12,500 had been practically completed. The applications have since increased to 66,500 and the connections to 34,000, while additional applications continue to come in at a satisfactory rate. By the end of the present year the Company will be able to supply current throughout the City area.

All the arc lamps in the main thoroughfares are erected and running, with the exception of a few for which positions have not yet been assigned by the Commissioners of Sewers. The Company is ready to commence the lighting of the lesser thoroughfares, but the City authorities have as yet only given the order to proceed with two streets with lamps of different candle-power to test their relative efficiency.

The Directors regret that through the death of the Duke of Marlborough they have lost a colleague who always took a keen and intelligent interest in the business of the Company. In accordance with the Articles of Association two of the Directors, Joseph Bevan Braithwaite, jun., and Frederick W. Reynolds, retire, but being eligible, offer themselves for re-election; and the auditors, Messrs. W. H. Pannell and Co., also retire, and, being eligible, offer themselves for re-election.

Eastbourne Electric Light Company (Limited).

The following is the report of the Directors to be presented at the next ordinary general meeting of the Company:—

The Directors in presenting the accounts of the Company for the year ended December 31, 1892, congratulate the shareholders upon the fact that, for the first time since the Company's incorporation, a sufficient profit has been made to permit of a dividend being paid upon the ordinary shares. This is due to the steady increase of the Company's business, coupled with the exercise of proper economy in the working of the concern. The profit available for dividend is £431. 7s. 2d., and out of this the Directors suggest that £3 per cent. per annum shall be paid upon the subscribed share capital as for the year ended December 31, 1892. This will absorb £317. 2s., and will leave a balance of £114. 5s. 2d. to be carried forward as a reserve. The Directors have purchased the freehold of works in Junction-road for £5,600. This will explain the heavy outlay on capital account on the one side and the overdraft at the Bank on the other. A considerable saving in rent has been effected by the purchase. The Directors have now under consideration the extension of the circuits to the Upperton district, where they have ascertained the light is greatly desired. They have also accepted a contract with the Corporation for increased arc lighting on the sea front, and other extensions of the Company's business can now be entered upon to great advantage. But this increase of business will need additional capital, and a prospectus for this purpose will shortly be issued. The whole of the Company's plant, machinery, and mains are in excellent condition. Mr. George Boulton retires from the Directorate this year, but is eligible for re-election. The auditors, Messrs. Hart Brothers, Tibbetts and Co., also retire, but may be re-elected.

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NEW COMPANIES, STATUTORY RETURNS, &c.

CALDWELL'S (LIMITED).—Capital £12,000, in £10 shares. Smiths, mill and colliery furnishers, mechanical and electrical engineers, electricians, &c., of Horsemarket-street and Scotland-road, Warrington.

COMPAGNIE FRANCAISE POUR L'EXPLOITATION DES PROCEDES THOMSON-HOUSTON.—A company with this title has recently been formed, with offices in London. The capital is 1,000,000fr.

DOMESTIC TELEPHONE COMPANY (LIMITED).—This Company was registered on April 4, 1893, with a capital of £20,000, divided into 3,990 ordinary, or "A," shares of £5 each, and 10 management, or "B," shares of like value, to enter into and carry into effect an agreement to be made between Sir Charles Stewart Forbes, Bart., and the Company, to acquire, develop, and manufacture, in accordance with certain inventions and patents, and any other inventions, patents, or other rights that may be acquired by the Company, and to carry on in the United Kingdom and elsewhere the business of a telephone company and exchange, electrical engineers, electricians, and manufacturers of all kinds of electrical, telephonic, or magnetic appliances used in connection therewith. The signatories are :— A Shares.

Sir Charles S. Forbes, Bart., 28, Queen's Gate-terrace, W..	1
James Mansfield, 29, St. James's-place, S.W.	1
Joseph R. Gibson, 312, Kennington Park-road, S.E.	1
C. Harrison, 67, Lincoln's Inn-fields, W.C.	1
Claude Hay, 28, Cornhill, E.C.	1
Thomas D. Croft, 17, Dorset-square, N.W.	1
Louis T. Fitzgibbon, 22, Harrington-road, S.W.	1

The first Directors are Sir Charles S. Forbes, Bart., the Hon. James Mansfield, the Hon. Claude Hay, Louis T. Fitzgibbon, and Thomas D. Croft. No qualification necessary.

HUMBER LAMP COMPANY (LIMITED).—Capital £5,000, in £1 shares. Dealers in lamps of all kinds, electric and otherwise, of Great Grimsby.

NEWINGTON, PRIDDLE, AND CO. (LIMITED).—This Company was registered on March 29th with a capital of £7,000 in £1 shares. The objects are to acquire, develop, and turn to account certain inventions, licences, privileges, and rights (the further particulars of which are not given) to be acquired on the adoption and acceptance of an agreement dated March 28, 1893, and made between Reginald W. H. Newington and Edward Priddle, of the one part, and Robert Hail (on behalf of the above-named Company) of the other part, and to carry on the business of electrical and general engineers. The first two signatories are Reginald H. Newington, electrical engineer and Edward Priddle, mechanical engineer, both of 4, Berry-street, Clerkenwell, London, E.C., who are also the vendors.

SOCIETE PAUL GADOT ET MICHEL PISCA.—Under this title a company has been formed, with offices in Paris, to carry on the manufacture of accumulators. The capital is 90,000fr.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The annual return of this Company made up to February 10, 1893, has been filed. The whole nominal capital of £7,000,000 stock is fully paid up.

BIRMINGHAM TELEGRAPH FACTORY (LIMITED).—A petition has been presented by Messrs. Alabaster, Gatehouse and Co. for the compulsory winding up of this Company, now in voluntary liquidation. The petition will be heard at the County Court, Birmingham, on Thursday next, the 13th inst.

BLACKPOOL ELECTRIC TRAMWAY COMPANY (LIMITED).—A meeting of the shareholders is called for May 3rd, at twelve, at Messrs. Godfrey, Rhodes and Evans's, Commercial Bank-chambers, Halifax, to receive an account of the winding up.

CAMBRIDGE ELECTRIC SUPPLY COMPANY (LIMITED).—The first annual return of this Company, made up to March 17th, has been filed. 2,306 shares, out of a capital of £50,000, in £10 shares, have been taken up, and a call of £8 per share made, resulting in the payment of £17,922, and leaving £526 as yet in arrears.

ELECTRICAL SUPPLIES AND FITTINGS COMPANY (LIMITED).—Claims against this Company, in voluntary liquidation, are to be sent to Mr. John Scott, 8 and 10, Charing Cross-road, by the 25th inst.——A petition has been presented by the Electrical Company (Limited) for the compulsory winding up of the Company, and is down for hearing at the Royal Courts of Justice, Strand, on Tuesday next, the 11th inst.

ELMORE'S FRENCH PATENT COPPER DEPOSITING COMPANY (LIMITED).—A petition has been presented by the Loan and Finance Corporation (Limited) for the compulsory winding up of this Company, and is down for hearing at the Royal Courts of Justice, Strand, on Tuesday next, the 11th inst.

HOPE-JONES ELECTRIC ORGAN COMPANY (LIMITED).—The statutory return of this Company, made up to November 8, 1892, has been filed. The nominal capital is £25,000, divided into 1,200 cumulative preference and 1,300 ordinary shares of £10 each, 445 cumulative preference and 1,300 ordinary shares have been taken up, of which the ordinary shares have been issued as paid to Robert Hope-Jones, of Argyle-street, Birkenhead, electrician (1,000), and Thomas Threlfall, of 19, Hyde Park-terrace, W. (300). Upon 20 of the preference shares the full amounts have been called, while upon the remaining 425 preference shares, £5 per share has been called, resulting in the payment of £2,325.

JULIUS SAX AND CO. (LIMITED).—The statutory return of this Company, made up to March 14th, has been filed. The whole nominal capital of £20,000, in £10 shares, has been taken up, of which 1,993 shares were issued as fully-paid. Nothing has been paid on the remaining 7 shares.

L. ALWYN (LIMITED).—The statutory return of this Company, made up to March 22nd, has been filed. The nominal capital of the Company is £2,000, in £1 shares. At the time of making-up, 1,514 shares were taken up, of which 500 were issued as half-paid. Upon the remaining 1,014 shares, 10s. per share has been called, resulting in the payment (including a sum of £2 in advance) of £509.

NORTHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to March 9, has been filed. The nominal capital is £50,000, divided into 10 "A," 49,990 "B" shares of £1 each. Ten "A," 10,000 "B" ordinary, and 3,180 "B" preference shares have been taken up. Upon the 10 "A" shares no calls have been made; upon the "B" ordinary shares the full amount has been called and all calls paid, and upon the "B" preference shares 10s. per share has been called, and £2,875 paid (including sums paid in advance of calls).

NORTHERN ELECTRIC WIRE AND CABLE MANUFACTURING COMPANY (LIMITED).—The fourth annual return of the above-named Company, made up to March 20th, has been filed. The nominal capital is £20,000, divided into 660 fully-paid and 3,340 ordinary shares of £5 each. All the fully-paid and and 2,167 of the ordinary shares have been taken up, of which the fully-paid have been issued to Blakey, Emmott, and Co. (Limited), of Halifax (now in voluntary liquidation). Upon the ordinary shares £2. 10s. per share has been called, resulting in the payment of £5,415, leaving £2. 10s. unpaid.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LTD.),—The annual return of this Company, made up to March 14th, has been filed. The nominal capital is £448,200, divided into 37,350 shares of £12 each. All these shares have been taken up, the full amounts called, and all calls (£448,200) paid.

TELEPHONE COMPANY OF AUSTRIA (LIMITED).—Claims against this Company, in voluntary liquidation, must be sent in to the liquidators at 53, Old Broad-street, E.C., by May 6th.

WOODHOUSE AND RAWSON ELECTRIC SUPPLY COMPANY OF GREAT BRITAIN (LIMITED).—A meeting is to be held at the office of the Company, Room 433, 11, Queen Victoria-street, E.C., on May 1st, at 4 p.m., to receive an account of the winding up.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended April 2nd were £744, as against £796 for the corresponding period of last year, being a decrease of £52. The total receipts for half-year amount to £12,014 against £11,019 in the corresponding period of 1892, being an increase of £995.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of March were £4,200, as compared with £4,038 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The traffic for the half-year ended December 31st last.—The traffic receipts for the month of March were £2,015, against £2,103 for the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of March amounted to £55,786 and to £59,037 in the corresponding period of 1892.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of March, 1893, amounted to £46,204, and to £43,805 in the corresponding period of 1892, or an increase of £2,399.

THE ELECTRIC LIGHT IN CANADA.—It is stated that a syndicate, having its head-quarters in Montreal, has obtained a controlling interest in the Ottawa Gas Company and the Ottawa Electric Light Company for $500,000. The syndicate has a bill before the Dominion Parliament to enable them to buy up and amalgamate all the gas and electric light companies in Canada.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for March amounted to £22,000, and from January 1st to March 31st to £63,200. In the corresponding months of 1892 and 1891 the amounts were £62,800 and £64,400 respectively.

NEW AUSTRALIAN ELECTRIC COMPANY (LIMITED).—A meeting of the shareholders of this Company was held on February 20th, at the offices, Melbourne. Prof. W. C. Kernot, who presided, said that the general position of the Company was certainly satisfactory, and they had been making steady progress during the past year. Their lighting business had not been extended very much, but it had been consolidated. Their financial position on the whole was also very satisfactory. Their total capital called up was, say, £22,000, whilst their assets amounted to between £70,000 and £80,000—that was to say, their two lighting stations, the plant, machinery, and stock were worth over £70,000. As a matter of fact, the capital on which they were working was very much larger than their subscribed capital, and consisted, to a considerable extent, of loans on mortgage—£35,000 in round numbers. On all that money they were paying an average interest of 8 per cent., which they were trying to get reduced. He referred with regret to the death of Captain Rowan, who was a notable figure in connection with electric lighting in the Australian colonies.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The receipts for the two weeks ended March 31st were £3,358, as compared with £3,040 for the corresponding period of last year.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended March 31, 1893, after deducting 17

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per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,339.

SHOOTING.—Several of the Eastern Telegraph Company's staff at Madras (general superintendent, Mr. W. T. Newitt) are members of the Madras Volunteer Guards, and distinguished themselves in the shooting competitions recently held. The following were included in the company winning the Commemoration Shield, those marked with an * taking additional prizes :—Colour-Sergeant W. Wilton,* A. J. Rebeiro,* W. C. Rebeiro, and J. W. Evers.*

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Mar. 28.	Price Wednesday, Apr. 5.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 5. Highest	Lowest
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	17/6	Anglo-American	52⅜ 53½	52⅜ 53½	5 2 10	Jan., Apr., July, Oct.	53¼	..
£2,876,140	Stock	35/0	Do. Preferred	93 94	93 94	5 17 0	" "	93⅞	93
£2,876,140	Stock	5/0	Do. Deferred	13 13½	12¾ 13¼	..	" "	13⅛	12½
£250,000	100	4%	African Direct, Telegraph 4% Debentures	101 104	101 104	3 16 11	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine xd	11¾ 12¼	11½ 12	5 8 4	Mar., June, Oct., Dec.	11 13/16	11¾
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	105 109	105 109	4 11 9	June and December	..	..
$7,716,000	$100	$1⅓	Commercial Cable Capital Stock	178 182	178 182	3 16 11	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½ 12⅝	11½ 12⅝	6 8 0	February and August	12 5/16	..
6,000	10	10%	Do. Preference 10%	18 19	18 19	5 5 3	" "	..	..
12,931	5	4%	Direct Spanish (£4 paid) xd	2½ 3½	2½ 3½	4 11 5	April and October..	3⅛	..
6,000	5	10%	Do. Preference 10% xd	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States xd	11⅜ 12	11⅝ 11⅞	5 18 2	Jan., Apr., July, Oct.	11⅞	..
400,000	10	2/6	Eastern	14⅝ 15⅜	14⅝ 15⅜	4 5 11	" "	15⅝	15 1/16
70,000	10	6%	Do. 6 per Cent. Preference	15⅝ 16¼	16 16½	3 12 9	" "	16⅝	16¼
£1,294,030	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113 116	113 116	3 9 0	May and November	115⅝	..
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15½ 15½	15⅝ 15⅝	4 9 7	Jan., Apr., July, Oct.	15⅝	15½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112 115	112 115	3 9 7	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103 106	103 106	4 14 4	January and July ..	103¾	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102 105	102 105	4 15 3	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101 104	101 104	3 16 11	February & August	..	..
180,227	10	1/3	Globe Telegraph and Trust	9¾ 10	9⅞ 10⅛	4 8 11	Jan., Apr., July, Oct.	10	9¾
180,042	10	6%	Do. 6 per Cent. Preference	15½ 15⅝	15⅝ 15⅝	3 16 10	" "	15⅝	15⅝
150,000	10	5/0	Great Northern	19¼ 19⅜	19¼ 19¾	4 6 1	Jan., April, and July	..	..
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104 107	104 107	4 13 6	March & September	..	..
17,000	25	12/6	ndo-European	44 46	44 46	5 8 8	May and November	..	..
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	106 109	106 109	5 10 1	March & September	..	..
10,802	8	4/0	Reuter's	7 8	7 8	..	April and October..	..	..
3,381	£100 Cert.	30.0	Submarine Cables Trust 6%	118 123	118 123	4 17 7	" "	..	..
15,609	10	5/0	West African Telegraph	6½ 7½	6½ 7½	5 6 8	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	..	..
30,000	10	2/0	West Coast of America	2½ 3½	2 3	..	January and July ..	..	..
£150,060	100	8%	Do. Debentures 8% 1902	105 109	105 109	7 6 10	June and December	..	..
88,321	10	6d.	West India and Panama	1⅛ 1⅜	1⅛ 1⅜	..	" "	1 1/16	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11¼ 11⅜	11¼ 11⅜	5 2 2	May and November	11⅜	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9 10	9 10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	108 111	108 111	4 10 1	June and December	109½	..
64,242	15	3/0	Western and Brazilian	7⅜ 8½	7⅜ 8½	5 9 1	May and November	..	..
33,129	7½	3,0	Do 5 per Cent. Cumulative Preferred	5⅜ 6½	5⅜ 6½	6 0 1	" "	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2 2½	2 2½	..	" "	2	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	105 108	5 11 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	105 108	5 11 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	101 104	101 104	5 15 5	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone (fully paid) xd and rights	3 4	3 4	..	..	..	..
22,500	14/0	1½d.	Consolidated Telephone Const. & Maintenance	¼ ⅜	¼ ⅜	1 13 4	May and November	..	..
20,000	£1	4⅜d.	Oriental (11s. paid)	⅜ ¼	⅜ ¼	7 18 2	Yearly	..	..
454,747	5	2/6	National	5¼ 5⅜	5¼ 5⅜	5 9 1	June and December	5⅝	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15 15½	15 15½	3 17 6	" "	15½	..
15,000	10	6%	Do 6% Cumulative 2nd Pref.	14½ 14⅝	14½ 14⅝	4 1 4	" "	14 7/16	..
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	5⅛ 5⅜	5⅛ 5⅜	..	..	5⅜	5⅛
726 477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	113 116	113 116	3 17 7	January and July	114¾	114½
48,000	£10	..	New Telephone, Limited (£4 paid)	..	..	..	..	..	..
58,000	5	1/0	United River Plate	2½ 3	2½ 3	..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	12 12½	11½ 12	.	—	11⅞	11½
20,000	£10	..	Do. 6 per Cent. Preference	10¼ 10⅜	10 10½	2 5 8	..	10 5/16	10⅛
19,900	£5	..	Electricity Supply Co. of Spain	..	..	..	—	..	—
£150,000	£5	..	Electricity Supply Company Ordinary	5 5¼	..	..	—	..	—
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	—	..	—
8,332	£5	..	House to House Electric	1½ 2⅛	..	..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully pd.) xd	5⅜ 5⅝	..	..	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid) xd	6 6½	..	..	January and July ..	..	..
30,000	£5	3/4 '92	Liverpool Electric Supply (£3 10s. paid)	4⅛ 4⅜	4⅛ 4⅜	..	March	..	..
10,000	£5	5/0 '92	Do. (fully paid)	5 1/16 5 3/16	5 1/16 5 3/16	..	March	..	..
111,000	5	..	London Electric Supply	1 1⅛	1 1¼	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6½ 7	6½ 7	..	—	6⅞	..
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	..	..
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5⅜ 6⅛	5⅜ 6⅛	—	—	..	..
18,680	£5	9½%	St. James' and Pall Mall	8¼ 8⅜	8 8⅛	..	—	8⅛	8⅛
7,900	£5	7%	Do. 7% Preference	8 8⅛	8 8⅛	4 2 4	—	8 1/16	..
42,853	5	2/0	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 18 4	—	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/6	Brush Electrical Engineering	3 3½	3 3½	..	—	..	..
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2¼ 2½	4 16 0	—	2⅜	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	103 105	103 105	4 5 9	..	..	..
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼ 5⅜	5¼ 5⅜	6 1 9	January and July	..	..
12,139	5	..	Edison and Swan United	—	—	—	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	1¾ 2¼	..	..	..	..	..
45,000	10	12/0	Electric Construction	2⅛ 3	2½ 3	..	—	2 13/16	2 1/16
70,000	2	10/0	Elmore's Patent Copper Depositing	⅛ ⅜	¼ ½	—	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1½ 2½	1 2	..	—	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	22⅛ 23½	22½ 23½	5 6 5	February & August	22 9/16	..
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0 6/0	5/0 6/0	..	..	..	..
78,949	5	4/2⅜	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	3½	..
37,350	12	24/0	Telegraph Construction and Maintenance	34 37	33 36	5 0 0	March and July	34¼	34
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July	..	..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..	..	—	—	—	—
..	£5	..	Do. Preference (fully paid)	..	..	—	—	—	—
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	..	..	—	—	..	..
600,000	Stock	5⅝	Do. Stock	37 39	37 39	2 17 8	May and November	..	..

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TELEGRAMS: "INDICES," LONDON.

WHEATLEY KIRK, PRICE and GOULTY

(ESTABLISHED 1850).

ELECTRICAL AUCTIONEERS, VALUERS, AND ARBITRATORS.

49, QUEEN VICTORIA STREET, LONDON, E.C.

And Albert Square, MANCHESTER.

SALE OF OLD TELEGRAPH STORES.

GENERAL POST OFFICE.

By Command of the Postmaster-General.

TENDERS are invited for the purchase of about 23 tons Gutta Percha in various forms (principally strippings), about 60 tons Copper in various forms (principally wire), about 14 tons Zinc, about 28 tons Canvas Bags, &c., a quantity of Brass, Steel, Mercury, Scrap Iron, India Rubber, Ebonite, Tarpaulins, Rope, Felt Cuttings, Leather, Firewood, Jute, Tar Barrels, Wicker, &c., &c., &c., the whole being arranged in convenient lots.

A Form of Tender, containing all particulars, may be obtained on application, by letter only, to the Undersigned.

Tenders will be received until noon on TUESDAY, the 25th instant.

The Postmaster-General does not bind himself to accept the highest or any Tender.

(Signed) CHAS. E. STUART,
Controller of Stores.

Telegraph-street, London, E.C., 12th April, 1893.

ABERDEEN ELECTRIC LIGHTING ORDER.

The TOWN COUNCIL of ABERDEEN invite TENDERS for the following Work under this Order.

Contract 1.—Water Tube Boilers.
Contract 2.—High-Speed Compound Engines, with Direct-Driven Dynamos, Steam and other Pipes, Pumps, Traveller, &c.
Contract 3.—Switch Board, Instruments, and Connections.
Contract 4.—Roadwork, including Supply of Cast Iron Pipes, Service Boxes, &c.
Contract 5.—Batteries.
Contract 6.—Copper Strip.
Contract 7.—Insulated Cable, Armoured and Unarmoured.

Full Specifications and Drawings can be had either from the Town Clerk at Aberdeen, or from Prof. Alex. B. W. Kennedy, 19, Little Queen-street, Westminster, on payment of a Fee of Two Guineas for each of Nos. 1 to 4, or One Guinea for each of Nos. 5 to 7, the fee to be returned on receipt of a bona fide Tender.

Tenders, addressed to the Town Council, and marked outside, "Aberdeen Electric Lighting, Contract No. ," must be lodged at the Gas Office, Town House, not later than 10 a.m. on FRIDAY, the 28th current.

W. GORDON, Town Clerk.

Aberdeen, 10th April, 1893.

BOROUGH OF BEDFORD.

The Mayor, Aldermen, and Burgesses of the Borough of Bedford, acting as the Urban Sanitary Authority for the said Borough, having resolved (subject to the approval of the Board of Trade) to transfer the BEDFORD ELECTRIC LIGHTING ORDER, 1890, INVITE APPLICATIONS from Companies or Firms, willing to undertake and carry out the Powers granted under the said Order.

Applicants are requested to state the system of lighting proposed, the maximum charges to consumers, the time for which the contract is to be entered into, and the terms of purchase by the Authority of the undertaking.

Applications to be sent to the undersigned, endorsed "Electric Lighting," on or before 13th MAY, next.

T. S. PORTER,
Clerk to the Urban Sanitary Authority.

Town Hall, Bedford, 11th April, 1893.

IN THE HIGH COURT OF CHANCERY.

FOWLER, LANCASTER and CO., Limited,

Electrical Engineers and Manufacturers,
ALBERT WORKS, BIRMINGHAM.

Mr. R. L. IMPEY, Chartered Accountant, 26, Waterloo-street, Birmingham, Receiver in the above matter,
Is open to receive offers for the PURCHASE of the BUSINESS as a going concern, with valuable PLANT, TOOLS, STOCK-IN-TRADE, &c.
Particulars on application.

IN THE HIGH COURT OF CHANCERY.

THE BIRMINGHAM TELEGRAPH FACTORY, Limited,

Telegraph Manufacturers and Contractors,
FREDERICK STREET, BIRMINGHAM.

Mr. R. L. IMPEY, Chartered Accountant, 26, Waterloo-street, Birmingham, Receiver in the above matter,
Is open to receive offers for the PURCHASE of the BUSINESS as a going concern, with valuable PLANT, TOOLS, STOCK-IN-TRADE, &c.
Particulars on application.

FOR SALE.—IN LIQUIDATION.

The BUSINESS, as a going concern, with the Machinery, Plant, Tools, Stock and Freehold, and all appurtenances thereto, together with the valuable patent rights used in connection with the business, of the AUTOMATIC STANDARD SCREW CO. (Limited), HALIFAX, in liquidation.

The Company is engaged in the manufacture of a very large variety of high-class screws for bicycle, electrical, telegraph, and philosophical instrument work, machine tools, and fancy turned metal.

For further information apply to the LIQUIDATOR, at the works.

FOR SALE, as a current-going concern, the BUSINESS carried on by the late firm F. Reid, Nichol and Co., at Forth House, Newcastle-on-Tyne, as ELECTRICAL ENGINEERS and CONTRACTORS, and having a large colliery connection.

Particulars on application to—
THOMAS BOWDEN and NEPHEW, Chartered Accountants,
42, Mosley-street, Newcastle-on-Tyne.

THE Telegrams: "CARWHEEL LONDON.

ELECTRIC & GENERAL CONTRACT CORPORATION, Limited.

Electric and other works for Local Authorities, Promoters, &c., undertaken and financed.

35, PARLIAMENT STREET, LONDON, S.W.

SITUATIONS VACANT AND WANTED, &c.

ELECTRIC ENGINEMAN WANTED to take permanent charge of and run large country house installation in Warwickshire, 2 steam engines and dynamos, 2 boilers and accumulators, also 2 other boilers and heating apparatus for large swimming bath. A house and assistant stoker provided. Married man with no family preferred. Must be thoroughly trustworthy and competent mechanic with satisfactory references.—Reply, stating wages required, with particulars of experience, age, &c., to "D. L.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

WANTED, a capable ELECTRICAL ENGINEER, with fair connection, and about £2,000 capital, to join a well-established business in London. Principals only.—Apply, "A. L.," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

ELECTRICIAN, experienced in lighting large buildings, pit work, and ship lighting, is open to TEMPORARY ENGAGEMENT.—Address HUNT. *Electrician* Office, Salisbury-court, Fleet-street, E.C.

ELECTRICAL ENGINEER seeks RE-ENGAGEMENT, had charge and construction of Central Stations, Installation work as Foreman and Superintendent, 8 years' experience with best firms. Moderate salary.—Address 1228, *Electrician* Office, Salisbury-court, Fleet-street, E.C.

ELECTRICAL ENGINEER, B.A. Cantab (Natural Sciences Tripos), A.I.E.E.; held chief assistantship at the Cavendish Laboratory, Cambridge for 5 years, experienced in accurate research work and now Demonstrator in Electrical Engineering at an Engineering School, desires ENGAGEMENT in June with firm of Electrical Engineers. Highest references.—1233, *Electrician* Office, Salisbury-court, Fleet-street, E.C.

ELECTRIC LIGHTING.—YOUTH (18) seeks EMPLOYMENT as Assistant Wireman.—Apply, "A. B.," 3, Elgin-terrace, Maida Vale.

GENTLEMAN, who has had much experience in the laying and maintenance of underground systems, desires engagement as ASSISTANT ENGINEER at a central station.—1224, *Electrician* Office, Salisbury-court, Fleet-street, E.C.

INCANDESCENT LAMP MANUFACTURE.—A Works Superintendent will be shortly open to accept a POSITION in or near London. Advertiser is a Chemist by education, has had eight years expert experience, including one of the leading factories in London, also in Vienna, and is at present Superintendent of one of the largest works in the United States.—For fuller information apply to "A. S.," 2, St. Mary's-road, Canonbury, London, N.

WANTED, by an A.I.E.E., post as FOREMAN WIREMAN, or as Electrician to take charge of an installation. Good outdoor experience, having served term of pupilage with an eminent firm of electrical engineers, from whom excellent testimonials can be obtained. Locality no object.—Apply, 1225, *Electrician* Office, Salisbury-court, Fleet-street, London, E.C.

WANTED, PIVOTTING, Jewelling, Electricity Meter Trains, Cardew movements. Experimental and all kinds of fine mechanical work done.—CLARKE BROS., 32, Bravington-road, Harrow-road, W.

WIREMAN wants SITUATION; lights, bells, &c.; can run own casing.—Address, "ELECTRON," 180, Shirland-road, Paddington, London, W.

WORK REQUIRED by experienced ELECTRICAL ENGINEER.—Write "M. S.," 66, Acland-street, Limehouse, E.

J. WEEKS AND CO., Horticultural Builders to Her Majesty, H.R.H. the Prince of Wales, H.M. Government, Admiralty Dept., War Dept., Royal Hort. Soc., Royal Botanic Soc., Parks and Public Buildings. Patentees of the Duplex Upright Tubular Boilers. King's-road, Chelsea, S.W.

Miscellaneous Advertisements, Plant Wanted and for Sale, &c., &c., continued on next page,

FOR VENTILATING AND COOLING ENGINE AND DYNAMO ROOMS,

20 HIGHEST AWARDS, including PARIS, 1889.

BLACKMAN VENTILATING CO. (Ltd.), 63, FORE STREET, LONDON, E.C.

METAL SPINNING.

Having a Special Department for the Manufacture of all classes of SPUN GOODS, including—

ARC LAMP CORONAS, REFLECTORS (any Radius), SWITCH COVERS, FUSES, BOSSES, INSTRUMENT CASES, &c.,

Your esteemed inquiries are invited for Prices, &c. Any Special Goods made on the Shortest Notice. Prompt Delivery guaranteed.

THE LONDON AND LANCASHIRE ELECTRIC AND GENERAL ENGINEERING COMPANY, Limited,

Telephone: WORKS: 608. CITY: 1812. DALSTON, N.E. Telegraphic Address: "PRYKE, LONDON."

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LONDON AGENCY.—Experienced ENGINEER, with large connection, having ground-floor premises with large show windows in one of the best leading thoroughfares in the West End, is open to REPRESENT a first-class firm. Highest references.—Application to be made "M," care of T. Sellers, Esq., 35, New Broad-street, E.C.

WANTED, and FOR SALE.

GAS ENGINE, 2½ horizontal (Crossley's) in good working order. May be seen at work. Price £50.—Apply by letter, WHITTON, 60, Queen Victoria-street, E.C.

J. WEEKS AND CO., King's-road, Chelsea, S.W., supply all kinds of Boilers, their improved and other Valves, tested Hot-water Pipes, Castings, Connections and Fittings at lowest retail prices.

THE ADVERTISER wishes to arrange with energetic firms who have travellers canvasing the whole of the United Kingdom for the SALE of a new first-class ELECTRIC LIGHT ARC CARBON on commission. In reply, please state what portion of the country is canvassed and what influence could be brought to bear in introducing the article named.—Address, "CARBONS," *Electrician* Office, Salisbury-court, Fleet-street, E.C.

MESSRS. DEBENHAM, TEWSON, FARMER, and BRIDGEWATER have a large selection of SHOWROOMS, OFFICES, WAREHOUSES, and FACTORIES suitable for ELECTRICAL ENGINEERS.
Their Monthly List is now ready, and may be obtained at their Offices, 80, CHEAPSIDE, E.C., or will be forwarded free by post

ALUMINIUM SHEETS, WIRE, TUBES, or PATENT HARDENED CASTINGS for ELECTRICAL WORK.
SOLDERS (Richards' Patent) for Brazing and Soldering Aluminium. The only practical one hitherto invented.
Correspondence Invited.
W. ARCHD. BRIGGS, 87, High Street, DUNDEE.

"THE PATENTEES' HANDBOOK,"
BY
J. G. LORRAIN, M.Inst.E.E., M.Inst.M.E.,
CHARTERED PATENT AGENT,
Gives full information and advice to intending Patentees. Sent post free on application to Mr. J. G. LORRAIN, Norfolk House, Norfolk-street, Strand, London, W.C.

Messrs. WILLIAMS and NORGATE, Importers of Foreign Books, have weekly parcels from the Continent with all the new Scientific Books.
(*Foreign Prices*).
14, HENRIETTA STREET, COVENT GARDEN, LONDON, & 20, S. FREDERICK STREET, EDINBURGH.

ROYAL INSURANCE BUILDINGS, 28, LOMBARD ST., LONDON.
ROYAL INSURANCE COMPANY.
ROYAL INSURANCE BUILDINGS, 1, NORTH JOHN ST. LIVERPOOL.

FIRE **LIFE**

Law Courts Branch: 33, Chancery Lane, W.C.
West End Branch: 48, St. James's Street, S.W.
Mercantile Branch: Gort House, 41, Mark-lane, and 71, Great Tower Street, E.C.

The following Statement shows the Financial position of the Company on the **31st DECEMBER, 1891**—

Capital Paid up	£366,702 0 0
Fire and other Reserve Funds, including Balance of Profit and Loss	2,981,078 0 0
Life and Annuity Funds	4,546,577 0 0
Total Invested Funds, 31st December, 1891	£7,894,357 0 0

INCOME FOR THE YEAR £2,230,635

The following Comparative Statement shows the progress of the Company :—

1881	... Life Funds	£2,737,858	... Total Funds	£4,673,299
1886	... „	3,257,609	... „	5,672,041
1891	... „	**4,546,577**	... „	**7,894,357**

INCREASE OF FUNDS IN TEN YEARS, £3,221,058.

EXTRACT FROM AUDITORS' REPORT.

"We have examined all the Securities held here . . . . and have found them correct and in order, and we further certify that the present aggregate Market Value thereof is in excess of the amounts in the Balance Sheets."

JOHN H. McLAREN, Manager.
DIGBY JOHNSON, Sub-Manager.
CHARLES ALCOCK, Secretary.
JOHN H. CROFT, Secretary in London.

THE EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (Limited).

FIVE PER CENT. AUSTRALIAN GOVERNMENT SUBSIDY DEBENTURES

NOTICE IS HEREBY GIVEN that in pursuance of the conditions upon which the above Issue was made, the undermentioned numbers of Debentures were drawn by lot on the 6th April, 1893, at the Offices of the Company, Winchester House, 50, Old Broad Street, in the City of London, in the presence of the Assistant Secretary, and of John Venn, Esq., Notary Public.

The said Debentures will be paid off at par on 1st day of July next, at Messrs. Barclay, Bevan and Co., 54, Lombard-street, E.C., after which date interest on them will cease.

353 DEBENTURES OF £100 EACH.

24	605	1252	1858	2481	2846	3531	4322	4980	5587
56	607	1265	1867	2499	2847	3561	4340	4981	5618
117	616	1273	1893	2522	2848	3578	4343	4988	5625
121	632	1278	1920	2548	2859	3608	4349	4989	5638
149	649	1294	1926	2549	2860	3643	4371	4995	5641
150	652	1318	1959	2556	2893	3648	4400	5012	5644
151	654	1322	1960	2561	2927	3670	4453	5016	5724
181	671	1340	2050	2563	2943	3684	4463	5023	5732
199	685	1354	2060	2575	2957	3692	4468	5036	5808
216	695	1358	2061	2579	2958	3693	4495	5048	5826
230	696	1402	2077	2595	2962	3770	4511	5065	5848
246	718	1414	2083	2596	2979	3784	4540	5098	5871
248	729	1447	2116	2613	3009	3791	4556	5127	5872
261	741	1456	2119	2614	3043	3855	4561	5156	5891
300	747	1467	2124	2615	3060	3859	4572	5224	5927
316	760	1468	2130	2652	3067	3866	4584	5245	5947
319	809	1480	2141	2655	3078	3872	4594	5368	5962
358	836	1481	2151	2665	3105	3879	4595	5387	6016
381	858	1491	2153	2684	3112	3905	4600	5394	6049
383	886	1514	2157	2690	3116	3971	4613	5399	6067
384	890	1524	2167	2698	3205	3978	4641	5441	6072
389	905	1527	2229	2714	3209	4019	4656	5458	6116
396	919	1549	2232	2715	3233	4034	4667	5467	6156
404	929	1550	2236	2725	3254	4041	4697	5470	6188
430	934	1566	2257	2726	3258	4059	4702	5475	6204
436	956	1605	2288	2736	3269	4076	4715	5479	6212
456	965	1610	2293	2744	3305	4109	4759	5499	6237
490	1075	1636	2311	2766	3343	4112	4772	5507	6246
491	1099	1642	2330	2767	3355	4119	4784	5513	6256
506	1100	1671	2350	2818	3359	4146	4838	5528	6260
512	1141	1715	2395	2820	3371	4154	4865	5554	6292
520	1171	1723	2404	2823	3406	4175	4878	5566	6326
535	1191	1750	2421	2825	3464	4221	4911	5573	6348
542	1216	1799	2425	2832	3469	4239	4968	5580	6393
544	1217	1811	2440	2838	3526	4242	4972	5581	6399
599	1239	1813							

Witness:
JOHN VENN,
9, Gracechurch-street, E.C.,
Notary Public.

By order of the Board,
F. E. HESSE,
Secretary.

Winchester House,
50, Old Broad-street, London, E.C.,
6th April, 1893.

THE EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY, LIMITED.

NOTICE IS HEREBY GIVEN that the THIRTY-NINTH ORDINARY GENERAL MEETING of this Company will be HELD on WEDNESDAY, the 19th, day of April, 1893, at Two o'clock in the Afternoon, at WINCHESTER HOUSE, 50, OLD BROAD STREET, London, when the Report and Accounts for the half-year ended 31st December, 1892, will be submitted, a Dividend and Bonus declared, and the ordinary business of the Company transacted.

And Notice is also given that the Register of Transfers will be closed from the 12th April to the 19th April, both days inclusive.

Dated this 10th day of April, 1893.

By order of the Board,
F. E. HESSE, Secretary.

Winchester House,
50, Old Broad Street, London, E.C.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

FIVE FER CENT. DEBENTURES (1884 ISSUE).

NOTICE is Hereby Given that, in conformity with the conditions upon which the above issue was made, the SEVENTH DRAWING for payment of these Debentures, 177 in number, WILL TAKE PLACE in the presence of a Notary Public of the City of London on MONDAY, the 17th inst., at noon, at the Offices of the Company, Winchester House, Old Broad-street, London, E.C.

By order of the Board,
RICHARD COLLETT, Secretary.

Winchester House, Old Broad-street, London, E.C.,
April 7, 1893.

SUBMARINE CABLES TRUST.

NOTICE is Hereby Given that a payment of £1. 10s. will be made on account of the Coupon due on the 15th April, on and after that date, by Messrs. GLYN, MILLS and Co., of 67, Lombard-street, London, E.C., between the hours of 10 a.m. and 2 p.m.

The Coupons should be left with the Bankers for examination Four clear days before payment. They will be stamped with the words "£1. 10s. paid." and returned to the holders.

By order of the Trustees,
A. BRODRICK, Secretary.

Winchester House,
50, Old Broad-street, E.C., April 7th, 1893.

KING'S COLLEGE, LONDON.

ELECTRICAL ENGINEERING.

A COURSE of LECTURES and LABORATORY WORK will be given on MONDAY evenings, commencing May 1st, 1893.

For particulars, apply to
J. W. CUNNINGHAM, Esq., Secretary.

NOW READY.

"HOUSE LIGHTING BY ELECTRICITY,"
POPULARLY EXPLAINED.
By ANGELO FAHIE, M.I.E.E.
Large 8vo. Illustrated. Paper Cover, 1s. Cloth and gilt, 2s.
LONDON: E. and F. N. SPON. DUBLIN: J. FALCONER. NEW YORK: SPON and CHAMBERLAIN.
To be had of all Booksellers.

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—THE—

INDIA RUBBER, GUTTA PERCHA AND TELEGRAPH WORKS CO.,

LIMITED.

ELECTRICAL ENGINEERS,

AND

INDIA RUBBER AND GUTTA PERCHA MANUFACTURERS.

MANUFACTURERS OF

CABLES, WIRES, INSTRUMENTS, INSULATORS, DYNAMO MACHINES, MOTORS, ARC LAMPS & FITTINGS, BATTERIES, CARBONS, TORPEDO APPARATUS.

SPECIALITY.—Underground Electric Light System for High and Low Tension. The only System which has given complete satisfaction.

Contracts entered into for the Erection and Equipment of Central Lighting Stations, the Lighting of Ships, Factories, Houses, and the Supply of Complete Plant for Electrical Traction and Transmission of Power.

VULCANISED INDIA RUBBER.

HOSE, DRIVING BANDS, STEAM PACKING, WATERPROOF GARMENTS and FABRICS, SHOE SOLES, MATS, VALVES, BRAKE BLOCKS, WHEEL TYRES for CABS, CARRIAGES, BICYCLES, &c. SHEET, WASHERS, BUFFERS, SPRINGS, TUBING, SOLID CORD, FOOTBALL BLADDERS, LAWN TENNIS BALLS. MOULDED GOODS to any Pattern.

EBONITE.

Not affected by Vinegar or Hydrochloric or Acetic Acid.

SPECIALITIES IN EBONITE FOR CHEMICAL WORKS.

INSULATORS, BATTERY CELLS, SPEAKING TUBES, SHEET & ROD, SURGICAL APPLIANCES, PHOTOGRAPHIC ARTICLES, SCREW STOPPERS, PUMPS.

GUTTA PERCHA.

TUBING, BELTING, BUCKETS, BOSSES for FLAX SPINNING, GOLF BALLS, SHEET and TISSUE.

ESTIMATES & PRICE LISTS ON APPLICATION.

HEAD OFFICES: 106, CANNON ST., LONDON, E.C. | **WAREHOUSES:** 100 to 104, CANNON ST., LONDON, E.C.

BRANCHES.

MANCHESTER.....4, Fountain Street.
LIVERPOOL.....54, Castle Street.
GLASGOW.....8, Buchanan Street.
BRADFORD, YORKSHIRE....1, Tanfield Buildings, [Hustlergate
SHEFFIELD.....64A, High Street.

BIRMINGHAM.....27, Albert Street.
BELFAST.....33, High Street.
DUBLIN.....15, St. Andrew Street.
PORTSMOUTH.....49, High Street.
BRISTOL.....28, Clare Street.

NEWPORT, MON.....119, Dock Street.
CARDIFF.....Pierhead Chambers, [Bute Docks.
NEWCASTLE-ON-TYNE..6, Neville Street.
COVENTRY.....2, Vicar Lane.

WORKS.

SILVERTOWN, ESSEX. PERSAN-BEAUMONT, FRANCE.

TELEGRAPH ADDRESSES:

HEAD OFFICE—"Silvergray, London."
BRANCHES—"Silvergray" (followed by Name of Town).
WORKS—{Silvertown, "Graysilver, London."
{Persan-Beaumont, "India, Beaumont-sur-Oise."

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Telegraphic Address: "OUKETI LONDON."

ELECTRICAL ENGINEERS and CONTRACTORS.

RUSSELL & CO.

Offices: 11, Queen Victoria St., London, E.C.

COUNTRY HOUSE LIGHTING.

BOILERS and HIGH-SPEED ENGINES.

SHIP-LIGHTING PLANTS.

All Orders carefully and promptly attended to. Estimates for any description of Electrical Work given Free.

WE INVITE OPPORTUNITIES FOR TENDERING, AND GUARANTEE OUR WORK TO GIVE SATISFACTION.

NO INFERIOR WORK.

Crompton & Co., Ltd. — *See Important Announcement on page xxvi.*

DAVEY, PAXMAN & CO.,

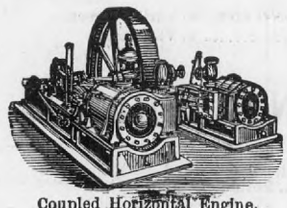
ENGINEERS, COLCHESTER.

London Office: 78 (late 139), QUEEN VICTORIA STREET.

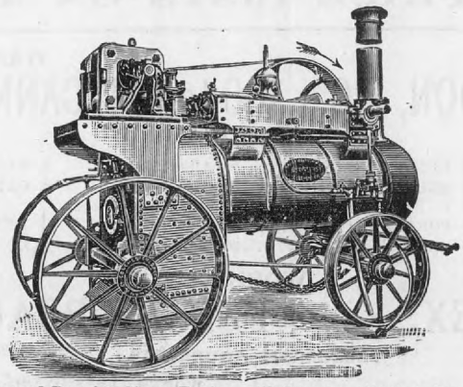
MAKERS OF A GREAT VARIETY OF STEAM ENGINES & BOILERS.

SPECIALITY: **Steady Running Engines for Electric Lighting.**

CATALOGUES,
PRICE LISTS, ESTIMATES,
PHOTOS, &c.,
POST FREE.

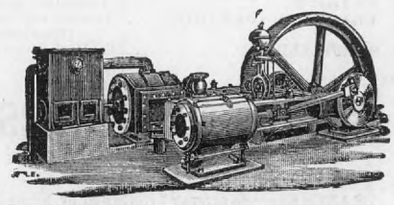


Coupled Horizontal Engine, 40 to 1,000 H.P.



Improved Portable Steam Engine, with Dynamo attached, forming a portable electric light plant. Single cylinder, 4 to 12 h.-p.; double cylinder, 8 to 25 h.-p.; compound, 8 to 30 h.-p. nominal.

TELEGRAPHIC ADDRESS:
"PAXMAN COLCHESTER."



Horizontal High Pressure Coupled Compound Engine. 12 to 1,000 H.P.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 778.—Vol. XXX. FRIDAY, APRIL 14, 1893. PRICE FOURPENCE.
Annual Subscription (U. K.), 19/6

NOTES.

The same week that has seen the death of one of the fathers of cable telegraphy has witnessed the successful completion of a new cable of a type never dreamed of until a few years ago. Whether the K R law on which the Irish telephone cable is based is a sure foundation or not is comparatively unimportant so long as first-rate cables are turned out. For all we know, the theory may be completely wrong. This matter will be settled some day, but it is a relief to think that, however ill-founded it may be, the speaking qualities of the London-Paris and Glasgow-Belfast cables will not be affected. Competent judges, says a Scotch paper, declare that line to be three or four times the efficiency of either of the London-Paris circuits. Unhappy word "efficiency," how many duties has it to perform! The success of this cable, particulars of which will be found elsewhere, is said to augur well for a London-Dublin line. The precise effect on the proposed Irish Parliament of easy conversation, at five or six shillings for a three-minute harangue, is happily beyond our province to consider.

The Paper by Mr. C. K. Falkenstein, which we are able, after a lapse of three weeks, to publish with the curves, is of wider interest than the somewhat unfortunate process with which it is connected. The commercial difficulties of electrical tanning companies have, however, nothing to do with the experiments and observations of Mr. Falkenstein. The distinctly different characteristics of the solid substances which were found to adhere to the electrodes in his first experiment, seem to point to a true electrolysis of the liquor. It must be remembered, however, that the hides do not form any part of the electrodes, nor are any diaphragms used in practice. The electrolysis, indeed, seems to be rather a waste of good liquor, and may, perhaps, be regarded as an accident in the process. Other experimenters have found that only about fifteen millionths of the liquor is actually electrolysed during the tanning of a batch of hides. The endosmotic effects seem to be of much more importance.

Mr. Falkenstein throws out a suggestion to the effect that the phenomenon of electricity being a vibration of the ether, chemical combinations are accelerated; but we know of no such vibrations in ordinary currents such as those employed by the author. His second suggestion is that the effect of endosmose is to propel the liquor in the direction of the lines of current flow. To examine these effects, Mr. Falkenstein has used diaphragms of porous clay and leather, and he found, and has measured, the flow of liquor through such diaphragms. While these observations are of considerable interest, it seems hardly possible to assume that a corresponding flow takes place through hides in tanning, either in the mass as in the Worms and Balé process, or when stretched as in the Groth process. In each case there is plenty of opportunity for the liquor to circulate round the hides; and although they offer but little resistance to the electric current, they must obviously behave very differently to an actual current of liquor. There seems to be an ill fate about certain problems on the borderland between chemistry and physics. The theory of solution has engaged the attention of many high authorities, but seems to become more and more involved. Electrolysis, if not settled theoretically, is, at all events, understood sufficiently well for practical purposes, and it is to be hoped that osmosis, even if as unintelligible as simple solution, may, nevertheless, become of practical importance in the commercial applications of electrical energy.

A most sensible suggestion is made in the *Builder* as to preparation in new buildings for running electric cables. In a few instances holes are left in walls and flooring by express orders, but in the large majority of cases considerable expense is incurred in cutting away work which has only been erected a few weeks before. Cutting holes is bad enough, but cutting chases is so serious that outside casing is resorted to five times out of six. Insurance companies very properly object to the running of cables in the same chase with water and gas pipes, but while these are almost invariably provided for by the builder, similar provision for electric cables is ignored. The suggestion is specially welcome, coming as it does from the leading building journal, and we warmly endorse it.

The calculations given by Mr. R. Wood in our correspondence columns are not very convincing in the absence of clearer definition of some of the terms employed. His theoretical arguments appear to depend upon a term p, representing the pounds of steam that are used non-condensing, which are saved by condensing, and these, he says, are constant for all loads on the engine. When Mr. Wood comes to actual figures taken from tables by Mr. Crompton and Prof. Kennedy, we are inclined to ask whether a simple

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comparison between these tables is warranted by those who compiled them. We print his letter, as he informs us that it is *apropos* of our leading article on condensers; but so far from arriving at any conclusion, his last paragraph alludes to one or two items which leaves the whole question open. It is not seriously disputed by anyone that a condensing engine of a reasonable size is more economical than a non-condensing, and it is well understood, as Mr. Wood observes in conclusion, that each case must be decided on its merits when the local conditions were known. Where evaporative condensers are concerned, and where local circumstances will allow them to be used, the cost of water for condensing need not be considered, since it appears to be conceded that the feed-water is more than sufficient for this purpose. The Paper by the late Mr. P. W. Willans, of which an abstract will be found in another column, will throw much light on the subject of compound engines of the limited sizes employed for electric supply.

We have frequently noted with considerable surprise and no little sympathy the predominance enjoyed by German electrical apparatus in France. Had we remembered that French manufacturers, who have always "enjoyed" a large measure of protection, had recently succeeded in getting the duties on foreign goods raised all round to "compensate" them for the increased cost of home labour, we might have come to much the same conclusion as M. Ch. Haubtmann arrives at in a brief but bitter article in *L'Electricien* for April 8th. Owing to the high tariff, German electrical apparatus, as such, is not able to make much way in France, but this very fact makes it highly profitable for a French firm to purchase the French patents of some foreign electrical manufacturing concern, obtain all the patterns, &c., from the same source, and then proceed to manufacture under the shelter of the high-tariff wall. This policy certainly stimulates manufacture, but of a very delicate hothouse kind, and it utterly kills both commercial enterprise and the inventive faculty which, after all, lie at the root of permanent prosperity. M. Haubtmann points out that the great Creusot Works are sole *concessionnaires* in France of the Zipernowski-Déri-Bláthy patents, and confine themselves to a tame imitation of the plant turned out by the well-known Budapest firm of Ganz. The Société Alsacienne de Constructions Mécaniques do the same as regards Siemens and Halske, of Berlin, and La Compagnie de Fives-Lille as regards the Allgemeine Electricitäts-Gesellschaft, whilst even the Cail Works make German cables.

Guided by what it knows "respecting the laws of conduction," a contemporary connected with building and architectural matters comes to the conclusion, in a brief article on "Lightning Conductors," that "copper is the best metal for the purpose;" the natural corollary to this ancient dogma being instructions to unite pipes, lead roofs, and masses of metal generally to the discharge rod, which is "on no account to be insulated by glass rings or pitch, as is sometimes done." Not having a supply of thunderstorms on tap suitable for settling controverted points, we are unable to go bail for all that Dr. Lodge has stated in a contrary sense with regard to the theory and proper mode of erecting lightning conductors. There is, however, a sufficiency of support from electro-magnetic theory, experiment, and observed facts to render it desirable in any article likely to be read by practical men to at least mention the Lodgian theory, and to summarise the leading deductions from it. There seems to be no mean in this matter of acceptance of new scientific ideas between the "impulsive rush," which is usually accompanied by considerable distortion of the original idea, and a state of steady neglect.

Dislike the fact as we may, the fact remains that we are rapidly travelling along the "checker'd paths" leading to complete municipalisation—whether the roads run uphill or down we leave it to experts to prophesy and events to decide. The Glasgow Corporation, not content with having municipalised the water, gas and electricity supply, now contemplate applying to the Postmaster-General for a licence "to supply the community with an efficient telephone service." A municipal telephone service is an experiment worthy of a trial—north of the Tweed. Even in the far East, local authorities have caught the infection. At the last meeting of the ratepayers of the foreign settlement north of the Yang-king-pang, a resolution in favour of buying out the local electric lighting company was carried by two votes, a majority having apparently been obtained by the Yang-king-pang argument that as there was a municipal *abattoir* there ought also to be a municipal central lighting station.

Cairo.—The local Gas Company has undertaken to supply electric light.

Electricity Supply Corporation.—Mr. W. H. Patchell has been appointed chief engineer to this Corporation.

Personal.—Mr. J. W. Curra has been appointed to the technical officers' class in the Engineer-in-Chief's Office, Post-office Telegraphs.

"**Elektrotechnische Bibliographie.**"—Under this title the publishing house of J. A. Barth, of Leipzig, intend issuing a monthly list of books and articles published, dealing with electrical matters.

Electrical Engineering Course.—A course of electrical engineering lectures and laboratory work will be given at King's College on Monday evenings, commencing May 1. For particulars, apply to the secretary.

Glasgow Telephone Service.—At the last meeting of the Town Council it was remitted to a Special Committee to consider the question of applying to the Postmaster-General for a licence to supply the community with an efficient telephone service.

Royal Institution.—At the general monthly meeting of this Institution, on Monday, the special thanks of the members were returned for a £21 donation by Mr. Alexander Siemens to the fund for the promotion of experimental research at low temperatures.

Aberdeen.—At a meeting of the Gas Committee of the Town Council on Friday last, plans and specifications drawn up by Prof. Kennedy with regard to the electric lighting works were submitted. The Committee authorised the invitation of tenders for the buildings in Cotton-street.

Gas Companies and Electric Lighting.—The Manager of the Dorking Gasworks reports that he has received many representations from customers urging him to supply electricity. He therefore recommends that the Board of Trade should be approached with the view of securing its help in the revision of present arrangements.

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Brighton and Rottingdean Sea-shore Electric Railway.—The Bill for incorporating a company for the construction of this line has been referred to a Committee of the House of Commons, consisting of Sir Richard Paget, Chairman, Sir J. D. Weston, the Hon. Henry Cubitt, and Mr. C. P. Huntingdon. The Committee will hold its first sitting on Tuesday next.

Mr. Henniker Heaton and the Cable Companies.—Mr. Henniker Heaton has given notice, on going into Committee of Supply, to move a resolution in favour of the acquirement by the State of the existing rights and property of the cable companies at their present market value, with the object of cheapening and facilitating electric communication with the different parts of the empire.

Southport.—The Electric Lighting Committee of the Southport Town Council, after discussing the electric lighting question for months, and having apparently made considerable progress, now find themselves, says the *Liverpool Post*, so divided in opinion as to the merits and demerits of the high-pressure alternating and continuous-current systems, that they have decided to submit the whole case to an electrical expert.

Edinburgh.—At a meeting of the Electric Lighting Committee of the Town Council held last week the question was discussed at some length whether the Corporation should themselves put in force the Electric Lighting Order, or hand it over to a company. By eight votes to three it was resolved that the Corporation should take the matter in hand themselves, and this recommendation will be reported to the next meeting of Council.

Brighton.—At the meeting of the Town Council on Thursday last week, the Town Clerk read a letter from the Local Government Board, stating that they had decided to sanction the loan of £30,000 for electric lighting purposes, on the understanding that the Council will, without delay, make a further application for authority to borrow such additional amount as may be necessary to cover the excess expenditure which has taken place.

Obituary.—We regret to report the death of Mr. Thomas H. Brayshaw, Superintendent of the Eastern Telegraph Company's system in Cyprus. Mr. Brayshaw was born in 1850, and joined the Electric and International Telegraph Company in 1863. In 1869 he was appointed to the Eastern Telegraph Company, and served in Aden, Florence, Malta, and Egypt, until 1878, when he was appointed Superintendent in Cyprus, where he remained until his death on the 11th instant, at the early age of 43.

Worcester.—Last week an inquiry was held by Major-General Crozier, inspector of the Local Government Board, with reference to applications by the Corporation for permission to borrow money in order to carry out electric lighting works and increase the filter beds at the Waterworks. The Town Clerk gave a *résumé* of the action taken by the Corporation in respect to electric lighting, and it was explained that the total expenditure contemplated under this head was £39,109, for purchase of Powick Mills, buildings, cables, &c.

Wolverhampton.—At the meeting of the Town Council, on Tuesday, Alderman W. H. Jones moved :—"That the report of the Lighting Committee relative to electric lighting be received, and that the recommendations therein contained be approved and adopted." The report empowered the Committee to advertise for a resident electrical engineer, at a salary not exceeding £300 per annum. Also to appoint an architect for the performance of such duties, fix his remuneration, and give instructions for the preparation of plans and specifications for the construction of all necessary buildings. The motion was agreed to.

A Useful Application of the Telephone.—The police authorities of Newcastle have taken a practical advantage of the telephone which might well be followed by the London County Council and other municipal bodies. They employ a combined receiver and transmitter with about 18in. of wire attached; it is very light and handy, and can easily be carried in the coat pocket. This apparatus is being chiefly used in cases of fire, when a constable, instead of breaking glass and pulling bells, has only to affix a key in the socket of the fire alarm provided for its reception; he is immediately in communication with the officer in charge of the fire station, and is able, without delay, to give full particulars.

Eastbourne.—In connection with the payment of a first dividend by the Eastbourne Electric Light Company, it is worthy of note that this Company commenced to supply electric light early in the year 1882. There are now operating 10,000 10-c.p. lamps in a circuit of nine or ten miles. There are also some 20 arc lamps running, and a contract for extending the lighting of the parade has just been entered into. The present members of the Board are those originally appointed. Mr. H. Towner, the Secretary, was also appointed at the incorporation of the Company, and has held the post ever since. Mr. H. W. Wilkinson is the present manager, and under his management the Company has made rapid strides.

Municipal Lighting in the Far East.—The municipalisation of the electric light has spread to Shanghai. At the annual meeting of ratepayers of the foreign settlement north of the Yang-king-pang, held on Tuesday, February 28th, in the Astor Hall, the following resolution was carried by 61 to 59 votes :—"That the Council be and are hereby authorised to enter into negotiations with the New Shanghai Electric Company for the purchase of the whole property, plant, and business of the Company, the Council itself undertaking the future supply of electric light for public and private use, the result of the negotiations to be laid before the ratepayers at a special meeting to be called for that purpose."

Scientific and Engineering Instruction.—We are in receipt of the prospectus of the Electrical and General Engineering College and School of Science, which is presided over by Mr. G. W. de Tunzelmann, at Penywern House, Earl's Court. The object of the College is to train engineering students in the general scientific principles underlying their proposed profession, and to prepare for the Central Institution, Cooper's Hill and the Royal School of Mines. The usual engineering course extends over two years, but there is also a special workshop course lasting a year. There are a variety of special courses, intended mainly for those actually in works who desire to study special subjects. The College is provided with physical and chemical laboratories, engine and dynamo room and workshops, and the engineering instruction is in the hands of Mr. Capito, late of Hanover-square School of Electrical Engineering.

The City Lighting.—In his report to the Commissioners of Sewers for the year 1892, Colonel Haywood states that in regard to electric lighting, there were at the beginning of the current year 409 lamps in operation, illuminating about eleven miles of streets. At the end of 1892 the Company had laid their mains and conduits in 22⅛ miles of streets. The gas lighting in the main thoroughfares was, says Colonel Haywood, discontinued from time to time as the electric lamps were put into operation. The gas lamps and fittings, however, were not removed, arrangements having been made with the gas company for cleaning and maintaining the lamps ready for lighting to meet the contingency of failure in the electric light. The number of gas lamps unlit at the end of the year was 1,126, the number of arc lamps lighted being 409; 2·75 gas lamps were extinguished for each arc lamp. The number of public ways remaining in which the Company have not laid conductors is 621, but the largest portion of these are small streets and courts and alleys.

Electric Light Wiring Facilities.—"As the majority of large buildings which are now being built, or which will be built during the next few years, will probably before long be fitted with electric light, it seems desirable," says the *Builder*, "that this probability should be taken into account in their construction. At present no one can calculate on the surprises in store for the electrical contractor. Contractors, however, would have a much clearer basis for estimate, and their rates of charges would be lower, if they could count on some preparation in the building for carrying electric cables through walls or flooring. It is too much to expect that the owner of a building which is in course of erection will put in all the necessary wiring for electric light unless there is the immediate prospect of that light being used. The cost of doing so would be considerable, and the money might lie idle for some

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time. But there is little or no cost involved in arranging that at every top corner of a wall there should be two circular holes in the solid material, one connecting the two sides of the wall and the other running up to the floor above. These holes might be carefully covered over so as not to disfigure the wall, and their existence would be an immense saving in cost and labour in putting wires throughout the house at any subsequent time."

Telephone Wires in Manchester.—At the monthly meeting of the City Council on Monday Mr. Southern asked if the Paving Committee had had any application from any company for the privilege of laying telephonic or other wires underground, and whether until the Council had had an opportunity of pronouncing upon this very important question the Committee would refrain from granting any special privileges in the direction indicated. Sir John Harwood emphasised the words of Mr. Southern. He submitted that before committees gave any privileges to private parties they should take the Council into their confidence. Mr. Tunstall said that if any privileges had been allowed to those companies they had had to pay for them. There had also been a provision that the wires should be removed if the Council desired it. Mr. Alderman King said he noticed telephone wires being laid in the streets in the very place where the Corporation were about to lay their own wires. It appeared to him that there would be two jurisdictions, and if they allowed one body to lay wires there might be interference with the laying down of the electric light wires. Mr. Alderman Hinchcliffe, in reply, said that applications had been received from one or two companies for permission to lay wires underground, but that nothing would be done until a full report of the decision arrived at by the Committee was laid before the Council.

The City of London Electric Lighting Company.—At the last meeting of the Commissioners of Sewers, the Finance and Improvement Committee made a report on the subject of an application by Mr. Morse, on behalf of the City of London Electric Lighting Company, for the Commissioners' consent, as the Local Authority, to the introduction of a Bill for amending section 8 of the Electric Lighting Orders (*re* setting aside 7½ per cent. on the capital expended for depreciation). The Committee recommended, after further consideration, that the Commissioners agree that such 7½ per cent. be on the outlay for plant and machinery, &c., as defined by the Board of Trade, and that 5 per cent. on the net profits be set aside as a reserve fund, the Company, however, to be at liberty to write off as depreciation such further sum as they may think proper, or as they may be required to do by the Board of Trade, not exceeding in the whole 7½ per cent. Mr. Williamson explained that, after an interview with a Director of the Company, it was found that by mistake the word "shall" was inserted in the agreement when it meant "may." That naturally made a very great difference in an agreement of such a public character. The Company asked the Commission to allow the 7½ per cent. to apply only to the plant and machinery. It was clear that if the Company wrote off that amount on the whole of their capital it would have no chance of paying a dividend, or reducing the price of the electric light, which the Commission greatly desired. The report of the Committee was adopted.

American Electro-culture.—The cult of Thomas Alva Edison appears to have been superseded across the Atlantic by that of Nikola Tesla. A writer who hides his identity under the not inappropriate initials of J. A. M. commences "A Psychological and Scientific Study of the Man," in a technical New York contempary, with the following pronouncement:—"I can confidently state that Nikola Tesla is one of those few productions of nature that have been termed geniuses," an asseveration which is unconsciously supported by the further statement that—"Business men of to-day, and especially Americans who are thoroughly in touch with the ideas of American progress, cannot put themselves in his place." In another electrical publication we are told that Mr. Tesla "Has shown that nearly all sanitary problems can be solved by the aid of electricity;" that "he was invited to visit London and explain his experiments on the very spot made immortal by Faraday;" that he went and "manufactured flames which appeared dangerous in the extreme, and then placed them in a wooden box, which was absolutely unaffected by them." It was in London also that he demonstrated that wires and globes might be dispensed with "without impairing the efficiency of the light one fraction," though just how this was done was what "puzzled the members of the Royal Institution of London, each an expert electrician and engineer himself." After which it is a relief to learn that "Tesla does not pretend to manufacture electricity out of nothing." We could wish, also, that transatlantic technical writers would not pretend to manufacture "copy" out of nothing.

The Hopkinson Three-Wire Patent.—At a recent meeting of a Special Sub-Committee of the Glasgow Corporation, after considering the opinion of counsel on the circular letters of February 16th and 23rd, issued by the Westinghouse Company, and having regard to (1) the advantages derived from the adoption of the three-wire system, (2) the uncertain issue of any litigation, and (3) the fact that the total amount which would have to be paid by the Corporation for the use of the patent would not exceed £900, resolved that an amicable arrangement should be made with the Company for the use of their patent, upon the terms indicated in the circular letters referred to. These terms are as follows:—(1) The Corporation to pay to the Company a royalty of £2. 10s. per annum till July 27, 1896 (being the date when the patent expires), upon each ton of copper which has been, or may be, actually laid down before that date. (2) The royalty to be reckoned from the date of delivery of the copper, as shown by the invoices sent to the Corporation. (3) Accounts to be rendered on every 25th day of March, 24th day of June, 29th day of September, and 25th day of December, within 15 days of such quarter days, and payment to be made in cash within seven days from such delivery of account, in one sum, covering the period from the dates of delivery of copper detailed in the account to July 27, 1896. (4) A formal agreement, embodying the foregoing terms, to be entered into and executed by and between the Corporation and the Company. The resolution come to by the special Sub-Committee as to the arrangements to be made with the Westinghouse Company has since been approved of by the General Electric Lighting Committee of the Corporation.

The Edison Lamp Patent in America.—Our columns are, as a rule, rigidly closed to poetry, but the following effusion by "Voltabout," which recently appeared in the columns of our New York contemporary, the *Electrical Review*, has managed to pass the censor:—

To sell, or not to sell infringing lamps—
That is the question which haunts us day and night.
Whether 'tis better business tact to obey
The warnings and printed things sent out by mail—
Ay, registered mail, forsooth—
Or to take up arms against Sir Edison,
And, by opposing, get into jail? to stop—to sell
No more; and, by stopping, to find we end
The trials and the chance of paying royalty
Our trade seems heir to—'tis a consummation
We truly do not like. Ah, yes—to sell—
To sell! Perchance to gain; ay, there's the rub!
For in this trade of ours what wealth may come
When we have shuffled off this *choking coil*,
Must give us pause; there's the law's delay
That makes uncertainty of so long life;
For who can stand the costs of tedious suits,
The lawyers' fees, the proud inventor's scorn,
The pangs of despised cause, the Court's keen eye,
The arrogance of triumph, and the spurns
Acknowledged right of the unworthy takes,
When we ourselves might peaceful quiet gain
By simple acquiescence? We would contracts sign,
And trust to luck to see us through.
But that the dread of something better coming after—
From the undiscovered future which
May hold our weal—puzzles our pockets,
And makes us rather sell the lamps we have,
Than wait for others that we know not of.
These injunctions make cowards of us all,
And thus the native hue of resolution
Is sicklied o'er with the pale cast of fear.
But other lamps of great life and low price,
With this regard, may come our way
And give us chance for action.

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ELECTRICITY AS A MOTIVE POWER.*

BY ALBION T. SNELL.

(Continued from page 624.)

§6. The Ratio between Radial Depth of Core and Diameter of Armature.

The following ratios between radial depth of core and diameter in gramme armatures have been taken from practice, and illustrate the difference of opinion on the subject. They all refer to bipolar machines. It will be noted that they vary from $\frac{1}{3}$ to $\frac{1}{4}$.

Table B.

Diameter of core = D.	Radial depth of core = r.
7 inches.	1·0 inch.
8 „	1·25 „
8·875 „	1·125 „
10 „	2·0 inches.
10 „	1·5 „
12 „	1·875 „
12 „	2·25 „
13 „	2·0 „
14 „	2·5 „
15 „	2·25 „
15 „	3·0 „
16·875 „	3.0 „
18 „	4·0 „
24 „	4·5 „

§7. Determination of the Number of Conductors on the Armature.

The factor neither known nor approximated to as yet is the number of conductors. This is found by putting

$$C_a = \frac{E\,60}{N_a\, n\, 10^{-8}}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

which determines the trial value of C_a. Dividing the necessary number of turns into the space for winding on the periphery gives the width over the insulation of one turn. Deducting the insulation thickness, say, from 7 to 8 mils on each side of the wire, the remainder gives the net width of copper. C_a may be a number that will conveniently form one or two complete layers on the armature; if such be the case a round wire may be chosen; but if the number will not fit into one or two layers, it will be advisable to use a wire of rectangular section, the width being such as to fill up compactly the winding space, and the depth such as to give a suitable air gap.

The current density has been thus far purposely neglected, as the determination of a suitable number of turns is of the first importance; and therefore special stress has been laid upon it. The relation of cross-section of copper to the current must now be carefully considered, since the heating of the armature, as well as the fall of potential ($i_a r_a$), and the efficiency of the machine depend on this. No current density can be said to be in all cases the best; it is a question of size of machine, cooling surface of armature, character of output, and time of duration of maximum load. The practical limits are between 1,500 amperes per square inch in large machines, and 3,000 with outputs as small as 5 H.P. If the number of volts to be lost over the armature resistance be determined from Table A, then r_a is known, and the cross-section of copper to give this value with the calculated number of turns can be found. It is advisable also with gramme armatures to consider the depth of copper in relation to the radial depth of armature core, since the output of the machine will vary as the depth of the copper up to a certain practical limit. This point is reached where the air gap becomes so deep that the resistance is too high for the field excitation to maintain the necessary magnetic density; or else when the circumflux,[3] $\frac{i_a C_a}{2}$, on the armature causes the length of the air gap. For with a standard size of field the excitation is practically fixed, and so a large air gap with deep back and cross fields of such magnitude that sparking ensues. It should be remarked, however, that the output of the armature is not greatly affected by even considerable differences in copper implies a weak magnetic density; and less copper means a corresponding gain in the number of lines of force.

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[3] This expression for the circumflux of an armature is applicable to machines with any number of poles, it must not be confounded with the ampere turns

Two empirical equations, due to W. B. Esson, connecting the circumflux and the armature diameter, are important; for they give at once the permissible value of C_a.

For gramme armature—

$$\text{Circumflux} = \frac{i_a C_a}{2} = D\ 1000; \quad . \quad . \quad . \quad (9)[4]$$

for drum armature—

$$\text{Circumflux} = \frac{i_a C_a}{2} = D\ 1500 \quad . \quad . \quad . \quad (10)$$

D in each case is the diameter measured in inches.

Practically, with gramme ring armatures, it is found that the best all-round results are obtained with a ratio of radial depth of copper to iron of from $\frac{1}{8}$ to $\frac{3}{16}$. With drums some 50 per cent. more copper may be allowed, as is evident from the empirical equations (1), (2), (9), and (10).

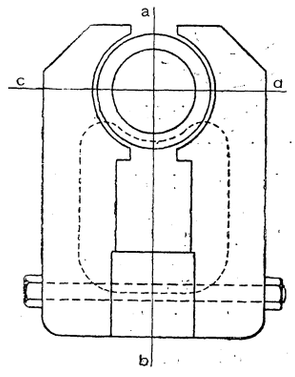

FIG. 1.—Wrought Cores, Cast Yoke, Upright Type.

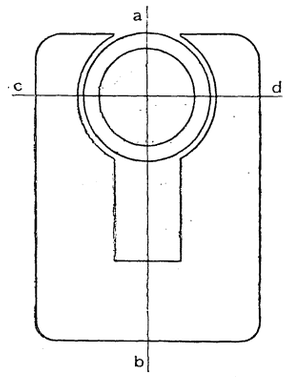

FIG. 2.—Cast Iron.

This ratio is important in gramme armatures, because the narrow section of iron must be magnetised to at least $B_a'' = 100{,}000$. In drums this ratio has no meaning, since the iron is made as deep as possible, reaching even to the shaft itself, and the depth of copper is determined simply from the heating limits and the possible length of gap, having regard to an economical field-magnet and excitation.

The thickness of the copper being known, the length of the air gap can be determined approximately. It may have to be adjusted when the field-magnet excitation is calculated from the trial equations.

§8. Design of Field-Magnets.

The function of the field-magnets is simply to supply the necessary magnetic flux with due regard to an economical distribution of iron and copper. The shape does not directly enter

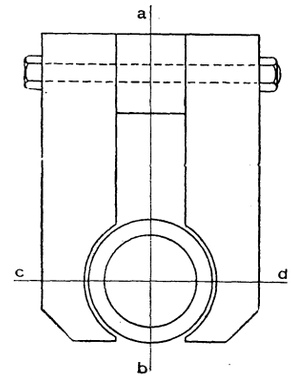

FIG. 3.—Wrought Iron Inverted Type.

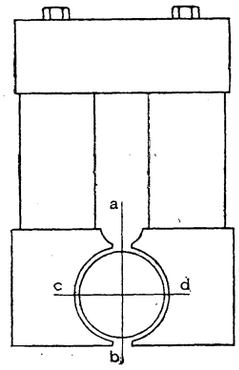

FIG. 3A.—Wrought Iron Cores and Yoke, Cast Iron Pole Pieces.

into the question, and is really a matter of convenience, and perhaps fancy. Broadly speaking, field-magnets may be divided into the bipolar and multipolar types, each of which is subdivided into a number of forms, sometimes possessing real advantages, but often only expressing individual taste. Some of the more general designs are shown in Figs. 1 to 9.

[4] In (9) and (10) the diameter is expressed in inches instead of centimetres, and so the coefficients have different values from those given by Mr. Esson.

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(*a*) *The Single Magnetic Circuit Bipolar Field-Magnet.*—This popular shape of magnet is simply a development of the primitive horseshoe magnet, and is largely used in both the upright and inverted form (Figs. 1 to 3). The former arrangement has a lower leakage coefficient than the latter, and is generally adopted for small armatures; but since the centre of gravity of the rotating part is high there is a tendency to want of stability, and, consequently, with large diameter armatures the latter is more generally adopted.

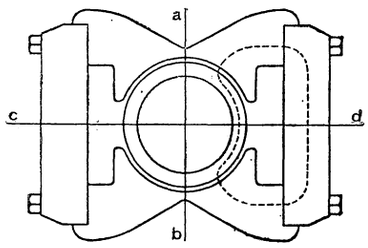

FIG. 4.—"Snell" Type of Double Magnetic Circuit Magnet. Wrought Iron Cores and Cast Iron Pole Pieces.

The single magnetic circuit field-magnet is cheap to build, and is excited with a relatively small quantity of wire. Its principal disadvantage lies in the unequal distribution of the magnet flux in the polar space, and hence inequality of induction in the armature wire. For the latter reason drum armatures are most frequently used in these fields. Large gramme rings are practically impossible with the single magnetic circuit. The largest size that is advisable is a diameter of about 12 inches; if this be exceeded there is a tendency to spark with

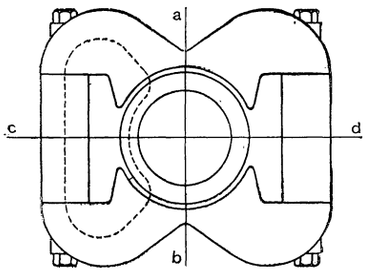

FIG. 5.—Wrought Iron Cores and Cast Iron Pole Pieces.

large outputs, so that the armature cannot be loaded to its proper limit. Larger sizes should be run in double magnetic circuit bipolar fields, or, if very large, in multipolar fields.

(*b*) *The Double Magnetic Circuit Bipolar Field-Magnet.*—Figs. 4, 5, and 6 illustrate this well-known form of field-magnet, and show the variety of ways in which it is built. The resulting distribution of magnetism is symmetrical, though the "field" as a whole may be rotated considerably. Therefore a gramme armature as large as 15 inches in diameter

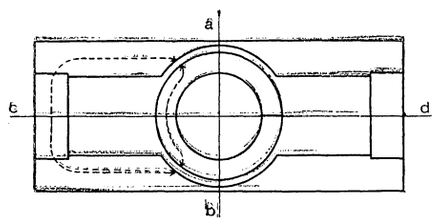

FIG. 6.—Wrought Iron.

may be profitably excited in them. The chief objection is that the number of ampere turns in the exciting coils has to be about twice as great as in the single-circuit type for a given induction in the armature. This type has also a larger coefficient of leakage than the single magnetic circuit.

If the armature be 18 inches or more in diameter, it will pay to increase the number of pairs of poles, although by doing so the exciting turns will be somewhat more numerous.

(*c*) *Multipolar Field-Magnets.*—The two types most in vogue are shown in Figs. 7 and 8. It is not easy to state exactly at what diameter of armature it is commercially profitable to depart from the bipolar type. But there seems to be some connection between the width of the polar cavity and the diameter of the armature. The ratio of interpolar space to the width of the poles, with gramme rings, is usually about 1:3; and the width of the pole, w, may be expressed in terms of the diameter, as

$$w = \frac{\pi D}{3}.$$

If the maximum economic diameter with a single magnetic circuit field be 12in. the width of pole will be $\frac{\pi}{3}\ 12 = 12{\cdot}5$ inches approximately. With a double magnetic circuit the

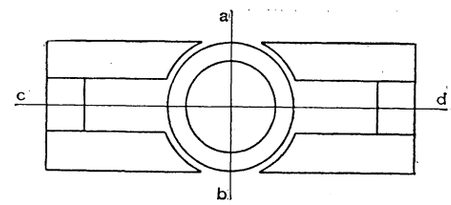

FIG. 7.—Wrought Iron. Four Poles.

diameter may be as large as, say, 15 inches; and the polar width will be $\frac{\pi}{3}\ 15 = 15{\cdot}75$. The limiting width of the polar cavities therefore varies between 12·5 and 15·75 inches. These limits accord well with practice, poles seldom being found shorter than the former or longer than the latter in multipolar designs. Continental engineers have lately developed

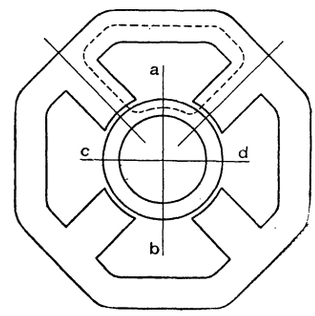

FIG. 8.—Multipolar Design in Cast Iron.

large gramme rings with multipolar field-magnets, and have attained considerable success. Recently this design has been appreciated in England and America. Some two years ago the author selected it for large transmission-of-power machines, and also for central-station dynamos; Kapp has developed the

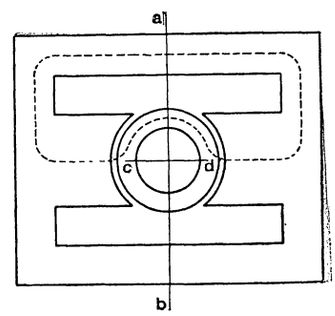

FIG. 9.—Made in Wrought or Cast Iron or with Wrought Poles and Cast Yokes. Armour-clad Type.

same idea, using, however, drum armatures; and the Thomson-Houston Company have also adopted the device for their traction dynamos.

(*d*) Armour-clad fields, as in Fig. 9, are coming into use for certain purposes, particularly for motors which have to work in very exposed positions. For tramcars, they are often built with only one exciting coil, one pole piece being made very short. This type offers no special advantages other than the excellent protection it affords to the armature and field winding.

(To be continued.)

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PARALLEL DISTRIBUTION.

BY FRANCIS JEHL.

(*Concluded from page 657.*)

Let us now examine the assertion made in reference to the loop systems, and find if it is possible to always maintain a constant difference of potential between the parallels. Let us take a simple case, as given already by Kapp,* and we will use his argument. Let c_1 and c_2 be the currents taken from the line of centres, at A and B in Fig. 6, p_1 and p_2 the corresponding pressures (or difference of potential) in these points, E the difference of potential between the terminals P_1 and P_2 of

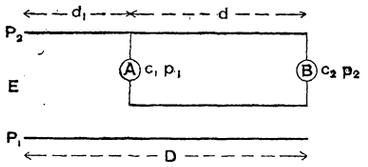

FIG. 6.

the line, and ρ the resistance of a unit length of conductor, then by applications of Ohm's law we find

$$p_1 = E - [(c_1 + c_2)\, d_1\, \rho + c_1\, d\, \rho + (c_1 + c_2)\, D\, \rho]$$
$$p_2 = E - [(c_1 + c_2)\, d_1\, \rho + c_2\, d\, \rho + (c_1 + c_2)\, D\, \rho]$$
$$p_1 - p_2 = (c_2 - c_1)\, d\, \rho \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

If the two centres A and B were supplied at the same pressure, the difference between p_1 and p_2 must be zero, and this can only take place if $c_1 = c_2$, and in all other cases we have equation 16, and therefore the difference between the pressures in A and B cannot remain constant if the currents vary. By

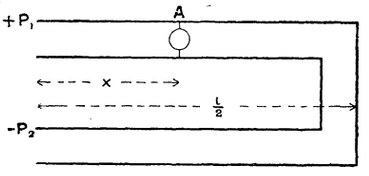

FIG. 7.

varying the difference of potential between P_1 and P_2 it is possible to keep the pressure at one of the two centres exactly at the proper standard, but then the pressure at the other centre must be wrong. It is impossible to make it right for both at the same time, and, as with a great number of centres this difficulty is not removed, but probably somewhat increased, it follows that the line of centre system does not equalise the pressure. It might be, however, objected that, by assuming only a few centres which necessarily are wide apart, we do not get a correct representation of the actual supply which will in most cases take place at a great number of points, all more or less evenly distributed. Even in that

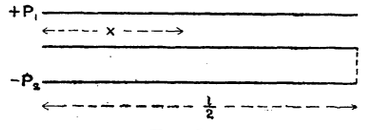

FIG. 8.

case the pressure is not equalised. To put the most favourable conditions possible, we will assume that all along the line a constant quantity of current per unit length of main is taken. Let c be the total current used in the district, l the length of the line of centres (or loop), and x the distance of A from the terminal Fig. 7. Then the current passing by A in the positive lead is $C[(l-x)/l]$, that passing by A in the negative lead is $C\,x/l$.

Let p_1 be the absolute potential in the positive lead at the distance x, and p_2 the absolute potential in the negative lead at the same distance. Then, if we call the potentials at the distance $x + dx$ respectively $p_1 + dp_1$ and $p_2 + dp_2$, we find

$$dp_1 = -C[(l-x)/l]\rho\, dx \quad . \quad . \quad . \quad . \quad (a)$$
$$dp_2 = -C\,(x/l)\,\rho\, dx \quad . \quad . \quad . \quad . \quad . \quad (b)$$

ρ being as before the resistance of a unit length of conductor. Integrating equations a and b we get

$$p_1 = -C\rho x + \tfrac{1}{2}\frac{C\rho x^2}{l} + \theta_1,$$
$$p_2 = -\frac{C\rho x^2}{2l} + \theta_2.$$

The values of the constant, θ_1 and θ_2, can be determined by putting $x = 0$ and we get $p_1 = P_1$, and for $x = l$ we get $p_2 = P_2$

$$p_1 = P_1 - \tfrac{1}{2} C\rho \left(\frac{2xl - x^2}{l}\right),$$
$$p_2 = P_2 + \tfrac{1}{2} C\rho \left(\frac{l^2 - x^2}{l}\right).$$

The difference of potential at the point A, or, as we have called it, the pressure in A, is therefore

$$p = p_1 - p_2,$$
$$p = P_1 - P_2 - \tfrac{1}{2}\frac{C\rho}{l}(2xl - 2x^2 + l^2).$$

We obtain the pressure at either terminal of the line by putting

$$x = 0 \text{ or } x = l \qquad p = P_1 - P_2 - \tfrac{1}{2} C\rho\, l,$$

If this be taken as a standard, the pressure at any distance x can be given with reference to it. It is

$$p = p_x - [(C\rho x)/l](l - x).$$

By taking the differential dp/dx and setting it zero, we get the maximum variation for $x = l/2$. Thus we get

$$p_m = p - \tfrac{1}{4} C\rho\, l,$$

which is the pressure in this point, and the greatest possible variation in pressure is $\frac{1}{4} C\rho\, l$. It will be interesting to investigate whether the single loop system offers some such advantage. We must again assume that the same amount of copper is used, but now subdivided into three mains, instead of four (Fig. 8). By virtue of this arrangement the resistance of the conductor per unit of length is only $\frac{3}{4}$ of its former value, and the length of the line (the part we are investigating) is one-half of what it was before. By making these corrections in the above formula for p, we find

$$p = P_1 - P_2 - \tfrac{3}{4}\frac{C\rho}{l}\left(xl - 2x^2 + \frac{l^2}{4}\right).$$

The greatest pressure occurs at the terminals where $x = 0$ and $x = 1/2l$; it is

$$p_x = P_1 - P_2 - \tfrac{3}{4}(C\rho\, l)/4.$$

The least pressure will be found in the middle of the line;

$$x = \tfrac{1}{4} l \text{ gives } p_m = P_1 - P_2 - \tfrac{3}{4}\, 3\, (C\rho\, l)/8.$$

Hence the greatest possible variation in pressure is $\frac{3}{4}(C\rho\, l)/8$. That is only $\frac{3}{8}$ of the variation we have found in the double line of centres (double loop) system. Let us now compare these two values of the loop systems with that of the direct system, expressing them in terms of R_d, that is, in terms of the direct system. What we have expressed as ρl in the above equations is equal to $R_m/2$, that is, $2\rho l = R_m$, and finding the values of R_m from equations 9 and 12, we get $R_m = 4 R_d$, that is, $2\rho l = 4 R_d$ or $\rho l = 2 R_d$. By substituting this value in the results found above, we get

$$\tfrac{1}{4} C\rho l = \tfrac{2}{4} C R_d = \tfrac{1}{2} C R_d \quad . \quad . \quad . \quad . \quad (17)$$

for the double loop system, and

$$\frac{3}{4}\frac{C\rho l}{8} = \frac{6}{4}\frac{C R_d}{8} = \frac{3}{16} C R_d \quad . \quad . \quad . \quad . \quad (18)$$

for the single loop system. Summing the results obtained from equations (13), (15), (17), and (18), we find that the greatest variations in pressure amount,

In the direct system ..... to $\frac{1}{2} C R_d$;
In the feeder system ..... to $\frac{13}{16} C R_d$;
In the single loop system ..... to $\frac{3}{16} C R_d$;
In the double loop system ..... to $\frac{1}{2} C R_d$.

* Kapp designates the single and double-loop, *the single and double line* of centres. *The Electrician*, Vol. XI., 1883.

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From this we see that the direct and double loop systems have the same amount of variations, and that under the conditions considered, the feeder and single loop systems also vary the same.

Notice must also be taken of the fact, that in the direct system, the fall of pressure commences at the first parallel (not counting the drop on the mains leading to the first point of consumption) and ends at the last, while in the double-loop system it commences on one side at the first parallel, and ends in the middle of the line, as our equations have shown, and then rises again up to the first parallel on the other side. Thus, in regards variation, it is the same as in the direct system, but in reality there is double the drop. The same relations apply between the feeder and single-loop systems.

Let us now find the amount of energy expended in heating the mains between the first and last points of consumption, assuming that the current is taken regularly per unit of length. In the first place we will find the relative values of ρ, that is, the resistance per unit of length in each system, taking ρ_d of the direct system as unit, and expressing the others in terms of the same. The relative lengths of the four systems as already taken is 2, 3, 3, and 4. Thus

$$2\,\rho_d = R_d, \qquad (3\,\rho_f) = (R_f), \qquad 3\,\rho_l = R_l \quad . \quad (19)$$

and $4\rho_m = R_m$. Now from equations 9, 10, 11, 12 we have $R_f = R_l = \frac{9}{4} R_d$ and $R_m = 4\,R_d$, substituting these values in the equations of (19) we find that $\rho_l = \rho_f = \frac{3}{2}\rho_d$ and $\rho_m = 2\,\rho_d$.

Now, in those parts of the mains before the branches, which carry the whole current C, it is evident that the relative waste of power ($C^2 R$) is as 1 to 3/2, 3/2, 2, respectively. This, however, does not concern us, as we only wish to know the power wasted in the four different systems The supply mains, up to the different systems, can all be made of one size, thus costing the same capital and having the same loss. Let us now calculate the power wasted in the mains from branch to branch, using the formula $C^2 R$. In Fig. 9 we have a group of

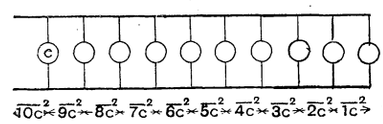

FIG. 9.

parallel branches, each branch taking a current c, and the resistance of the line or main is constant per unit of length. Now, in the first unit of length we have as power wasted $(10\,c)^2\rho$, in the second $(9\,c)^2\rho$, third $(8\,c)^2\rho$, and so on. Putting this in a series we get

$$(10\,C)^2\rho + (9\,c)^2\rho + (8\,c)^2\rho + (7\,c)^2\rho + (6\,c)^2\rho + (5\,c)^2\rho + (4\,c)^2\rho + (3\,c)^2\rho + (2\,c)^2\rho + (1c)^2\rho = C^2\rho[1^2 + 2 + {}^2 + 3^2 + \ldots + 10^2] = C^2\rho\,\frac{n(n+1)(2n+1)}{6} = 385 C^2\rho \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

n here is equal to the number of branches. We see that we can calculate the power wasted in any main, when that part forms part of a direct system. We may thus lay down our rule as follows: In any direct system, where the current is taken off equally per unit of length, and the resistance per unit of length of the mains being constant, we have as energy lost in the mains

$$2\,c^2\rho\left[\frac{n\,(n+1)(2\,n+1)}{6}\right] \quad . \quad . \quad . \quad (21)$$

where c is the current of each branch, ρ, the resistance per unit of length of the mains and n, the number of branches.

We must of course, as shown above, take it double, as we have two mains. Now this formula can be applied also to the other systems, plus a term, for those parts of the systems that carry the whole current. Thus if we had a district containing n number of branches evenly taken off *e.c.t.*; we would have as energy expended in the mains of the direct system,

$$2\,c^2\rho_d\left[\frac{n\,(n+1)(2\,n+1)}{6}\right] \quad . \quad . \quad . \quad (22)$$

in the feeder system,

$$4\,c^2\rho_l\left[\frac{n/2(n/2+1)(n+1)}{6}\right] + l\,\rho_l\,c^2\,n^2 \, . \quad (23)$$

Here we see that we must calculate from the points where the feeders supply, and that they supply $n/2$ on one side and $n/2$ on the other. Also the term, $l\rho_l c^2 n^2$ is the amount lost in the feeders where, l is the total length of the feeders (going and return). In the single loop system we have

$$2\,c^2\rho_l\left[\frac{n(n+1)(2\,n+1)}{6}\right] + l'\,\rho_l\,c^2\,n^2 \, . \quad (24)$$

Here $l'\rho_l c^2 n^2$ is that part of the loop carrying the whole current. In the double loop system we have

$$4\,c^2\,\rho_m\left[\left(\frac{n\,(n+1)\,(2\,n+1)}{6}\right) - 2n^2\right] \quad . \quad . \quad (25)$$

Here we have the distribution also evenly, but at double the lengths of the other systems. Now substituting the values of ρ_f, ρ_l and ρ_m in terms of ρ_d in the formulæ 23, 24, and 25, and noting that in our Figs. 2 and 3 that $l = l' = n$, we get as the relative values of the energy lost in the four systems, the general expressions in terms of the direct system.

Energy lost in direct system,

$$\frac{n\,(n+1)\,(2\,n+1)}{3} c^2\rho_d \quad . \quad . \quad . \quad . \quad . \quad (26)$$

Energy lost in feeder system,

$$\left[\frac{n}{2}\left(\frac{n}{2}+1\right)\left(n+1\right) + \frac{3}{2}n^3\right] c^2\rho_d \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

Energy lost in single loop systems,

$$\frac{3}{2}\left[\frac{n\,(n+1)\,(2\,n+1)}{3} + n^3\right] c^2\rho_d \quad . \quad . \quad (28)$$

Energy lost in double loop system,

$$\left[\frac{4\,n\,(n+1)\,(2\,n+1)}{3} - 2\,n^2\right] c^2\,\rho_d \quad . \quad . \quad (29)$$

n should always be an even number, and greater than 2 in order to make fair comparisons with the four elementary systems. By putting n equal successively 4, 6, 8, 10, and assuming $\rho_d =$ unity and $c =$ unity we get the following values as energy lost in the four systems.

n =	Direct system.	Feeder system.	Single loop system.	Double loop system.
4	60	126	186	208
6	182	408	597	656
8	408	948	1,380	1,504
10	770	1,830	2,655	2,880

From this we see that the waste of energy is the least in the direct system, and the greatest in the double loop system,

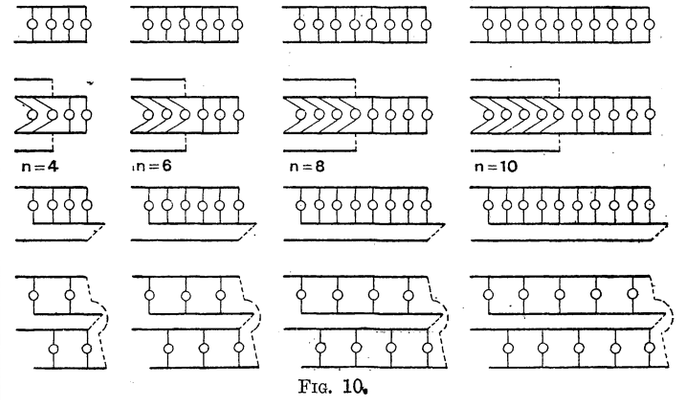

FIG. 10.

Also that in the feeder it is less than in the single loop. We must also notice that the waste of power in the direct system is all in the mains from which the branches emanate, while in the feeder system, there is only a small amount wasted in the secondary mains, the principal amount being lost in the feeders. In the single loop system part is lost in the mains which have branches, and part in the main which carries the whole current, while in the double loop the whole is wasted in the mains from which the branches spring or issue. The formulæ given above can be easily verified, by calculating from unit length to unit length the power wasted in the mains, as per example, if we calculate from Fig. 10 the power

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wasted, when $n=4$, 6, 8, 10 we will arrive at the same figures as given above. We must remember that the same amount of copper is used in the four systems, and that their relative length is 2, 3, 3, and 4, and consequently the unit resistances per unit of length, taking that of the direct system as unit are $\rho_d=1$ for the direct, $\rho_f=\rho_l=\frac{3}{2}\rho_d$ for feeder and loop, and $\rho_m={}^2\rho_d$ for the double loop.

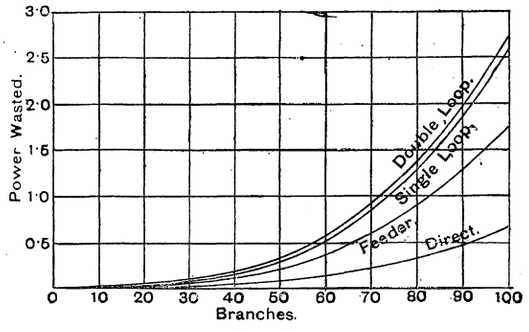

FIG. 11.

From the formulæ 26, 27, 28, and 29 we can construct the curves as shown in Fig. 11, which show us the *relative power* wasted in the different systems under consideration with a given number of branches.

NORTHRUP'S NEW DRY CELLS.

BY J. T. SPRAGUE.

Primary batteries are becoming of secondary importance as their place is taken by the dynamo, and by supply from main services. Secondary batteries will further displace them as commercial enterprise provides facilities for charging them; but they have still their uses, and will always fulfil some special purposes, notwithstanding the cost of the energy they supply as compared with other sources. They are like watches and clocks, which are not likely to go out of use, although from the point of view of foot-pounds utilised they are very costly pieces of machinery. For the special residuary uses of primary batteries the so-called "dry cells" appear to have advantages, and a compact form giving high E.M.F. is described in a Paper read to the Franklin Institute in March last by Mr. E. F. Northrup.

The author recites the general principles which govern primary batteries, and the steps which led to the construction which he has devised. He says that all substances may be divided into (1) non-conductors: (2) conductors not decomposed by electric current; (3) electrolytes or conductors which are so decomposed, and shows that while class 1 is out of consideration, class 2 cannot maintain a current except by means of an outside energy or E.M.F. Again, substances of class 3, while they can transmit current and energy, can only produce them when a differential stress is produced between the two electrodes, such stress being in fact proportional to the difference of the chemical affinities at work. Hence the conditions of a good battery are:—(1) The electrolyte capable of decomposition; (2) two electrodes differing as much as possible in potential; (3) a depolariser or agent, chemical or mechanical, which removes the ions and prevents the establishment of electric equilibrium in the liquids; all being of good conductivity.

The *positive* electrode is almost necessarily zinc, from considerations of cost and efficiency.

Negative electrodes are:—(1) Those which have to be depolarised by a chemical agent not united to it; (2) those which unite with a freed ion; (3) those which depolarise themselves mechanically, or, as in the single case of arsenic, by a chemical union. Mr. Northrup states that a couple,

$$Zn \mid H_2 S O_4 \mid As,$$

employs very cheap materials, but only gives volt 0·7, and many other objections prevent its being of practical use; but he does not mention, for the benefit of experimenters, the most fatal objection, viz., that it sets free a most deadly gas, arseniuretted hydrogen. It is remarked that where a metal is reduced it should be of the same potential as the electrode to prevent local action; thus, "with copper oxide as depolariser, copper, and not carbon, should be used." Yet carbon negatives have been used with copper salts for this very reason, that copper will be deposited while current passes, and then slowly redissolved when the circuit is open. But when the product is inert, as $Pb\ O_2$ reduced to Pb O or $Pb_2\ O_3$, carbon makes the best electrode, and may, "as we shall see later, be made to serve the purpose of a porous cup, as well as electrode." This, however has long been known and utilised in several forms of battery—Faure's bottle, Bunsen, and others.

Electrolytes available in cells are substances containing one or more of the six elements, S, O, Fl, Cl, Br, and I; of these fluorine is not practically useful, owing to the volatility and acrid nature of its products. Acid and alkaline electrolytes give higher E.M.F. than salts, but act upon the positive electrode, the zinc, and, as a rule, these are best suited to open cells giving large currents, while neutral salts are best for closed cells giving small and occasional currents.

The author makes a judicious observation as to selection of electrolytes. He says that the salt containing the metal of the positive electrode and the acid radical of the active depolariser is the best, because that salt is formed by the action of the cell, and if other salts are present there is liability to secondary actions; this is, in fact, the trouble of the Leclanché cell. Thus, he says, in a zinc carbon cell with bromine as depolariser, zinc bromide is a better electrolyte than magnesium chloride. Next to this the best selection is a salt having the nearest similar relations of E.M.F., &c.

The *depolariser* must be a substance which will readily take up hydrogen, as this is the real polarising agent, and practically O, Cl, Br, or I must be used in some available condition, there being difficulties in the use of them in the free state, as all of them act on the positive electrode, and it is impossible to maintain a separation for any lengthened period, either by porous diaphragms or gelatinous mixtures as used in the so called "dry cells." Oxygen and chlorine, being gases, are useless for these small cells, while bromine and iodine are non-conductors; Br is also a highly diffusible liquid, while I, though nearly insoluble in water, is soluble in iodides of the metals. The methods employed by the author are—(1) to give the depolariser the form of a substance insoluble in the electrolyte, except when current sets up a change in the conditions; (2) to use a heavy, oily liquid having no tendency to diffuse from the bottom of the cell.

$Pb\ O_2$, $Mn\ O_2$, and other solids used, do not act perfectly, because they do not liquify, and they cause high resistance. Silver chloride and copper oxide have advantages because the process of reduction diminishes resistance by forming a porous metallic mass. Bromine is a cheap and powerful agent,

$$Zn \mid Mg\ Cl_2 \mid Br \mid C,$$

giving 1·9 volts; it is easy to handle, and when dissolved in $C\ S_2$ loses largely its fuming nature. Mr. Northrup used this in a porous electrode made of a piece of arc-light carbon, $\frac{1}{2}$in. diameter, and 2in. inches long, in which a 3-16th hole was drilled, packed with grains of carbon, filled with bromine, and stopped with a carbon plug, connected with a platinum wire, and placed with a sheet of zinc in a 5oz. beaker containing a solution of caustic potash. This gave over 2 volts and a current of 3·25 amperes on a low external resistance, though, of course, only for a short time, as the bromine was soon used up.

"Any cell which uses as its depolariser a salt with a haloid acid radical should make use of some such substances as Mg O or Zn O if gassing is to be prevented," as pastes of starchy matters, or hydrate of silica, do not neutralise acids. The *sealing* of the cell is also important, in view of its preservation, and that used in the cell described consists of—(1) A film of cork placed over the paste to hold the zinc in position; on this is poured a layer of a hot mixture of gutta-percha, pitch, and resin oil. This is again covered by a layer of the same mixture with an equal part of plaster of paris added to it. The

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actual cell described is shown (Fig. 1) to half scale. It consists of a glass specimen tube: A is the carbon electrode with platinum connecting wire, D, moulded into it; G is the depolariser; B the zinc surrounded with C, a paste of aluminium hydrate and zinc chloride with a little manganese dioxide, used partly to thicken the paste and partly to improve its appearance; E and F are the two layers of the seal. Fig. 2 shows a form of carbon electrode used in larger cells, and for still larger cells a grating of porous carbon is used, in which the solid depolariser is packed just as the lead peroxide is held in the lead gratings for secondary batteries.

It is stated that the resistance of these small cells is at first 25 or 30 ohms, falling somewhat in action. The E.M.F. with sulphur iodide is 1·45 volt, and the total output 0·2 to 0·3 of an ampere hour. But the author adds in a note that later experiments show "that Hg O, one part ground up with four parts I, with a little alcohol, makes the most efficient and durable depolariser he has yet tried."

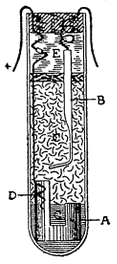

FIG. 1.

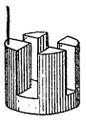

FIG. 2.

A series of the working curves of such cells is given, and compared with those of silver chloride and copper oxide cells. These show that the cells are very fairly constant, a slight fall of E.M.F. and also of R in the first few minutes resulting in a current line which is nearly straight after the first small drop. Such small cells are, of course, suited only for special purposes, such as testing, and Mr. Northrup remarks: "Assuming the average resistance is 1,000 ohms, that 40 volts are used, and the duration of each closure is one second, 17,500 taps would be required to exhaust one of the smallest cells, and 57,375 to exhaust one of the larger ones." The larger cells, similar to Fig. 1, with a cubic capacity of 1·1 cubic inch, with Hg O + I as depolariser, gives 1·4 voltage and 0·64 ampere hour total output.

THERMAL GALVANOMETERS.

BY E. TREMLETT CARTER.

In *The Electrician*, Vol. XXIX., page 589, an ingenious hot-strip ammeter, the invention of Captain Holden, was described. This description led the writer to criticise the action which goes on in such electrical measuring instruments, and to inquire into the cause of the force, and the source of the energy, which moves the pointer to the proper deflection. For this inquiry the reader is referred to Vol. XXX., page 249; and in the same number of *The Electrician* the Editor proposed the following interesting problem, which bears directly on the subject:—"A simple experiment might be arranged by taking two long wires, similar in every respect, and hanging, say, a pound weight to one of them, and an ounce to the other. Pass the same current through the two, heating them and causing them to extend. Now cut off the current, and one wire in retracting would appear to do more work than the other. . . Will these two wires assume the same temperature? By how much is the resistance, and therefore the C^2R, affected by the difference in tensions? As the pound does work in falling, will this appear as heat in the wire? And finally, does one wire really do more work than the other?" The writer purposes now to attempt to answer these questions, and to investigate further the principle of the action of thermal galvanometers.

The answer to the first question depends on that to the second; for the limiting temperature of each wire is attained when the rate of diffusion of heat from its extended surface is equal to the rate of dissipation of electrical energy in overcoming the resistance. In this matter we are considerably helped along by the recent researches of Messrs. Gray and Henderson, on "The Effects of Mechanical Stress on the Electrical Resistance of Metals," a paper on which was communicated to the Royal Society by Lord Kelvin. The conclusions arrived at by these experimenters is that "for practical purposes any mechanical treatment, however severe, does not affect the electrical properties of the metal tested." To be more exact, they have found that the maximum permanent stretching of copper produced a permanent alteration in specific resistance of only 1 per cent.; and in the case of steel, a temporary alteration of specific resistance equal to 1·6 per cent. was produced by stretching within the elastic limit. We may assume, then, that difference in loading does not cause any serious difference in the *specific* resistance of the two wires.

Applying Young's modulus, to obtain the amount of increment in length and decrement in diameter of the wires, we should find that the actual resistance of the wire carrying the pound would be slightly higher to start with than of that carrying the ounce, so that the former would continuously dissipate more energy per second than the latter. At the same time, it must be remembered that the change in length under such a stress—if well within the elastic limit—would be very small, that the alteration of section would be even smaller, and that there would be a slight increase in the surface of the wire tending to increase the diffusion of heat. If we assume that the coefficient of radiation remains unaltered—which it probably would do—there would arise in each wire, as the stretching force was applied, a small increase in its resistance, causing C^2R to become greater, and an opposing small increase in its radiating surface, which would tend to equalise the temperature. The exact relation between these two conflicting tendencies will depend on the material of the wires. Poisson's ratio has been investigated for some metals by the above-named experimenters, who have found that in the case of copper the alteration of density is only one-half per cent., and in lead only four-fifth per cent. According to Unwin, the value of Young's modulus for copper is 36,000,000lb. per square inch, and the elastic limit of this material is, when under tensile stress, 4,300lb. per square inch. Suppose the wires to be each one metre long and one millimetre in diameter, then the equal resistances will be 0·206 ohm. Now, put a pound weight on one and an ounce on the other. The first becomes 100·02228cms. and the second 100·00141cms. long; and, neglecting the change in volume—which would be of a still lower order—their resistances would immediately increase proportionately to the squares of their new lengths. If one ampere be sent though each wire, there will be 0·2060915 watt wasted in the former and 0·2060590 wasted in the latter. Now, their surfaces, before heating takes place, are 31·4194 sq. cms. and 31·4181 sq. cms. respectively. So that the former and more heavily loaded will rise to that temperature at which it will radiate 0·00655937 watt per cms. continuously and the latter to a temperature at which the radiation per sq. cm. will become 0·00655859 watt. Taking a coefficient of radiation equal to 0·0105 watt per cm. 1°C., the limiting temperatures will be 0·62470°C. and 0·62463°C. respectively, above the temperature of surrounding objects; or, in other words, the more heavily loaded of the two wires will rise to a limiting temperature 0·0112 per cent. higher than the one bearing the lesser load. A still further correction becomes necessary when we consider the *final* lengths of the wires; for the unequal expansion causes an unequal increment of their initial resistances. It is not necessary, however, to investigate this effect, for it will manifestly tend to increase the difference between the limiting temperatures.

We now come to question three. The writer thinks there can be little doubt that the energy expended by the weight in falling takes the form of heat. This conclusion is strengthened by the fact that if a live load is applied to a chain or a vertical wire, as in the experiment under consideration, the temperature is temporarily raised, the rise being due to the deformation which momentarily takes place. On the other hand, it cannot be supposed that this heat causes and maintains the

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difference in temperature in the wires; for it is only momentarily, and not continuously, generated. What happens when the current is switched on is this: heat is generated internally on account of the resistance, and heat is simultaneously generated on account of the fall in the level of the weight. The sum of these two amounts of heat must at any instant be equal to the sum of the radiation from the entire surface of the wire and of the heat which is being stored; or, in other words, the total rate of heat production from every cause must equal the rate of radiation *plus* the rate of storage of heat by rise in temperature. The effect of increasing the weight on the wire is, then, to cause the limiting temperature to be arrived at earlier—to increase the steepness of the curve representing the temperature rise. *At* the limiting temperature all the heat is generated by the current alone. It will be seen that the effect is analogous to that which causes the difference between the true and the spurious specfic heats of gases.

When the current is switched off, the wires lift their respective weights to the initial levels, and thus do work against gravitational attraction. Of the reality of this work there can be no dispute; the question is as to its source. That a pound or an ounce weight lifted a certain fraction of an inch represents the same amount of work, whether lifted by hand or by the contraction of a wire, necessarily follows from the impossibility of affecting either mass or the value of g by any known physical process. The question is, whether the energy which does this work is due to the current or not. The probable explanation is that the rate of cooling of the wire is assisted by the load, just as the rate of heating was assisted. The whole subject is enveloped in the mystery which surrounds the physical explanation of the elasticity of solids—a mystery which has not yet been penetrated by the keenest mathematical mind of the present day; but some help may be derived from a consideration of the case of gases. When a gas under pressure contracts, on account of diffusion of heat through the walls of the containing vessel, its rate of cooling is *less* than if the same gas were allowed to cool without contraction, the reason being that work is done by the external pressure, which work is turned into heat in the gas. Now a gas cannot be put under negative pressure (tension), but a wire is an elastic body which can; and there seems no reason why the effect of negative pressure on the latter should not be the *reverse* of the effect of positive pressure on the former. Allowing that this may be the case, we find that the probable effect of putting a cooling wire under tension is to accelerate its rate of contraction. The source of energy to enable the wire to lift the weight would, in that case, be the heat in the metal. Some of the heat would be dissipated, but less than if the wire were not under tensile stress.

We may illustrate this further by considering what would take place if a pound and an ounce were held in suspension by hot wires of equal lengths, not at slightly different temperatures, but at absolutely the same temperature. Then both wires would have the same amount of heat energy in them; yet one would do more work than the other, because it would lift the greater weight to the same—or practically the same—height. What is the explanation of this apparent paradox? If we apply our theory of accelerated rate of cooling, as above, we find that a large proportion of the heat of the less loaded wire escapes by radiation, and only a small amount of it does lifting work; whereas, with the more heavily-loaded of the two wires, cooling occurs more quickly, there is less time for the heat to radiate away, *less heat will radiate away*, so that more heat will be available to do lifting work—namely, sixteen times as much heat as in the other wire. The total heat is the same in each case, and might be due to the same current flowing through quite the same resistance; but the distribution of that heat into lifting work and radiation is different for different loads. Such are the conclusions which have been forced on the writer by applying the method of analogy. We are unacquainted with any adequate theory of the elasticity of solids; but the elasticity of gases has long been discussed to a satisfactory solution, and this, together with other well-established physical laws, would seem to point to the conclusion we have drawn as being the only admissible one.

STEAM ENGINE TRIALS.*

BY THE LATE P. W. WILLANS, M.INST.C.E.

The Paper dealt with an extensive series of condensing trials made with a 40 I.H.P. Willans Central-Valve Engine. These were intended to form a sequel to the investigations described in the Author's Papers, entitled, "Economy Trials of a Non-condensing Steam-Engine, Simple, Compound, and Triple," read before the Institution in 1888 and 1889. The principal objects in undertaking these trials were—(1) To ascertain the initial condensation in the first cylinder, and to trace the behaviour of the steam in the succeeding cylinders, when working as a compound or triple-expansion engine; (2) To observe the effect of speed of rotation, area of exposed surface, and range of temperature, upon the initial condensation, and upon economy generally; (3) To ascertain the percentage of the theoretical mean pressure actually obtained; (4) To ascertain the ratio of the work done by each pound of steam to the theoretical work due from it; (5) To determine the consumption of steam at all loads, and under various conditions.

The consumption of steam was determined by discharging the condensed water from the exhaust into a tank carried by a weigh-bridge and observing the intervals of time required for fixed weights of water to run in. By this method, a continual watch was kept on the performance of the engine during the whole trial, and any disturbing cause was immediately detected; leaky steam-pipe joints did not affect the result, and the length of the trial might be much reduced. Special experiments, made to ascertain whether any addition was necessary to cover leakage in the engine and exhaust-pipe, showed that this leakage was slight.

The method of determining the theoretical work due from one pound of saturated steam when discharging into a condenser was next considered, and it was shown that the thermal efficiency of a condensing engine must of necessity be less than that of a non-condensing engine, owing to the greater proportionate size of the "toe" of the diagram cut off for practical reasons. In the non-condensing trials the best number of expansions was computed from the approximate formula $p^6 v^7 =$ constant; but for the condensing trials the error in this could not be neglected. The best ratio of expansion and mean pressure were therefore calculated for adiabatic expansion by Mr. MacFarlane Gray's $\theta\phi$ diagram, combined with a volume curve. Altogether, 62 trials were made under various conditions of speed, steam-pressure, load, and ratio of expansion, as well as with the engine working simple, compound, and triple, and the results were embodied in the tables accompanying the Paper.

One of the principal deductions from these experiments was the "straight-line" law of steam-consumption; and it was shown by diagrams that the *total* water for the horse-power corresponding to any mean pressure P, was W+K P, where W was the water which would be used by the engine at zero mean pressure (through initial condensation, radiation and conduction), supposing it were frictionless, and K was the water per hour required to produce each pound of mean pressure. These factors were shown to vary with the conditions under which the engine was working.

Eighteen of the trials were planned to assist in determining the law connecting initial condensation with revolutions; and it was found that in the high-pressure cylinder at high mean pressures the total condensation per unit of time was directly proportional to the square root of the number of revolutions per unit of time. As the mean pressure was diminished, the condensation became more and more nearly constant at all speeds; and finally, at low mean pressures, the law appeared to be reversed. For the low-pressure cylinder the law was modified.

The important question of the changing proportions of steam and water present during the expansive part of the stroke was investigated by the $\theta\phi$ diagram. The matter was first examined theoretically by considering the effect of a thin liner of infinitely-conducting matter, and a curve was drawn on the $\theta\phi$ diagram showing the rate at which the steam initially condensed in warming up the liner from the exhaust to the initial temperature was re-evaporated as the expansion proceeded. The actual re-evaporation, as obtained by measurement of the indicator cards, was compared with this theoretical re-evaporation, the difference measuring the delay in the return of the heat from the liner to the steam. The losses due to conduction and radiation, to passage through ports, and to incomplete expansion, could also be shown on the $\theta\phi$ diagram.

The question of the economical advantage of reducing the power by automatic cut-off *versus* throttling was discussed. Broadly, the result was that the gain by varying the expansion was large for a simple engine, moderate for a compound engine, and for a triple engine almost inappreciable. It further appeared that the gain at high speeds was greater than at low speeds. A few trials made

* Abstract of a Paper read before the Institution of Civil Engineers on April 11th.

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with the cylinders steam-jacketed showed a slight gain, but further experiments were required to show whether the gain was likely to be worth the extra trouble and expense involved. The missing steam at cut-off varied in the trials to even a greater extent than it did in the non-condensing trials—the amount being much affected by the range of temperature, the density of the steam, and by other conditions.

It appeared, that, under all circumstances, the triple-condensing engine showed an advantage over the compound in regard to steam consumption; but that, except for very large engines, the compound-transfer engine was probably the best for pressures below 150lb. (absolute) pressure per square inch.

THE DETERMINATION OF HIGH POTENTIAL DIFFERENCES.*

BY DR. A. HEYDWEILLER.

The author remarks that Thomson and Tesla have given their potential differences as being as much as half a million volts, but points out that this is only an estimate. The highest pressures actually measured up to date are probably not over 50,000 volts. The easiest method is, of course, the measurement of sparking distance, which gives with periodic electromotive forces the maximum and not the effective volts; but the method assumes the discharge potentials for every kind of length of gap, and the author points out that all formulæ hitherto published tend to give infinite voltages with growing length of gap, and this is only true when the electrodes are two infinite parallel planes. The electrodes usually employed are two balls. Kirchhoff has given equations for this case to determine the rate of fall of potential at the place of discharge from known values of radius of balls, sparking distance and potential. Table I. is calculated from these equations and gives values of rate of fall of potential g_1 and g_2 for an insulated and earthed electrode; v is the discharge potential, d the sparking distance, and r the radius of the balls.

Table I.

d/r	$g_1(r/v)$	$g_2(r/v)$	$(g_1+g_2)\,r/2\,v = g\,r/v$	d/r	$g_1(r/v)$	$g_2(r/v)$	$(g_1+g_2)\,r/2\,v = g\,r/v$
0·02	50·33	50·33	50·33	1·20	1·390	1·006	1·198
0·03	33·67	33·67	33·67	1·40	1·305	0·864	1·084
0·04	25·34	25·34	25·34	1·50	1·272	0·806	1·039
0·05	20·34	20·34	20·34	1·60	1·245	0·755	1·000
0·06	17·00	17·00	17·00	1·80	1·201	0·671	0·936
0·07	14·61	14·61	14·61	2·00	1·170	0·601	0·885
0·08	12·84	12·84	12·84	2·20	1·145	0·544	0·844
0·09	11·44	11·44	11·44	2·40	1·124	0·497	0·810
0·10	10·34	10·34	10·34	2·80	1·094	0·422	0·758
0·15	7·016	7·004	7·010	3·00	1·084	0·392	0·738
0·20	5·346	5·338	5·342	3·20	1·075	0·366	0·720
0·25	4·350	4·337	4·343	3·60	1·061	0·323	0·692
0·30	3·687	3·658	3·672	4·00	1·050	0·288	0·669
0·35	3·211	3·158	3·184	4·80	1·036	0·237	0·636
0·40	2·876	2·810	2·843	5·00	1·034	0·227	0·630
0·45	2·608	2·522	2·565	6·00	1·024	0·186	0·605
0·50	2·398	2·292	2·345	8·00	1·016	0·137	0·576
0·55	2·228	2·099	2·163	10·00	1·009	0·108	0·558
0·60	2·089	1·940	2·014	12·00	1·006	0·089	0·547
0·70	1·876	1·682	1·779	16·00	1,004	0·066	0·535
0·80	1·723	1·485	1·604	20·00	1·002	0·052	0·527
0·90	1·607	1·328	1·467	40·00	1·001	0·026	0·513
1·00	1·517	1·200	1·358	∞	1·000	0·000	0·500

The author has already shown† that the arithmetical mean

$$g = \tfrac{1}{2}(g_1 + g_2)$$

(called for short the "mean" rate of fall of potential in discharge) is independent of the distance apart when this is not too small. It is possible, therefore, knowing the value of g which depends on r, to determine from Table I. the discharge potential difference for any sparking distance. In experiments on this point note that the rate of fall of potential g is dependent on the density of the air; being diminished about 1% for every diminution of 8mm. in the height of the barometer or 3°C rise of the thermometer. The electrodes must not be influenced by neighbouring bodies. Note that the law leads to $r_{max.} = 2gr$ for infinite distance apart, and does not give an infinite value.

Using a torsion-balance mirror electrometer (see Figs. 1 and 2), the author made extensive experiments on the above law, the results of which are summarised in Table II.

* Abstract from the *Elektrotechnische Zeitschrift*.
† *Wied. Ann.*, 40—1890, p. 664.

Table II.—*Potential Difference Discharge in Kilovolts.*

Similar ball electrodes; Radius r cm.; Sparking distance d cm. Barometer 745 mm. Temp. 18° C.

r=2·5cm. g=38 Kilovolt/cm.			r=1·0cm g=42 Kilovolt/cm.			r=0·5cm. g=48 Kilovolt/cm.			r=0·25cm. g=55 Kilovolt/cm.		
d.	v. obs.	v. calc$^{d.}$	d.	v. obs.	v. calc$^{d.}$	d.	v. obs.	v. calc$^{d.}$	d.	v. obs.	v. calc$^{d.}$
0·5	18·4	17·8	0·1	4·7	4·1	0·1	4·8	4·5	0·1	4·8	4·8
0·625	22·3	21·9	0·2	8·1	7·9	0·2	8·4	8·4	0·2	8·4	8·6
0·75	26·1	25·9	0·3	11·4	11·4	0·3	11·4	11·9	0·3	11·3	11·4
0·875	29·5	29·8	0·4	14·5	14·8	0·4	14·5	14·9	0·4	13·8	13·7
1·0	32·8	33·4	0·5	17·5	17·9	0·5	17·3	17·7	0·5	15·7	15·5
1·125	36·3	37·0	0·6	20·5	20·8	0·6	19·9	20·0	0·6	17·2	17·0
1·25	39·7	40·5	0·7	23·2	23·6	0·7	22·0	22·1	0·7	18·3	18·1
1·375	43·2	43·9	0·8	26·0	26·2	0·8	24·1	24·0	0·8	19·0	19·1
1·5	46·2	47·2	1·0	31·3	30·9	0·9	25·6	25·6	1·0	20·2	20·5
1·6	48·7	49·6	1·2	35·5	35·0	1·0	27·0	27·1	1·5	22·3	22·7
			1·4	38·6	38·7	1·5	31·8	32·5	2·0	23·2	23·8
			1·6	41·3	42·0				3·0	24·3	25·1
			2·0	47·5	47·5				4·0	24·9	25·7
									6·0	25·7	26·0

These values may be taken as right within 1 per cent., and can be used if corrected for temperature and air pressure for testing of instruments. For small electrodes no distances over 1cm. should be taken, but larger electrodes should be used for higher voltages.

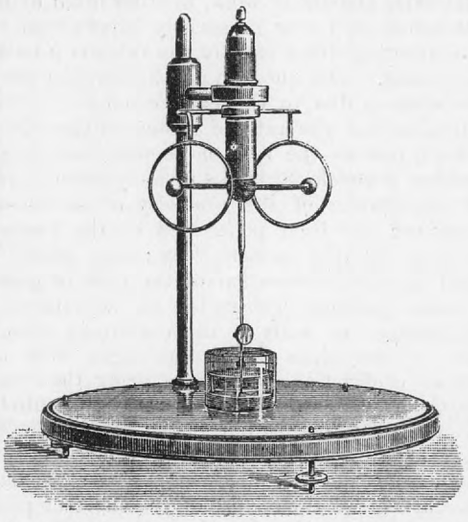

FIG. 1.—Torsion Balance Mirror Electrometer (one-eighth actual size).

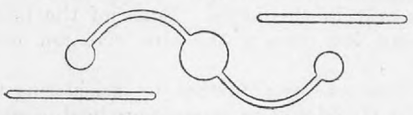

FIG. 2.—Details of Electrometer (one-fifth actual size).

Table III. gives approximate values for higher voltages, using larger electrodes. This table should be within 4 per cent.

Table III.

r=5·0cm.	g=35 kilovolt/cm.	r=5·0cm.	g=35 kilovolt/cm.
d.cm.	v calc. kilovolts.	d.cm.	v. calc. kilovolts.
1·0	33	4·0	110
1·5	48	5·0	129
2·0	61	6·0	147
2·5	75	7·0	162
3·0	87	8·0	175

All this applies to slowly raised pressure. The author had made no experiments on rapidly altering potentials.

Rope-Gearing.—The experiences of a French engineer have convinced him that the cost of maintaining rope gearing is three times that of belts. The weight of the ropes, moreover, is 2·64 times that of belts, while the loss in transmission is 5·77 per cent. with ropes and only 1·44 per cent with belting.

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THE COATING OF CYLINDER WALLS.*

BY A. BANDSEPT.

The process of lining, not the outside as is usually done, but the interior walls of a cylinder which come into direct contact with the live steam, with a non-conducting coating is deemed by Prof. Thurston to be "the final and last improvement" of the steam engine. Iron, as ordinarily employed, is very avid of heat and quickly conducts it to the open air to dissipate it by radiation. To remedy this defect it is necessary to suppress, or rather mitigate as much as possible, condensation during admission. To attain this end we must employ for cylinder walls a metal having a low specific heat, or as it would be difficult to dethrone cast iron, we must coat this all over the surface in contact with the steam with a superficial non-conducting layer having some chance of lasting. Prof. Thurston pointed to the method described by M. Dwelshauvers-Déry in the *Révue des Sciences pures et appliquées* of February last, and which may be succinctly summed up as follows:—The substances to be coated are submitted for several days to the attacks of dilute nitric acid. A spongy material is obtained in this way which lends itself to impregnation with a non-conducting varnish. Linseed oil is then spread over the surface and adheres to it, filling the pores of the metal. Experiments on a small scale show that this process results in a considerable saving. Prof. Thurston, however, recognised that this glazing process was very far from an ideal one, and, therefore, emphasised the importance of giving the problem a more complete solution.

I think I can point out another way, of which I have had some experience, by which we can attain the desired result. The process consists in incorporating with metallic surfaces, previously expanded by heat, refractory non-conducting finely divided substances, projected with force by means of a pulveriser actuated by steam under pressure. These substances, brought to a state of extreme tenuity, are carried on to the body to be penetrated in the form of a fog, while the metal is cooling and its pores contracting. The non-conducting material lodges in the atomic interstices of the surface to be treated, so that in addition to the mechanical action, which is made use of to apply the glaze, there are intimate reactions between the smallest elements of the bodies in contact. The penetration thus becomes complete, and by passing the surface so treated under the roller, the non-conducting substances are spread evenly over the uppermost layers of metal, of which they become an integral part. In order to insure success it is sufficient that the active layer, some few tenths of a millimetre in depth, should be brought to a temperature sensibly h gher than the maximum at which the engine works. The non-conducting substances are projected in a gaseous state by steam pressure, and by means of a spiral or centrifugal jet. The lubrication of the contact with the piston is easily attained by polishing the treated surface at a high speed.

A simple and practical method of preparing steam cylinders for the molecular incorporation of refractory non-conducting substances in a state of powder is to plunge the surfaces whose conductivity we wish to destroy into an electrolytic bath. Under these circumstances, and with a suitable bath, the metal becomes the seat of reactions caused by the passage of the current. As in other cases the current spreads over the surface of the conductors in the manner which I claim to have demonstrated in my memoir "On the Propagation of the Electric Current," and if care is taken only to dip the cylinder very slightly into the liquid, the molecular disturbances not being able to diffuse themselves over the bath, will be confined to the metallic surface which constitutes the focus of the reactions. Exposed in this way the surface will be brought to a very high temperature, and will become susceptible of being reduced by the pulverising process just described. In order to avoid the use of powerful currents, the surface to be treated can be divided up. The electrolytic solution can be placed in a narrow trough approximately the same length as that of the cylinder. This trough is placed against the internal wall of the cylinder in such a way that the liquid only moistens a narrow strip of metal, the length of the cylinder. By giving the cylinder a slow rotary motion round its axis, longitudinal strips —elements of the internal surface—come successively into contact with the liquid of the trough, into which they dip slightly. When the current is switched on, the strip of metal becomes red hot. On either side of the trough nozzles are placed, which project the powdered substances on to the red hot metal as it emerges from the bath. During electrolysis the uppermost atomic layers alone take part in the transfer of the current, the underlying layers are not directly affected by the disturbances, of which the internal surface of the cylinder is the seat. The heat, therefore, has not time to penetrate far into the metal before the latter is impregnated and penetrated with the finely-powdered non-conducting substances. The superficial treatment to which the walls of the cylinder is subjected has but an insignificant effect on its outline. The walls can be surfaced before treatment, and have only to be polished up afterwards.

Mechanical pulverisation, owing to the effect which it has on the physical and chemical properties of bodies, presents a vast field of investigation in connection with improvements in certain branches of the industry. Substances in a state of extreme tenuity often give results which would otherwise be unattainable. The reactions between the minute elements in contact are rendered more easy and more thorough, and the multiplication of surfaces tends to the production of phenomena which are not manifest when masses alone are concerned, and in which action is confined to surfaces in imperfect contact. The process in question relates to a subject of the highest interest, one with which specialists are much occupied at the present moment; finally, it is only a particular application of the method of impregnating by pulverisation described in the *Bulletin* in 1887.

* From the *Bulletin Technologique* de la Société des anciens Élèves des Arts et Métiers

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, April 14th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "The Manufacture and Efficiency of Armour-Plates," by D. Carnegie, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Seals," by Sir W. H. Flower, F.R.S.

SATURDAY, April 15th.

ROYAL INSTITUTION.

3 p.m. Tyndall Lecture: (1) Some Applications of Electricity to Chemistry," by James Swinburne, M.Inst.E.E.

TUESDAY, April 18th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be discussed: "Steam-Engine Trials," by the late P. W. Willans, M.Inst.C.E., after which there will be the monthly reception by the President and Council.

WEDNESDAY, April 19th.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Papers to be read: (1) "The Direction of the Wind over the British Isles, 1876-80," by F. Campbell Bayard, L.L.M.; (2) "Notes on Photographs of Lightning taken at Sydney Observatory, December 7, 1892," by H. C. Russell, F.R.S.; (3) "Notes on Lightning Discharges in the neighbourhood of Bristol, 1892," by Ernest H. Cook, D.Sc.; (4) "Constructive Errors in some Hygrometers," by W. W. Midgley, F.R.Met.Soc.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Some Economic Points in connection with Electricity Supply," by Gisbert Kapp.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary Meeting at 20, Hanover-square, W.

THURSDAY, April 20th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "The Atmosphere," by Prof. Dewar, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Ordinary General Meeting at the Institution of Civil Engineers. Papers to be read and discussed, as far as time permits: (1) "Second Report to the Alloys Research Committee," by Prof. W. C. Roberts-Austen, F.R.S.; (2) "Tensile Tests and Chemical Analyses of Copper Plates from Fire-Boxes of Locomotives on the Great Western Railway," by William Dean; (3) "Research Committee on Marine-Engine Trials; Abstracts of Results of Experiments on Six Steamers, and Conclusions drawn therefrom in regard to the Efficiency of Marine Boilers and Engines," by Prof. T. Hudson Beare, F.R.S.E.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting.

FRIDAY, April 21th.

INSTITUTION OF MECHANICAL ENGINEERS.

7.30 p.m. Ordinary General Meeting.

OLD STUDENTS' ASSOCIATION.

8 p.m. Smoking Concert at Masons' Hall Tavern.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Possible and Impossible Economies in the Utilisation of Energy," by Prof. A. B. W. Kennedy, F.R.S.

SATURDAY, April 22nd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Some Applications of Chemistry to Electricity," by James Swinburne, M.Inst.E.E.

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The Electrician.

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PATENT LAW REFORMS.

THE policy of the Patent Law has been very well described as a reward to those who devote themselves to the improvement and advancement of the manufacturing arts, granted in the form of an exclusive privilege of limited duration in return for the benefit conferred upon the community by the disclosure of some new and useful invention, which, on the expiration of the term of exclusive privilege, the public at large will be at liberty to freely exercise and enjoy. The principle thus defined is purely arbitrary and artificial; it is a voluntary bargain. The right and property which, according to some persons, a man should have in the creations of his own intellect are not recognised in our patent laws. Such a right is advanced in the law of copyright, and a copyright certificate is a mere matter of form compared with a patent. While occasionally an invention is made which may be said to be creative, by far the greater number are modifications, developments, or improvements on existing objects or processes, and for this reason, if for no other, the protection offered by the State must be of a very different nature from that which is given to works of literature or art. The majority of the agitators for patent reform seem to imagine, however, that every inventor has a property in his idea, and that the patent is a registration accompanied by a tax, and that an inventor owning an idea as he would own a piece of land, registers and pays a tax which gives him a title to his idea, just as might be in the case of land. This mistaken view of the principle of a patent

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is the only excuse that we can find for the unending proposals for patent reform. On certain of these proposals, Mr. W. Lloyd Wise has contributed some interesting notes to a recent number of the *Chamber of Commerce Journal*. From these notes, which we reprinted in our last issue, we have taken the definition quoted above.

The recent reduction in patent fees may be regarded as a concession to this agitation for reform, and, as Mr. Lloyd Wise observes, it would be well to give the present system a fair trial before going any further. We are inclined, however, to take up a more decided attitude than this, and to deprecate any additional reduction; for if a patent is not worth £5 a year to the owner at the end of four years, and £6 at the end of five years, and so on, it must either be that the invention in its present form is not marketable, or that the inventor or owner of the patent is not making proper use of his privileges, and it would be better that the idea should be thrown open to the public who may, perhaps, be able to make more use of it than its author can or cares to do. There, is perhaps, some justice in the complaint that patent fees are treated as a source of revenue, but this is silenced, at all events for the present, by the construction of the new buildings and library; the formation of provincial libraries, the reconstruction of the index on a uniform plan, and the bringing up and keeping up the abstracts to within six months of date would be excellent objects to apply the surplus to in future.

Already we have rather too many patents, and the protection which was intended to relieve the inventor of competition is used too often for very different purposes. We suffer in this country from patentees who sow the seed, and stand by while others not only begin to till but to reap, and who then come forward to claim the fruits as theirs. In America the monopoly-mongers use patents as powerful weapons, and to increase the number of petty patents would lead to frivolous restrictions and vexatious black-mail.

A patent is meant to be worked, and not to be kept until it can be used for extracting royalties or, perhaps, damages from others who have been actively engaged on the same lines. In most countries, a patent must be worked or the patent lapses. This is an excellent idea but very difficult to apply. An assistant of doubtful competence may be sent abroad, with instructions to "work the invention" in his bedroom at an hotel. We know of one, competent, indeed, to make glow-lamps in a laboratory or lamp-factory, but who "worked the invention" under great difficulties abroad, carbonising filaments in his bed-room stove. It is a pity that patents should lend themselves to such tricks, when copyrights are comparatively free from them. The plagiarist is a clumsy thief compared with the adroit ingenuity and subtle craft of the infringer of patents; but the difference cannot be explained by any theory of proprietorship. There is a sweet simplicity about copyright. What would be the analogue of a mechanical equivalent; would anything of the nature of a "fishing" or of an "omnibus" patent be possible in literature or art? An author need not, at all events, trouble himself about conformity between "provisional" and "complete," or trouble himself about "claims." A patent being a bargain, it is not necessary to inquire into the real reason for any special terms, as distinguished from the formal or perfunctory reasons. The decision that a United States patent, applied for after similar application in foreign countries, lapses on account of the lapse of foreign patents whether by invalidation, expiry of term, or non-payment of renewal fees, may or may not be good American law; but there is no fairness or unfairness about it, unless, indeed, the patentees, buyers, sellers, licencees, infringers, and the general public have a right to know how long a patent has to run. An owner of an English patent need only be careful to pay his fees, and he may be sure that his patent will stand, for whatever it may be worth, for the whole period of fourteen years. The limitation of American and certain other patents to the term of foreign patents is arbitrary, and is said to defy justification or excuse. The same limitation existed in our own patent law prior to 1883, whence it was copied into foreign systems. The result of this simultaneous happy despatch of American and foreign patents, as affecting the American telephone patents, is referred to by our New York correspondent in another column.

OBITUARY.

CHARLES VICTOR DE SAUTY.

We regret to have to record the death, at the age of 63, of Mr. Charles Victor de Sauty, which took place from paralysis on the 11th inst. at Gibraltar, where he was Superintendent of the Eastern Telegraph Company.

The deceased was born in 1830, and after some time spent in a solicitor's office, entered the Submarine Telegraph Company's service. In 1856 he joined the original Atlantic Telegraph Company, and was Superintendent of the Newfoundland Station during the short period the cable worked in 1858, and in the laying of which cable he took part as electrician. In 1859 he joined the firm of Glass, Elliot and Co., afterwards the Telegraph Construction and Maintenance Company, as their chief electrician, and was engaged upon all the expeditions for the laying of that firm's cables up to 1865, including the Atlantic cable of that year. He then went to New Zealand, and was in charge of the Government Telegraphs there until 1870, when he entered the service of the Falmouth-Gibraltar and Malta Telegraph Company, which was afterwards amalgamated, with three other cable companies, into the Eastern Telegraph Company. Although Mr. De Sauty had no regular training in that direction, he was a most ingenious mechanician and kept well in the van of all the early developments of electrical science and submarine telegraphy, in proof of which may be cited his method for the comparison of electrostatic capacity, which was the earliest differential method used for that purpose and contained within it the elements of the duplex. Mr. De Sauty was largely concerned in the practical development of the duplexing of cables which was finally perfected by the introduction of Dr. Alexander Muirhead's condensers. His name was better known on the American side, in connection with the laying of the first Atlantic cables, than that of any other member of the scientific staff, as is evidenced by the quaint verses of Dr. Oliver Wendell Holmes which we have reproduced below. Mr. De Sauty was a man of strong personal character, expressing his opinions very plainly, and one of the staunchest friends it was possible to have. His loss will be regretted by a wide circle of acquaintances.

DE SAUTY.

AN ELECTRO-CHEMICAL ECLOGUE.

Professor. *Blue-Nose.*

PROFESSOR.

Tell me, O Provincial! speak, Ceruleo-Nasal!
Lives there one De Sauty extant now among you,
Whispering Boanerges, son of silent thunder,
Holding talk with nations?

Is there a De Sauty ambulant on Tellus,
Bifid-cleft like mortals, dormient in nightcap,
Having sight, smell, hearing, food-receiving feature,
Three times daily patent?

Breathes there such a being, O Ceruleo-Nasal?
Or is he a *mythus*,—ancient word for "humbug,"—
Such as Livy told about the wolf that wet-nursed
Romulus and Remus?

Was he born of woman, this alleged De Sauty?
Or a living product of galvanic action,
Like the *acarus* bred in Crosse's flint-solution?
Speak, thou Cyano-Rhinal!

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BLUE NOSE.

Many things thou askest, jackknife-bearing stranger,
Much-conjecturing mortal, pork-and-treacle-waster !
Pretermit thy whittling, wheel thine ear-flap toward me,
Thou shalt hear them answered.

When the charge galvanic tingled through the cable,
At the polar focus of the wire electric
Suddenly appeared a white-faced man among us :
Called himself "DE SAUTY."

As the small opossum held in pouch maternal
Grasps the nutrient organ whence the term *mammalia*,
So the unknown stranger held the wire electric,
Sucking in the current.

When the current strengthened, bloomed the pale-faced stranger,—
Took no drink nor victual, yet grew fat and rosy,—
And from time to time, in sharp articulation,
Said, "*All right !* DE SAUTY."

From the lonely station passed the utterance, spreading
Through the pines and hemlocks to the groves of steeples,
Till the land was filled with loud reverberations
Of "*All right !* DE SAUTY."

When the current slackened, drooped the mystic stranger,—
Faded, faded, faded, as the stream grew weaker,—
Wasted to a shadow, with a hartshorn odour
Of disintegration.

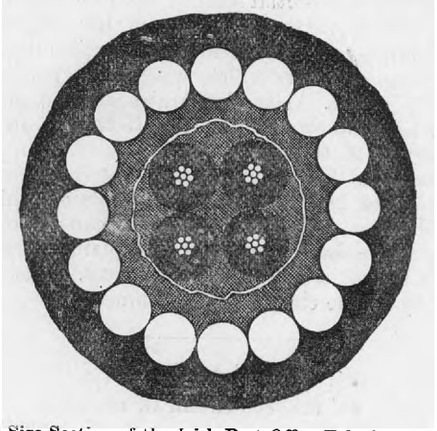
Drops of deliquescence glistened on his forehead,
Whitened round his feet the dust of efflorescence,
Till one Monday morning, when the flow suspended,
There was no De Sauty.

Nothing but a cloud of elements organic,
C. O. H. N. Ferrum, Chlor. Flu. Sil. Potassa,
Calc. Sod. Phosph. Mag. Sulphur. Mang. (?) Alumin. (?) Cuprum (?)
Such as man is made of.

Born of stream galvanic, with it he had perished !
There is no De Sauty now there is no current !
Give us a new cable, then again we'll hear him
Cry, "*All right* ! DE SAUTY."

THE IRISH TELEPHONE CABLE.

On the 4th inst. Her Majesty's Post Office telegraph ship "Monarch" successfully laid a new cable, containing four conductors of special size, designed for telephonic use between Great Britain and Ireland. The cable was laid between Port Kail on the Scotch Coast and Donaghadee on the Irish coast. The engineering staff of the Post Office has been busily engaged during the last eight months in erecting the land wires, and the cable connections having been completed on Thursday last



Full Size Section of the Irish Post-Office Telephone Cable.

week, the wires were tested by Mr. J. C. Lamb and Mr. W. H. Preece. Conversation was carried on with perfect ease and freedom between Belfast and Glasgow. Amongst the first to speak between Glasgow and Belfast were: Lord Kelvin, Sir John Purvis, the Lord Provost of Glasgow, and Sir Daniel Dixon, Lord Mayor of Belfast, all of whom expressed their gratification with the great success of the new communication.

To ensure that the go and return land wires shall preserve the same mean distance from disturbing causes, they are made to exchange their positions, as in the case of the London-Dover section of the London-Paris line, by revolving round each other like the strands of a rope over the whole distance, about seven complete twists being made in every mile. The cable wires are twisted in a similar manner. At present only the Belfast-Glasgow circuit is completed, but a second pair of wires is erected as far as Stranraer on the way to Manchester, Liverpool, Leeds, and eventually London; whilst a pair is also just being commenced to Dublin, and will ultimately be extended to Cork. The Belfast-Glasgow line will be opened very shortly to the public. The charge for a conversation of three minutes will be 5s. The tariff for the London-Paris line is, it will be remembered, 8s. for a similar period.

The Belfast-Glasgow line is 150 miles long, and the cable 23½ nautical miles. The London-Paris line is 303 miles long, and its cable 21 nautical miles. Both cables are made to practically the same specification. The conductors are of 160lb. copper, and the dielectric 300lb. gutta percha; the electrical resistance at 75°F. is 7½ ohms, and the electrostatic capacity ·3 micofarad per nautical mile of 2,029 yards. Both cables have been made by Messrs. Siemens Bros. and Co. There is one point alone in which they differ. Surrounding the core of the Irish cable there is, as will be seen by our illustration, a sheathing of brass tape, intended to protect the conductors from the ravages of the teredo. This has not been considered necessary in cables laid heretofore in British waters, but the teredo has now made its appearance here and must be guarded against.

NOTES ON THE INFLUENCE OF ELECTRICITY IN TANNING OPERATIONS.*

BY CONRAD K. FALKENSTEIN.

It has been known for the last thirty years that the application of of an electric current to hides in process of tanning exerts a beneficial effect, increasing the rapidity with which the gelatinous material of the pelt combines with the tannin in the liquors to form leather. Before going further, it may be well to briefly sketch out what occurs when hides are tanned. Ox hide consists roughly of three layers, as follows:—(*a.*) The *epidermis*, consisting of an outer layer which is constantly being shed, and an inner layer, from which the material of the outer layer is supplied. (*b.*) The *pars papillaris*, of close fibre, in and below which are situated the hair sheaths, fat and sweat glands, and the muscles which erect the hair; the upper coat of this layer forms the "grain" of leather. (*c.*) The *pars retcularis* or corium, a network of fibres, which forms the greater part of the section; this is densest near the layer (*b*), the bundles of fibre becoming more open towards the flesh side. When the hide is taken off the animal the exterior of this layer is covered with flesh, fat and tissue.

The first thing to be done is to wash the hide free from all blood, salt, &c., or, if sun-dried or cured, to thoroughly wash and soften it (this is sometimes assisted by mechanical means); when clean and soft it is treated with solutions of lime of gradually increasing strength, which have the effect of swelling up the hide and splitting up or commencing to dissolve the fibres. This action takes place most vigorously at the two surfaces; on the grain side it dissolves away the outer cells or epidermis, and the hair *papilla* or knob of corium, which holds and supplies nourishment to the hair, thus allowing it to be easily scraped off by the blunt unhairing knife; on the flesh side it plumps up the *pars reticularis*, causing it to be easily distinguished (by its firmness) by the flesher from the loose membrane and fatty matter which is to be removed. When the hair and flesh are removed, the hides are washed and worked over on the grain side with a stone or blunt knife to force out the lime solution and the remains of hair, epidermis, &c., which are left in the hair cavities after unhairing; after another washing, the hides are ready for tanning.

Now the hide material or gelatine to be tanned consists of bundles of fibre, each bundle being made up of a refractory base surrounded by gelatinous, tannable fibres, the axes of which lie generally at right angles to the surfaces of the hide. After liming, the fibres are in a swelled condition, both acids and alkalis (with exceptions) having this property of distending the hide and causing it to absorb water. The action of the tannic acid is to displace the water, and, while converting the gelatinous fibres into leather, to maintain the plumpness by an acid reaction after the lime has been neutralised. Other methods are employed for unhairing on the Continent and elsewhere, such as sweating or partial putrefaction, use of sodium sulphide, &c., in which this plumpness has to be produced by the use of sulphuric, acetic, or other acids, or by liquors which contain acetic, lactic acids, &c., through natural fermentation.

* Paper read before the Institution of Electrical Engineers, March 23rd.

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The hides are then treated with solutions of tannic acid of gradually-increasing strength, until they show a uniform brown colour in a freshly cut section (lighter or darker according to the tanning materials employed), and have the necessary firmness and weight. Care must be taken as to the rate at which the tannic acid solution is increased in strength, for if, after the tannage is fairly commenced and the lime neutralised, the hides be not fed with stronger and stronger liquors, they lose their firmness and are said to "go back," after which a species of putrefaction is set up in the interior untanned portion of the hide which causes adjacent bundles of fibre to unite, thus destroying the open fibrous structure of the hide, and practically stopping diffusion; this result may also be produced by using too strong liquors at first, which bind up the pores and prevent liquor from reaching to the interior.

For dressing leather somewhat different methods are followed, but the same precautions must be taken in working the liquors as just described.

The above is the process to be gone through, the functions of the electric current being:—(1.) To increase the rate at which liquor diffuses itself through the hide by endosmose effects. (2.) To increase the chemical activity of the reaction by molecular vibration.

Many methods of applying the current have been proposed, some depending upon the action of the gases evolved at the electrodes, and others upon the endosmose and molecular effects of the current on the hides and liquor. M. Gaulard patented a process in 1883, making use of the first method, the hides being suspended in a pit, from the perforated false bottom of which is sent, first, a stream of hydrogen from the kathode; after eight days the current is reversed, and the hides subjected to the action of a stream of oxygen until they are tanned. The other method, which has been employed by Gaulard, Landin and Abom, De Meritens, and others, is to use a pit with electrodes on opposite sides, and pass the current through the liquor and suspended hides at right angles to their surfaces. When the hides are struck through, they are transferred to the layer pits where they are put in alternate layers with ground bark, &c., liquor being run in either before or afterwards. The current is now applied by electrodes placed one underneath and one on top of the pile, the positive pole generally at the bottom. This laying away is repeated until the hides are tanned. By thus applying electricity to the ordinary methods of the tannery, the time necessary for tanning heavy sole leather may be reduced from 120 to 45 days, as proved by the practice of Messrs. Landin and Abom in Sweden, and De Meritens at St. Petersburg. Messrs. Landin and Abom use alternating currents. If now the electrical action be assisted by suitable mechanical agitation of the liquor and movement of the hides, so as to mix the liquor which has passed through the hide with that remaining in the vat, we shall obviously have an increase in the rate at which the tannage proceeds.

Several processes have been devised to combine the effects of the electric current and motion, amongst which may be mentioned those of Messrs Worms and Balé, L. Groth, and others. Mr. Groth employs a vat, in the centre of which is a rotating or reciprocating (according to the shape of the vat) frame, on which are suspended the hides or skins to be tanned, an electric current being passed from one side of the pit to the other, through the liquor and hides. This process reduces the time necessary to tan a hide to about 28 days.

Messrs. Worms and Balé's system combines the application of an electric current with the use of a rotating drum; the drum is about 11ft. in diameter and provided with internally-projecting pegs; in operation it is nearly half filled with liquor, and the hides being put in (one by one), the drum is closed and rotated; while in motion an electric current is applied by electrodes, so disposed as to fill the liquor with, and hence subject the hides to, a uniform field of endosmotic force. When the drum is in motion, the hides, floating in the body of the liquor, are turned over and the liquor mixed, the bottom layers being continually brought to the top by the skin friction. Under these conditions, running continuously, hides may be tanned in about 100 hours. It will be seen that the rotating drum contains four variable factors:—(1) The strength and disposition of the electric current; (2) The speed of rotation; (3) The proportional amount of liquor in the drum; (4) The length and number of the projecting pegs, thus giving the system considerable flexibility of treatment. It has now been worked on a commercial scale for some years by the British Tanning Company (Limited) in London, by MM. Brion et Dupré, in Paris, and also in America.

Considering the purely electrical and chemical effects on the hides and liquor, the final result established by the experiments of Messrs. Rideal and Trotter, Prof. Müntz, of Paris, Dr. Foelsing, Dr. Zerener, and others is that raw hide is capable of combining with its equivalent weight of tannic acid in from 4 per cent. to 38 per cent. (according to the process employed) of the time taken when electricity and apparatus, or electricity alone is not applied.

Below I give particulars of some experiments which I have made, bearing on the action of the electric current. Let us first consider what happens when a current is passed through a carefully filtered solution of tannic acid, made from an oakwood extract, using platinum electrodes. The cell employed was divided into three by two porous clay diaphragms, each compartment being of equal capacity, 200 c.c., and containing 150 c.c. In the first compartment was placed the anode, and in the third the kathode, the intermediate one completing the circuit. A current of 0·0024 ampere was applied at a potential difference of 7 volts. On completing the circuit the following actions took place: at the anode bubbles appeared and collected round the wire as a straw-coloured froth; at the kathode there was considerably more evolution of gas, and the froth produced was darker in colour and showed streaks of dark red colouration radiating from the wire. After passing the current for 90 hours it was stopped, and the electrodes and liquor examined. The anode had a small quantity of soft, brown precipitate on its surface ($\frac{3}{8}$in. × $\frac{3}{8}$in.) which was easily soluble in warm distilled water, and was absorbed by hide powder; the kathode was covered closely with a hard, dark-brown coat of precipitate to the depth of from one sixty-fourth inch to one thirty-second inch at the edges. This precipitate is insoluble in hot distilled water, but is immediately dissolved on addition of a very small quantity of H_2SO_4, forming a clear tan-coloured solution which is bleached on treatment with hide powder, thus proving the precipitate to be a dark, tanning, colouring matter. On examining the liquid in the three compartments, No. 1, containing the anode, was as clear as at the commencement of the experiment, so was No. 2, both having a slight coat of tannin anhydride on the bottom; No. 3, containing the kathode, was somewhat turbid with dark-brown particles which were soluble in hot distilled water and absorbed by hide power. At the end of the experiment it was found that in the compartments 1 and 2 the level of the liquid had fallen and in 3 it had risen.

The above gives a general view of the action which I have amplified as follows:—I. To compare the endosmose effects in solutions of tannic acid, at varying potential differences, at varying strengths of tannic acid, and with diaphragms of different materials. II. To compare the precipitation of anhydride, &c., in solutions of tannic acid, when a current of electricity is passed through them, and when allowed to remain during the same time and under the same conditions but without passing a current. III. To examine the amount of tannin in the liquor before and after passing an electric current.

I.—*Endosmose.*

Cells were made consisting of two ebonite boxes (each having one side cut away) fastened together with a plate of porous clay or leather between them, thus forming two compartments, joined through a porous diaphragm, each having a capacity of 200 c.c. In experimenting, 100 c.c. of the liquor to be examined was placed in each compartment and the current applied from accumulators, &c., through platinum electrodes, and the variation of level with time noted; the top and bottom surfaces of the cells were made parallel and carefully levelled during experiments. Between each set of readings the clay diaphragm was cleaned and allowed to soak in water, so that the mechanical resistance to flow of liquor might remain as nearly constant as possible.

This method was adopted as the apparatus is simple, and if differences of level between the two sides of the diaphragm be considered, evaporation errors are eliminated, as the surfaces exposed to the air are equal in both compartments.

The first experiments undertaken were to see in what way the rate of flow varied with the difference of potentials applied, the results of which are shown in the following curves:—

Curves and **Table A_1** *and* **A_2**.

I.	II.	III.	IV.	V.	VI.	VII.
Volts.	(Volts)^2.	Tangent to curve.	Mean current by voltameter.	Proportional rate of flow.	Calculated rate of flow.	Proportional current.
4·7	22·09	0·27	0·00089 A	0·22	0·27	0·13
9·0	81·00	1·22	0·0066 ,,	1·00	1·00	1·00
13·2	174·24	2·71	0·0162 ,,	2·22	2·15	2·45
17·7	313·29	4·42	0·0274 ,,	3·62	3·86	4·15

From A it may be seen that:—(1) with an approximately constant mechanical and electrical (at one voltage) resistance, the rate of flow of the liquor varies at a higher rate than simple proportionality to the voltage between electrodes (*see* columns I. and V.); (2) the current varies at a slightly higher rate than the rate of flow, as measured by tangent to curve (*see* columns V. and VII.: *see also* curve A_2); (3) the rate of flow approximately varies as the square of the voltage (*see* columns V. and VI.).

In order that Ohm's law may be satisfied, it follows that the resistance of the tan liquor examined must vary inversely as the potential difference applied. In some experiments I am making on this point, I find that between certain limits of current density

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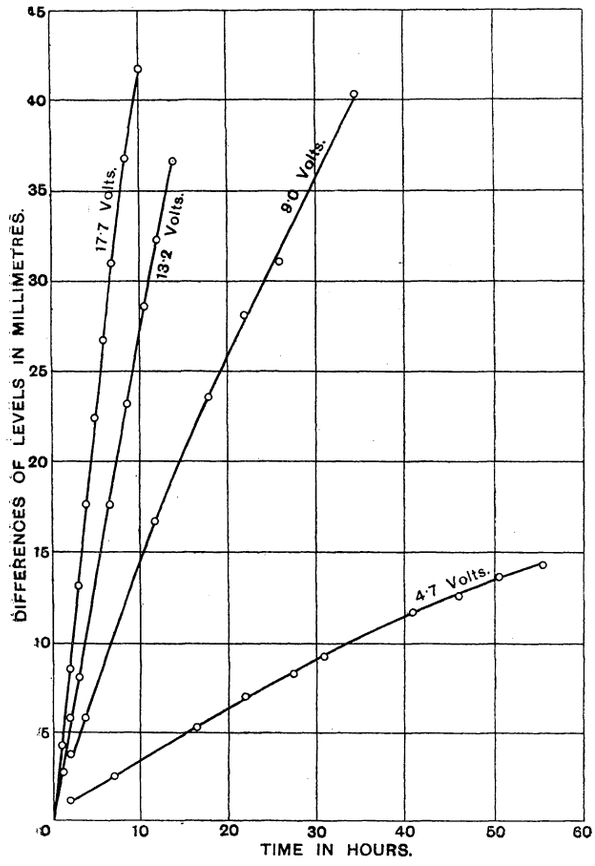
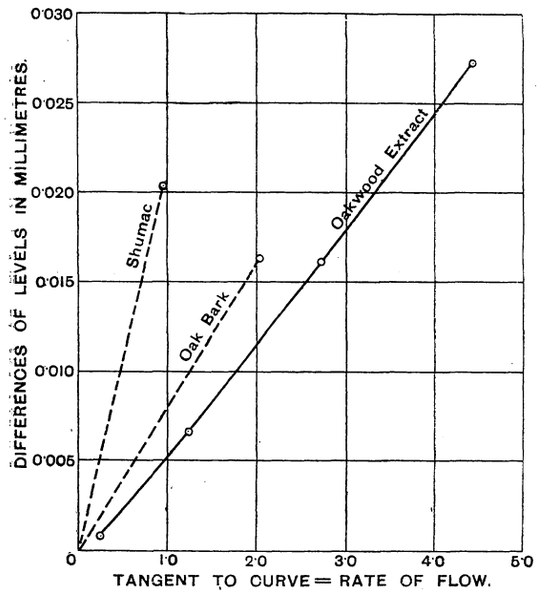
the resistance varies inversely as the electromotive force, but after the solution has been subjected to electrolysis for some time at the higher current density it loses its power of offering an increased resistance to a lower potential difference, the resistance remaining fairly constant at the minimum value for all potential differences below the high one which broke it down. This, taken in

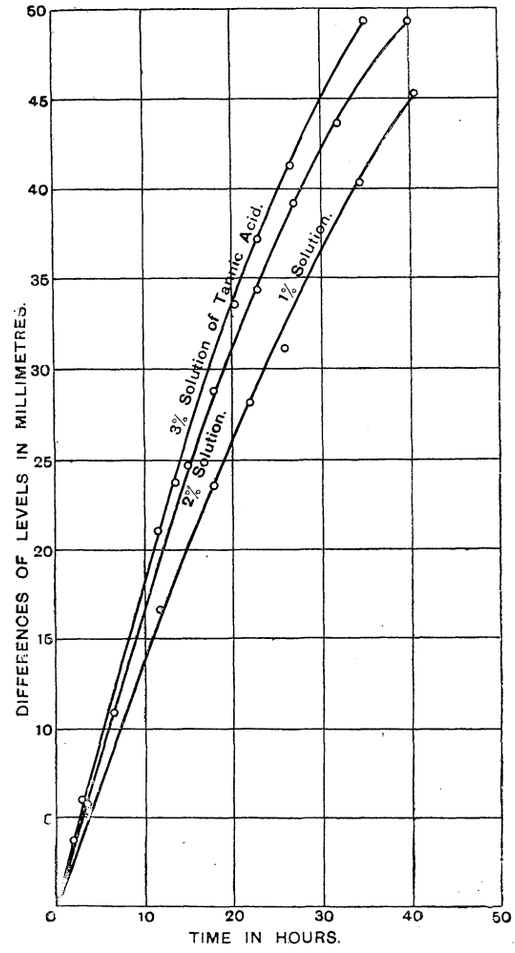


CURVES A.—1 per cent. Solution of Tannin.



CURVES A_2.

conjunction with the results given in Division III., points to an alteration in the structure of the tannin molecule being produced by electrolysis, the resinous dark tanning matter being separated in the form of insoluble precipitate on and about the kathode, the remaining liquor being of higher electrical conductivity and clearer, the amount of available tannin remaining constant although in separate forms. The next experiments were made to find in what way the rate of flow varied with the percentage of tannin in the solution at constant potential difference and using the same porous diaphragm in each case.

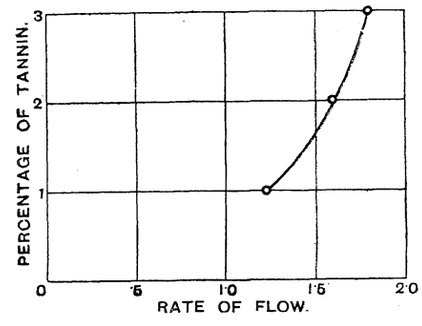


CURVES B.—P.D. = 9·0 volts.

Table B.—*Curves* B_1 *and* B_2.

Percentage of tannin.	Volts.	Mean current.	Rate of flow.	Proportional rate of flow.	Proportional current.
1	9·0	0·0066 amp.	1·22	1·00	1·00
2	9·0	0·0079 ,,	1·60	1·31	1·19
3	9·0	0·0109 ,,	1·80	1·47	1·65

From the above it will be seen that the rate of flow (as measured by tangent to curve) increases with the strength of the liquor. This fact is specially important for the following reason: In ordi-



CURVE B_2.

nary tanning operations it is well known that the greater portion of the gelatine is combined in the first month or so of the tannage, the remainder of the time being spent in tanning the middle layers and giving weight, owing to the increased resistance which the outer tanned portions offer to diffusion. Now, for reasons given earlier in the Paper, it is necessary to use liquors of gradually increasing strength as the tannage proceeds, and which, for any given potential difference, give (as shown in curve B_2) an increasing

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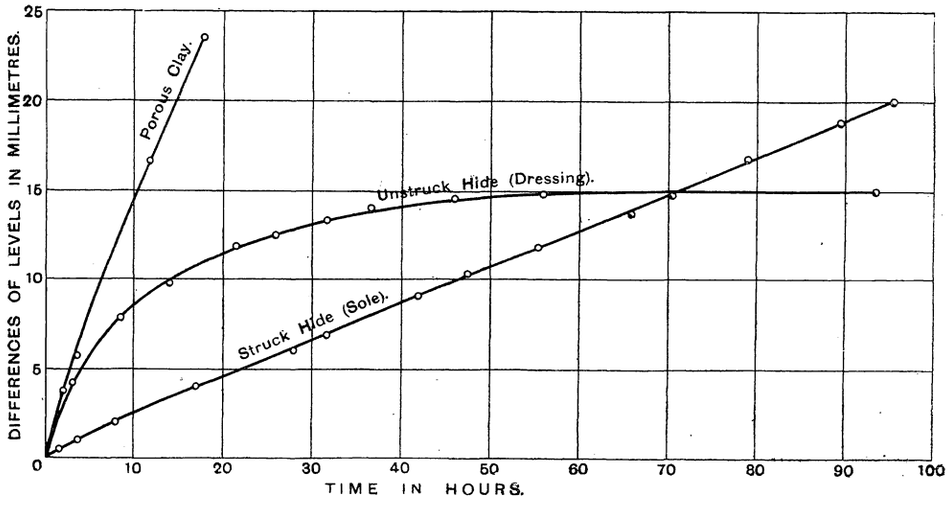
hydrostatic pressure or head tending to force the liquor through the hide; thus there is a kind of self-regulating arrangement, viz. :—as the mechanical resistance of the hide increases, so the endosmotic pressure increases to overcome that resistance.

The next experiments were made using diaphragms of different materials and keeping potential difference and strength of liquor constant, the results being shown below :—



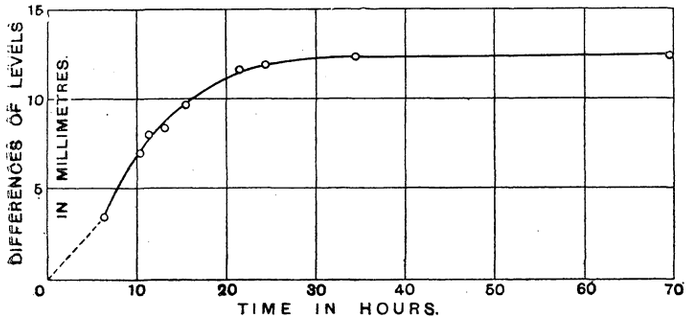
CURVES C.—1 per cent. Solution of Tannic Acid. P.D. = 9·0 volts.

Table C.—*Curves C.*

9 volts. 1 per cent. solution of Oakwood tannin.

Diaphragm.	Mean current.	Rate of flow.	Proportional current.	Proportional flow.
Struck sole	0·0041 *a*	0·20	0·62	0·16
Porous clay	0·0066 „	1·22	1·00	1·00
Dressing hide	0·0106 „	1·58	1·60	1·29

In the above will be noticed the great difference in mechanical resistance to diffusion between leather before and after it has been struck (*i.e.*, smoothed down and worked over with the striking pin) and rolled. The curious bending over of the curve for unstruck hide is due to the influence of the head of liquor and openness of the pores allowing the liquor to run back again, a certain point being reached at which this leakage becomes equal to the flow and the difference of levels remains constant. This effect is also shown in Curve D with tap water and a porous clay diaphragm.



CURVE D.—Porous Clay Diaphragm. Tap Water. P.D. = 7·2 volts.

Curve D.

The next experiments were made, using liquors prepared from different tanning materials, and keeping the potential difference constant and using the same porous clay diaphragm, the results being shown below :—

Table E.—*Curves E.*

9 volts. 1 per cent. solutions.

Liquor.	Mean current.	Rate of flow.	Proportional current.	Proportional flow.
Distilled water	0·00078	0·095	0·12	0·077
Shumac	0·0204	0·97	3·09	0·79
Oakwood extract.....	0·0066	1·22	1·00	1·00
Oak bark	0·0164	2·02	2·48	1·65

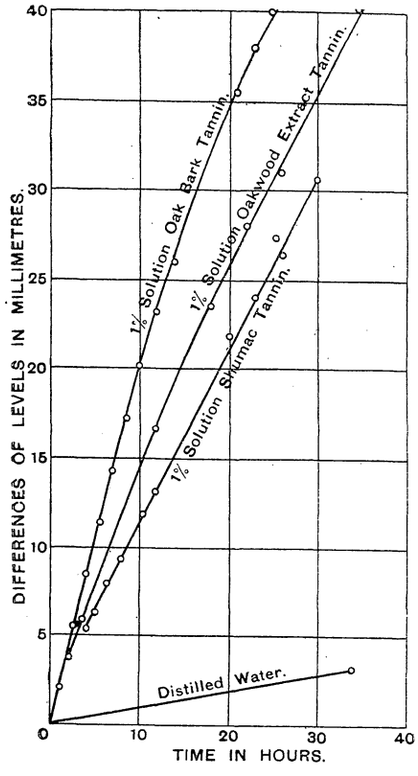
In the above curves 10 mm. difference of levels corresponds to 11·36 c c. passing through the diaphragm, the levels in both compartments being the same on starting experiment.

II. and III.—*Chemical Action.*

II. To compare the precipitation of anhydride, &c., in solutions of tannic acid when a current is passed through them, and when allowed to remain during the same time and under the same conditions but without passing a current.

III. To determine the amount of tannin in the liquor before and after passing an electric current.

In carrying out the above, two beakers were taken in each of which 150c.c. of tan liquor (containing 5 per cent. oakwood tannin) was placed. Through the liquor in one beaker a current of 0·0086



CURVES E.

ampere (measured by voltameter) was passed for 96½ hours, and the other was allowed to stand open by its side, being thus under exactly the same conditions, excepting that it had no electricity passed through it.

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In the analyses below :—
33·4 c.c. of permanganate = 10 c.c. n/10 crystallized oxalic acid.
17·6 ,, ,, = 20 c.c. indigo carmine.

No.	Description of liquor.	10 c.c. infusion.	10 c.c., after hide powder.	C.c of non-tannin.	Tannin %.	Non-tan' in %.
I.	Liquor before experiment	32·75	19·5	1·9	5·007	0·69
		32·70	19·4	1·8		
II.	After exposure, without passing electric current.	32·50	19·55	1·95	4·88	0·72
		32·45	19·50	1·9		
III.	No. II., filtered	32·15	19·45	1·85	4·79	0·69
		32·15	19·45	1·85		
IV.	After passage of electric current and exposure ...	32·5	19·0	1·4	5·073	0·54
		32·5	19·1	1·5		
V.	No. IV., filtered	31·0	18·9	1·3	4·57	0·48
		31·0	18·85	1·25		

The same solutions were used throughout the above experiments ; 10 c.c. of a diluted solution (1-20th) were titrated with permanganate in presence of indigo carmine before and after treatment with hide powder. On examining the above results we may notice :—(i.) The action of the electric current on bodies which are absorbable by hide powder. (ii.) The action of the electric current on bodies which are not absorbable by hide powder.

(i.) On comparing Nos. I. and IV. it will be seen that the total amount of tannin remains unaltered, or, if anything, slightly increases after the passage of the current. On filtering IV. and again analysing, it will be seen that some of the tannin has been precipitated (*see* V.), probably as anhydride or phlobaphene. This precipitate, as seen from the experiment with the three-compartment cell, is produced at the kathode by the action of the hydrogen evolved there ; this tannin is proved by column IV. to be still available for tanning purposes (after heating).

(ii.) This action is very marked, as will be seen from examination of columns 5 and 7 in table above, the number of c.c. of permanganate consumed by these non-tannin bodies goes down from 3·7 in the original liquor to 2·9 in the unfiltered electrolysed solution, and to 2·55 in the filtered ; this reduction is really greater than is apparent here, because the electrolysed solution was exposed to the air for exactly the same time as the other, and therefore the increase of 0·15 c.c. produced by exposure in the non-electrolysed should be added. This leads one to think that there may be a kind of restoration of the liquor, the tannin which has been decomposed by exposure to the air being reduced, possibly by the nascent hydrogen at the kathode; this would account for the reduction in the quantity of non-tannin matters, although, if these were more easily oxidisable than the tannin, the oxygen evolved at the anode might influence this result.

Summary.—The principal chemical actions of the current on tan liquor, using platinum electrodes at a current density of 1·6 ampere per square foot, are :—1. Precipitation of anhydride of tannin ; this precipitate is more copious with a tannin capable of yielding "bloom," as shumac, in which case the electrical conductivity is higher (*see* Table E). 2. Reduction of the amount of non-tannin matters in the solution. The above shows that, at all events below current densities of 1·6 ampere per square foot, a limit which is never exceeded or reached in practice, there is no loss of tannin due to the action of the electric current as the ratio $\left(\frac{\text{number of ampere-hours}}{\text{number of c.c. of liquor}}\right)$ in this experiment is considerably greater than that employed in practice—say 366 : 1. I have found that the solubility of the precipitate decreases as the current density increases. There is an effect (referred to earlier in the Paper) which doubless influences the rapidity at which the gelatine and tannin combine—viz., the molecular vibration of the liquid and hides, due to the phenomenon of electricity being a vibration of the ether, agitating the particles and making them combine with their affinities sooner than they would do if left to themselves. In support of this, the fact of tanning operations being accelerated by rise of temperature may be brought forward, heat being a similar vibration of the ether, differing only in period from the electrical vibration.

In endosmose, however, we have a perfectly tangible, measurable effect, propelling the liquor in the direction of the lines of current flow, tan liquor also being a particularly favourable medium for his purpose for the following reasons :—1. The force increases with the percentage of tannic acid in the solution, thus falling in with the practical methods of tanning—*i.e*, increasing as the permeability decreases. 2. The electrical resistance of tan liquor being high, the necessary difference of potentials (to the square of which the endosmotic flow is proportional) can be obtained between adjacent portions of the liquid without an undue expenditure of current, and, therefore, of energy.

We might approximately calculate how much tannin would be likely to pass through a 20lb butt (tanned and dry wt.) in an hour, using, say, a 12-ampere current at 9 volts, with proportionally larger electrodes, but keeping the distance between electrodes and hide the same, as in Experiment C with unstruck hide (it must be remembered that the leather in question was fully tanned, and therefore its permeability was at its minimum value).

Area of butt = 54″ × 66″ = 3,564 square inches.

Working area of diaphragm = $2\frac{5}{8}$ square inches.

Tangent to curve near origin = $\frac{10\text{mm.}}{6{\cdot}3\text{ hours}} = \frac{11{\cdot}36}{6{\cdot}3}$ c.c. per hour.

Current in experiment = 0·0106 ampere.

One gallon = 4,536 c.c.

Increasing the current to 12 amperes, and assuming (from Table A and curve A_2) that the flow is proportional to the current, we have $\frac{11{\cdot}36 \times 12}{6{\cdot}3 \times 0{\cdot}0106 \times 4{,}536} = 0{\cdot}45$ gallon of liquor passing through the butt per hour ; this, supposing the liquor to contain 4 per cent. of tannin and to have a specific gravity of 1·02, would be equivalent to $\frac{0{\cdot}45 \times 10 \times 1{\cdot}02 \times 4}{100} = 0{\cdot}1836$lb. of tannin. If the butt require $20 \times 0{\cdot}45 = 9$lb. tannin to tan it, then this amount would pass through in 49 hours. From the above it will be seen that, having a means of bringing the liquor into intimate contact with the fibres of the hide and also of assisting it to combine whilst passing through, we are in a much more favourable position than when working with only diffusion and capillary attraction to bring the liquor to the interior and replenish it when exhausted, especially as the tannage proceeds and the hide becomes less and less permeable.

In conclusion, I must express my thanks to the British Tanning Company (Limited) for facilities granted in carrying out experiments and permission to publish results.

On sheet A_2 is shown the variation of rate of flow, with current, for three different tanning materials, the curves for oak bark and shumac being taken from the results given in Table E, from which it will be seen that the relative velocities imparted by the current to 1 per cent. infusions of oakwood extract, oak bark and shumac, are approximately as $3\frac{1}{4}$, $2\frac{1}{2}$ and 1, the endosmose effect being smallest on the shumac infusion, which is, however, one of the most rapid tanning materials, and therefore needs the least extraneous assistance. We have thus, to some extent, a means for separating tannins from a mixture of various different tannins, since, with the same current, different tannins move at different velocities in the same electrolyte ; the application of electric endosmose to similar problems was, however, suggested by Dr. Silvanus Thompson in his contribution to the Discussion on Mr. Swinburne's Paper on "Problems of Commercial Electrolysis," last November.

DISCUSSION.

*Mr. SWINBURNE cordially congratulated Mr. Falkenstein on the Paper, which seemed to be full of most important information. It was a very important Paper ; but it was one that he could hardly discuss without having seen it before.

*The PRESIDENT, in proposing the usual vote of thanks to the author, said that it was a great advantage to the Society that they had from time to time brought before them new and fresh subjects. Many of the members of the Institution seemed to labour under the impression that the whole of the electric world was contained in the magnetic field of a dynamo, and it was just as well that sometimes they should find that there were other people in this world who were studying other forms of electrical agency and electrical action, and that in no respect did the application of electricity to such a process as tanning detract from the extreme interest which the members of the Institution should feel in every practical application of electricity.

LEGAL INTELLIGENCE.

Woodhouse and Rawson United (Limited).

Mr. Justice Vaugham Williams on Wednesday had before him three petitions for the compulsory winding up of this Company.

After a lengthy discussion, the petitioners abandoned the applications for a compulsory order in favour of a supervision order, whereupon Mr. UPJOHN, on behalf of a holder of ordinary and preference shares, said his client wished to have an opportunity of presenting a petition.

His LORDSHIP said on the 29th inst. a new rule came into force which would enable him on the hearing of any petition, if those who presented it abandoned the petition, to substitute another petitioner. He would, therefore, adjourn these petitions until the new rule was in operation.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March* 31, 1893.

The Telephone Patents.—The past week has been signalised by two decisions in the Courts which are likely to have a most important bearing upon the various electrical industries. The first of these was rendered on March 27th in the case of Henry Huber and others *v rsus* the Nelson Manufacturing Company. The question at issue was:—What is the life of a United States patent applied for *after* the same has been applied for in foreign countries, and also after the foreign patent has expired by reason of non-payment of taxes or failure to work? Justice Blatchford, of the United States Supreme Court decided that under those circumstances the United States patent was void. The electrical interest of this decision is connected with the telephone situation, since by this decision the three patents of Edison which broadly cover the use of carbon in telephone transmitters become void. This simplifies the telephone situation, owing to the fact that the only "basic" telephone patent having any length of time to run is the Berliner microphone patent, the validity of which is itself in question before the Courts. Great interest was manifested recently in telephone matters by reason of the expiration of the Blake transmitter patent and the Bell parchment diaphragm telephone patent, and the expiration in January next of the Bell iron diaphragm patent. The Edison patents, however, and the Berliner patent so fully covered the ground of transmitters of the variable contact type that it was a question whether with the lapse of the patents referred to, the telephone business would in fact be open to the public. This led to a close study of the history of telephone development, and this disclosed the fact, long since forgotten by most people, that as early as 1883 telephonic communication was carried on experimentally on grounded circuits between New York and Chicago, and between New York and Cleveland, so that long-distance work, which was thought to be new, is now ten years' old. In these long-distance experiments, which were conducted over a No. 4 compound wire (composed of copper and steel), a large number of transmitters were tried. It is not quite clear that the Bell magneto instrument was actually used as a transmitter between New York and Chicago, though there are some who claim that it was. The Bell instrument was undoubtedly used, however, as a trasmitter over the line from New York to Cleveland, and over many other lines of lesser length, thus showing that it is capable of giving fair transmissions over almost any distances reached at the present day. These lines were said to have been noisy, but this was, of course, no fault of the transmitter, but was probably due entirely to the fact that a grounded circuit was used.

The Edison Feeder Patent.—The second decision relates to what is known as the Edison Feeder Patent. In this patent, which was issued September 19, 1882, Edison claims the use of feeding conductors connecting the consumption circuit with the source of electrical energy, and having no translating devices connected therewith, and extending from a source of electrical energy to the centre of the consumption circuit. As the employment of feeders is almost universal in the distribution of energy over large areas, it will be seen that this patent is very broad. The suit was between the Edison Electric Light Company and Westinghouse, Church, Kerr, and Co., and it was decided by Judge Green, of the United States Circuit Court for the District of New Jersey, in favour of the Edison Company. The Judge, in announcing his decison, merely stated that he had found for the Edison Electric Light Company, and that his decision in full would be published in a few days. Since this judgment has not as yet come to hand, it is not known how broadly the judge construed the patent, and the scope of his decision has given rise to much speculation. The General Electric Company, the present owners of the Edison patent, claim that it covers the use of feeders, not only in the distribution of current for electric light, but also that it covers the use of feeders in the operation of electric railroads and all other applications where the drop of potential is avoided by the use of feeding circuits. The Westinghouse people, however, affect to believe that the decision will have very little importance, that it does not apply to electric railroad feeders, nor to the methods usually in vogue in this country for distributing alternating currents. They claim also that this patent will expire in September of next year by reason of a similar patent which was issued in England in September, 1880. The General Electric Company, however, deny this. Referring to the Edison patent we find that the specification refers more specifically to the use of feeders for incandescent lamp circuits, and the Westinghouse people are inclined to interpret it as being thus limited. However, Mr. Edison in describing his patent uses these words: "This invention relates to a method of equalising the tension or pressure of the current through an entire system of electric lighting, or *other translation* of electric force, preventing what is ordinarily known as 'drop' in those portions of the system the more remote from the central station." It would scarcely seem that without a disclaimer Edison's patent could be limited to electric light distribution, but that it must apply equally to the distribution in a similar manner of current for other purposes. If this broader view is taken by the Court, it not only gives the General Electric Company a more perfect monoply of the lighting business, but will also place within its control all of the method now employed of operating electrical railways except two; these exceptions are the storage battery and the series method of electrical propulsion. The storage battery has been experimented with a good deal in this country for street-car propulsion, but in no case has it met with much success. The series system of propulsion is best known through Prof. Sidney Howe Short's attempts to render it practicable, which, however, were finally abandoned. Prof. Short got just about as far with his series system as Mr. Charles F. Brush did with his arc lighting system up to the time of his discovery of the automatic cut-out, which was the key to success. Prof. Short met with the same difficulties that Mr. Brush did up to that time, and found that while he could operate two or three cars quite economically and successfully, when the number was increased beyond this the difficulties multiplied rapidly. Another inventor taking the subject up at this point and having experience of the Short system has introduced the missing link, namely, the automatic cut-out, and although his plans have never been put into operation, there seem to be no theoretical objections to them, and they certainly possess some valuable features. It seems not unlikely that if the Court takes the broad view of the Edison claims the result will be the development of the series method of distribution for movable translating devices.

CORRESPONDENCE.

HIGH VACUUM TUBES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With regard to Mr. Kerdel's letter published in your last issue, I may remark that I have several times tried placing a vacuum tube between two charged plates and suddenly removing it, hoping to obtain a luminous flash, but was always unsuccessful. Apparently the field at the edges fell off too gradually to allow a sufficiently rapid rate of change of induction through the tube when pulled out of the field by the hand. The other day, however, when showing the experiment of the rotating tube and excited ebonite rod to a friend, I found that when the tube was at rest on removing the rod suddenly there was a distinct flash in the tube. The same happened when the rod was suddenly approached or moved past the tube. Another form of this experiment is to take a straight tube (mine was about 5in. long and $\frac{3}{4}$in. in diameter) and rub it on a piece of flannel laid flat on the table, the whole of the tube being on the flannel; nothing much will happen in the way of luminosity so long as the tube is in contact with the flannel, as, of course, the electric induction passes from the outer surface of the glass straight to the flannel, which is practically in contact with it, and

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does not go through the rarefied gas. On suddenly lifting the tube some of the induction will pass from the charged surface of the glass through the tube, and will cause a fairly brilliant flash in the tube.

Obtaining a luminous glow on rubbing an exhausted tube or bulb with a piece of silk or flannel is a very old electrical experiment, and has, I expect, been put to practical use before now for the purpose of obtaining (so-called) spirit lights by unscrupulous mediums at dark *séances*.—Yours, &c.,

E. C. Rimington.

The Park, Norwood, S.E., April 7, 1893.

CONDENSING FOR ELECTRIC LIGHT STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Assume that all the engines in a station are of the same size. The smaller the size the smaller will be the steam consumption. Let the year's load curve be covered by these engines, the number of engines running at any time being suitable to the load. The result can be expressed by an annual number of engine-hours (n). The lbs. of steam per hour (p), used non-condensing, that are saved by condensing are constant for all loads on the engine. The total saving of steam is np. The lbs. of steam per hour (P) required to run the engine non-condensing, at full speed, excited are constant for all loads. n P lbs. of steam are required to run the engine excited. Each unit costs a constant additional number of lbs. of steam per hour (π). If the year's units be ν, total steam consumption is $n\,\mathrm{P} + \nu\,\pi$ non-condensing.

The proportion of the saving by condensing to non-condensing consumption is $\frac{np}{n\mathrm{P} + \nu\pi}$ = one-fifth about. The steam used in the engines is produced by five-sixths or six-sevenths of the coal burnt, the remaining one-sixth or one-seventh being utilised in keeping stand-by boilers warm. These two figures correspond to the cases of Kensington and Millbank respectively, from tables given by Mr. Crompton and Prof. Kennedy. The saving of coal can then be tabulated as the percentage of the total amount, used non-condensing, that would be saved by condensing.

Ratio condensing to non-condensing plant.	Percentage of total coal saved.	
	Apportioned to engines.	
	$\frac{5}{6}$	$\frac{6}{7}$
$\frac{1}{5}$	8·88	9·14
$\frac{2}{5}$	12·7	13·
$\frac{3}{5}$	13·9	14·3
1	16·66	17·1

Prof. Kennedy's figures were for the summer, and Mr. Crompton's for the winter, so the results may be averaged. With a condensing plant capable of maintaining a suitable vacuum at full load, 17 per cent. of the total coal consumption is saved, and this applies to carting, shovelling, and removing ashes—17 per cent. of the water is saved.

The rate of saving of steam being 18 per cent. at full load, $\frac{1}{5}$ of the boiler power is saved. This leads to some saving from stand-by losses, and since the rate of saving at no load is as much as 40 per cent., obviously a smaller boiler unit may be adopted with, again, a gain from stand-by losses.

On the other side must be put the cost of water for condensing, the cost of circulating it and cooling it, and charges on condensing plant and addition to engine. In this connection it is well to note that a saving is affected in boilers, a plant with heavy rate of depreciation, repairs, and up-keep, and an addition is made to capital account on which the charges for depreciation and repairs and up-keep would be almost negligible. Each case must be decided on its merits when the local conditions are known. I may add that this statement follows from Mr. Willans' straight-line curve of total steam consumption. (*Proc.Inst.C.E.*, Vol. CVI., p. 62.)—Yours, &c.,

Reginald Wood.

A letter from Mr. S. Mavor in answer to Mr. S. F. Walker has come to hand too late for insertion in this issue.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "The Electrician" Electrical Trades' Directory and Handbook is now ready. This useful book contains over 1,000 pages, and several new and handy features have been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

Tenders Invited.—The Postmaster-General invites tenders for the purchase of about 26 tons of gutta-percha in various forms (principally in strippings), about 60 tons of copper (principally wire), and quantities of zinc and other metals, &c. Some further particulars will be found in our advertisement pages, and all necessary information may be obtained on application (by letter only) to Mr. Chas. E. Stuart, Controller of Stores, Telegraph-street, London, E.C. Tenders have to be in by the 25th inst.

——— The Town Council of Aberdeen invite tenders for various work under their Electric Lighting Order. Further particulars are given in our advertisement columns, and full specifications and drawings can be had either from the Town Clerk, Aberdeen, or from Prof. A. B. W. Kennedy, 19, Little Queen-street, Westminster, London, S.W. Tenders have to be in not later than 10 a.m. on Friday, April 28th.

——— The Bedford Urban Sanitary Authority, it will be seen by our advertisement columns, invite applications from companies or firms willing to undertake and carry out the powers granted them under their Provisional Order. Applications must reach Mr. T. S. Porter, the clerk to the Urban Sanitary Authority, on or before May 13th.

——— The General Direction of the Posts and Telegraphs in Madrid is inviting tenders until the 24th inst. for the establishment and operation of a telephone exchange in the town of Haro, in the province of Logrono, Spain.

Tenders Accepted.—The Great Northern Railway Company have accepted the tender of the Brush Electrical Engineering Company for the supply and erection of alternators and arc dynamo machines for the large station to be put down at Holloway for lighting a number of the Company's stations up and down the line.

——— In reference to the acceptance of the tender of Messrs. Siemens Bros. and Co. for supplying and laying the whole of the electric conductors for the Whitehaven installation (which appeared in our last issue), the total sum of the tender is £4,014. Messrs. Siemens' tender has been finally accepted.

For Disposal.—Mr. R. L. Impey, chartered accountant, of 26, Waterloo-street, Birmingham, is open to receive offers for the purchase of the business plant, &c., of Fowler, Lancaster and Company (Limited), (in Chancery).

——— Mr. Impey also invites offers for the purchase of the business plant, tools, &c., Birmingham Telegraph Factory (in Chancery).

——— The liquidator of the Automatic Standard Screw Company (Limited), of Halifax, invites offers for the business as a going concern, with machinery, plant, tools, &c. The Company is engaged in the manufacture of a variety of high-class screws, fancy turned metal, &c.

Bankruptcy.—In the matter of Austin Herbert, recently trading as an electrician at St. James's-street, Nottingham, recently adjudicated a bankrupt, the liabilities amount to £172, and the assets are estimated at £55.

Legal.—An action brought by Mr. R. Lawrance, of Liskeard, against Mrs. Mary Knight, of Torquay, to recover certain sums for fixing electric bells, telephonic communication, &c., was on Monday last dismissed in favour of the defendant with costs against the plaintiff.

Change of Address.—The address of Mr. James Swinburne, consulting engineer, is now 4, Hatherley-road, Kew Gardens, Kew.

Earl's Court Exhibition.—The Brush Electrical Engineering Company have contracted for the supply of the electric generating plant required for the electric lighting of the Gardening and Forestry Exhibition to be held at Earl's Court this year.

Messrs. Drake and Gorham.—During the Easter holidays this firm removed and reinstalled the extensive electric light plant of the London and River Plate Bank without inconvenience to the bank officials. The plant was originally put down six years ago. The new bank premises have been fitted with an electric lift, which will be worked by the accumulators used in the lighting. The new

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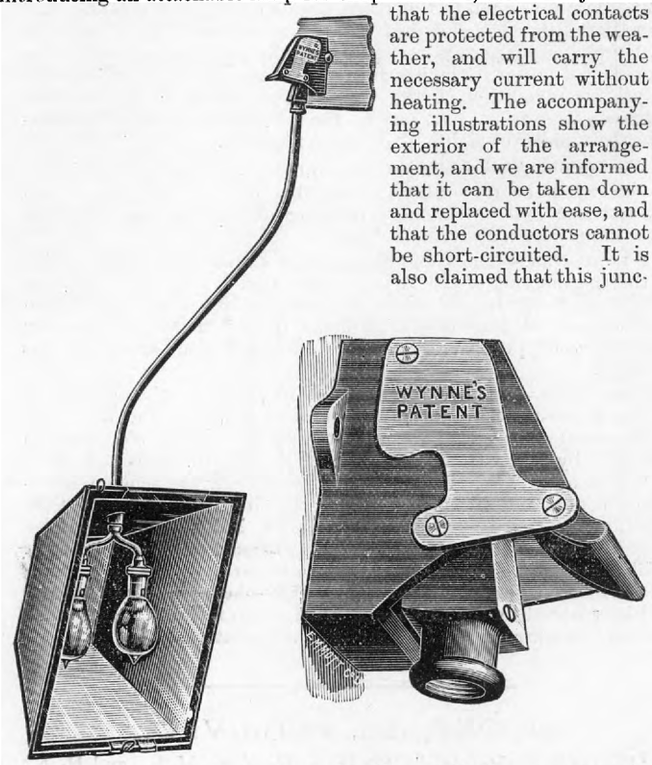
lift is similar to those originally put in the old premises, and which has been at work for years without costing anything for repairs.

J. E. H. Gordon and Co. (Limited).—An advertisement requests trade creditors of this Company (in liquidation) to communicate with Mr. Henry F. Kite, solicitor, 11, Queen Victoria-street, E.C.

Messrs. Coupier and Drouart.—Those in search of artistic statuettes and reproductions will find on show at this firm's premises at 75, High Holborn, London, W.C., a very choice variety of examples in the highest style of art. The firm are well in touch with the requirements of the trade, and their show-rooms will repay a visit.

The Priestman Oil Engine.—Messrs. Priestman Brothers (Limited) report a steady progress in the sale of this engine, and that, in order to meet the demand, a large addition to their shops and plant has been made, enabling them to reduce the cost of production. The firm are now in a position to make a reduction in the prices of their oil engines, without in any way lowering the quality of the workmanship or material hitherto supplied; and to all engines of 5 H.P. and upwards a new patent self-starter is fixed free of charge. A new price list is issued, and can be obtained on application at the Hull, London, Glasgow or Melbourne offices of the Company.

Shop Window Lantern.—Messrs. Wynne and Barnard are introducing an attachable lamp for shop windows, &c. They claim that the electrical contacts are protected from the weather, and will carry the necessary current without heating. The accompanying illustrations show the exterior of the arrangement, and we are informed that it can be taken down and replaced with ease, and that the conductors cannot be short-circuited. It is also claimed that this junction can be applied for railway signalling and other purposes, including the lighting of picture galleries, for which purpose the lamps are made in ornamental designs.



Telephone Transmitters.—The National Telephone Company have for some weeks past been experimenting upon various forms of transmitters and with the latest inventions and modifications of these instruments, in view of selecting the best form for use with their telephones. We understand that the Company do not contemplate superseding the Blake transmitter, but are anxious to secure for their subscribers the most efficient form of transmitter in the market.

The "Victor" Turbine.—Mr. F. Nell sends us a well-illustrated pamphlet of illustrations and particulars of the "Victor" turbine water-wheel, from which particulars may be obtained of a variety of purposes to which these water-wheels have been in the past, and are being, applied. Tables of power, speed, head of water, and cubic feet discharged are given, together with instructions for measuring water-power, construction of head races, &c. Illustrations show the setting of turbines for high falls, &c., and testimonials from users are also included.

Messrs. Hampton and Sons' Catalogue.—The claim of Messrs. Hampton and Sons' that their new catalogue and book of designs surpasses anything of the kind yet produced cannot be gainsaid. We are accustomed to the finest printing and elaborate get-up in electrical catalogues, but Messrs. Hampton and Sons have put every other list in the shade, not only in the photographic collotype illustrations, but in the handsome embossed binding. A special electric light department has been opened by this firm, and we find lamps, switches, and ceiling roses, as well as a number of designs for fittings. Messrs. Hampton and Sons seem to have succeeded where so many others have failed, in offering some graceful but simple wall-brackets.

Aberystwith.—Prof. Garnett has furnished the Town Council with a lengthy report on their electric lighting schemes, which is to be printed in full and circulated amongst the members. Prof. Garnett has reported upon three possible schemes, discarding the one by which the town refuse is to be utilised. We understand the lowest estimate is £11,000, and several members of the Town Council were of opinion that this was too large an amount to be expended at the present time. It was, therefore, resolved to ask the Public Lights Committee to present a smaller scheme for the Terrace and some of the principal streets. The opinion was freely expressed that the desirability of the light was beyond question, an experimental installation having given the greatest satisfaction. The subject will again come up for discussion at an early meeting of the Town Council.

Belfast.—A meeting of the Town Council was held on Tuesday last to take into consideration the report of Prof. Kennedy relative to the introduction of the electric light into Belfast. A full abstract of this report appeared in *The Electrician* of March 10th last, and the scheme for the lighting of the central, or compulsory, area at an estimated cost of from £19,000 to £20,000 was, adopted by the Council. The Gas Committee was authorised to carry the recommendations into effect forthwith. It will be seen from Prof. Kennedy's report referred to above, that the plant proposed to be put down in the estimate would be sufficient to keep 6,100 lamps alight simultaneously, with sufficient reserve for a total estimated supply to 8,500 lamps in all.

Blackpool.—The residents in the North Shore complain that the electric lighting installation has not been extended to that district. The Electric Lighting Committee have the matter under consideration.

Bombay.—The Municipal Council Chamber and offices have been fitted throughout with the electric light, under the supervision of Mr. P. Mossop, of the Laing, Wharton and Down Construction Syndicate (Limited), whose agents, Messrs. Richardson and Cruddas, have had the contract in hand. There are between 350 and 400 lights.

Bowness.—The Police Commissioners have appointed a Committee to inquire into the practicability of utilising water-power from the River Avon for the purpose of lighting the district by electricity.

Burnley.—The Electric Lighting Committee have decided that the price for the supply of current for electric lighting purposes, be fixed at 6d. per unit, and that the rent for meters be 10 per cent. the first cost to the Corporation.

Chelmsford.—The large Pantechnicon, No. 2, which Messrs. Wenley and Sons have erected in New-street, has been fitted throughout with the electric light. The old building, No. 1, has also been similarly fitted.

Church Lighting.—A correspondent of the *Yorkshire Post* appeals warmly to the parishioners of Leeds for the sum required to instal the electric light in the parish church, on the plea that "the best of everything should be found in the house of God." A meeting was held last week, and the proposal to adopt electric lighting was strongly approved by the vicar.

Dundee.—A statement has been prepared by which it is shown that the electric lighting scheme entails a gross expenditure of £28,030, including the cost of the Provisional Order. The Gas Commission have power to borrow to the extent of £20,000, and it has been resolved to borrow a further £10,000 in order to meet any slight additions that may be necessary. Applications for the light are very encouraging.

Halifax.—The Gas Works Committee have resolved that the proposed purchase of the plant of the Halifax Mutual Electric Light and Power Company (Limited) be not entertained, but that the Company be asked for permission for an inspection of their books to be made, and to state whether they are prepared to continue the supply of light until the Corporation's works are ready, the Corporation paying a consideration under such an arrangement. The Council have approved the action of the Committee. The engineer to the Council has presented his report, and it is intended to have plans prepared and tenders obtained with the view to carrying out the engineer's recommendations on the subject of lighting the Borough.

Hastings.—We understand that the contract between the Town Council and the Hastings Electric Light Company for the lighting of the whole of sea-front line has been completed.

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HEREFORDSHIRE.—A meeting of the Joint Committee of the Quarter Sessions was held last week, and the subject of lighting the Shire Hall was discussed. Sir Herbert Croft strongly advised the introduction of the electric light throughout the Nisi Prius and other courts. Sir Richard Harrington, in reply, stated that the County Surveyor (Mr. Wakelam) would be asked to consider how best the Court could be lighted and at what cost. He agreed that the electric light would be much preferable to gas, but the cost would have to be considered, as the installation would be an isolated one.

ISLINGTON (LONDON, N.).—The Electric Lighting Committee of the Vestry has had under consideration a communication from Messrs. Sharp and Kent, offering to sell to the Vestry at any time within two years the whole of their property, lands, leases, machinery, and mains in the parish, for the amount expended upon them, plus a fair profit, on condition that the Vestry gives its consent to their application for a Provisional Order. The Committee recommended that the proposal be not entertained, and their report has been adopted.

LEEDS.—Several members of the City Council are desirous of removing the engines and dynamos used in the municipal buildings installation, and taking their supply from the public lighting mains. In all about 3,000 lamps are used in the Corporation buildings, and the Yorkshire House-to-House Electricity Company have notified the Council that they are not in a position to supply so many lamps from their mains.

LECTURES.—Electricity, or some of its varied applications, has formed the topic of lectures delivered respectively by Mr. Crompton at Hove, Mr. Watkinson at Sheffield, Mr. Headworth at Poplar, Mr. Anderson at Caithness, and Mr. J. Ritchie at Edinburgh.

LIGHTING OF TOWER CLOCKS.—The tower of the Bradford Town Hall is furnished with a clock of which the citizens are proud, and some time back agreed to an expenditure of no less than £800 per annum in lighting the clock by electricity. The Lighting Committee of the Corporation have recently been experimenting with the object of reducing the cost, with the result that at the present time it is estimated that the annual cost of lighting the clock will be reduced to £137, which is about £70 less than the cost of lighting it by gas.

LLANGOLLEN.—Mr. Davies, a member of the Local Board, has brought the subject of lighting the district by electricity prominently forward, but at the last meeting, after some discussion, it was resolved to defer the consideration of the matter for a month.

MIDDLESBOROUGH.—The Electric Lighting Committee of the Town Council have appointed a Sub-Committee to obtain information as to the cost of lighting the municipal buildings by electricity, and for providing arc lamps for the exterior lighting.

MONTROSE.—The Police Commissioners have appointed a Committee to consider the advisability of having the town lighted by electricity. It is probable that water-power will be used.

OXFORD.—The Oxford Electric Light Company have agreed to supply current to the Carfax clock free of charge during the continuance of their contract with the Corporation for street lighting.

PARTICK.—A Bill confirming the Provisional Order by the Board of Trade for the electric lighting of Partick has been issued.

ROMSEY.—It is stated that Romsey Abbey is to be lighted by electricity during the current year.

ROTHESAY.—The Joint Committees of the Harbour Trust and Town Council have decided to defer for the present the consideration of the adoption of the electric light for the harbour and esplanades.

RUGBY.—It has been decided to adopt the electric light for Rugby School. The installation will consist of about 750 16-c.p. lamps and 750 8-c.p. lamps for the various schools, boarding-houses, and other buildings. Mr. J. A. McMullen has been appointed consulting engineer to the scheme, which will be carried out during the ensuing term and the August vacation.

SCARBOROUGH.—The report prepared by Mr. Bernard Drake has been submitted to the Electric Lighting Committee of the Town Council and approved, with the addition that the mains be laid throughout the route selected by the Scarborough Electric Supply Company as near to the houses as possible.

TAUNTON.—The National Telephone Company are contemplating opening an exchange at Taunton, with subscribers at £9 per annum.

THEFT.—At the Salford Borough Police Court on Saturday last, John Pollitt was charged with stealing electric bells, coils of wire and other articles, from the works of the General Electric Company, at Clegg's-court, Chapel-street, Salford. A quantity of goods had been stolen from the works, and suspicion fell upon the prisoner, and a man named Charles Woodward was charged with receiving the goods so stolen. Pollitt was fined 40s. or fourteen days imprisonment, and Woodward was liberated on his own recognisances to come up for judgment when called upon.—— Percy Gordon Glynn, described as an electrician, was sentenced to three months' imprisonment at the Northamptonshire Quarter Sessions, for stealing a bicycle.

TIVERTON.—Mr. Siddalls, the surveyor to the Town Council, has presented his scheme for lighting Tiverton by electricity. A Provisional Order was obtained in 1890, but efforts to transfer the powers under the Order to other persons have proved unsuccessful. Mr. Siddalls has, therefore, prepared an estimate of the probable cost of the work if the Council undertake their own lighting, recommending the use of the high-pressure alternating-current system. He also recommends the use of water-power, which it would, in his opinion, not be difficult to obtain. Two estimates were submitted. Under one estimate (using water-power) the capital outlay is put down as £13,740, and maintenance, including interest, &c., at £1,700 per annum; using steam-power, capital outlay £10,170, maintenance £2,349 per annum. The second estimate embraces a more extensive scheme, and includes 4,000 private lights, the capital outlay for which is estimated at £17,080, by water-power and by steam £12,640, with an annual cost of maintenance in the first case of £2,050, and in the second of £2,842. Mr. Siddalls estimates that with water-power a revenue may reasonably be expected of £1,800 per annum in the first estimate; in the second estimate, £2,800 per annum.

TUNBRIDGE WELLS.—The report of the Electric Lighting Committee was presented to the Town Council at the last meeting, and was approved. The Board of Trade had informed the Committee that they had no powers for extending the period stipulated in the Provisional Order for laying down the mains, but were prepared to defer the revocation of the Order for a period of six months. Circulars were to be sent out to the inhabitants in order to ascertain the number of lights likely to be required.

WATFORD.—After discussing the question of the introduction of the electric light at Watford, a member of the Local Board has given notice that at the next meeting he will propose that the Board apply for a Provisional Order.

WINCHESTER.—The General Purposes Committee recommended at the last meeting of the Town Council that a sum not exceeding £60 be spent for inquiries into the cost of electric lighting for the district, and the feasibility of utilising the water-power at the city mill for that purpose. The Committee's recommendation was adopted.

WORCESTER.—A local Government inquiry into the application of the Worcester Corporation for powers to spend the necessary money on their electric light undertaking was held at Worcester on April 6th by Major-General Crozier, R.E. Mr. W. Geipel attended on behalf of Mr. W. H. Preece and explained the scheme, afterwards conducting the inspector over the site acquired by the Corporation for the central station, Penrith Mills, about two miles from the city. It is estimated that the maximum water power available at the fall is 1,500 H.P., and turbines for upwards of 600 H.P. are to be at once erected. This scheme, as it progresses, will be watched by the profession with much interest. It is anticipated that current will be supplied early next year.

BOOKS, &c., RECEIVED.

"Elements of Physics." By H. S. Carhart, M.A., and H. N. Chute, M.S. (Boston, U.S.A.: Allyn and Bacon). 380 pp., 8vo.

"Proceedings of the Royal Society." Vol. LII. No. 319. (London: Harrison and Sons).

"Alternating Currents." By F. Bedell, Ph.D., and A. C. Crehore, Ph.D. (New York: W. Johnston and Company). 320 pp. Demy 8vo.

"Leçons sur l'Electricité." By Eric Gerard. (Paris: Gauthier-Villars et Fils). Two vols. Third Ed. 630 pp. 8vo.

Journal of the Iron and Steel Institute, 1892. (London: E. and F. N. Spon.) 600 pp., 8vo.

"Die Elektrischen Leitungen." By J. Zacharias. (Vienna: A. Hartleben.) 245 pp., 8vo.

"Fundamental Theorems of Analysis." By Alex. Macfarlane, D.Sc. (Boston: J. S. Cushing and Co.).

"The Imaginary of Algebra." By Alex. Macfarlane, D.Sc. (Massachusetts: The Salem Press).

"Dynamos, Alternators, and Transformers." By Gisbert Kapp. Illustrated. (London: Biggs and Co.) Price 10s. 6d.

"Electrical Measurements and other Advanced Primers of Electricity." By E. J. Houston, A.M. (New York: W. J. Johnston Company.) 420 pp. 8vo.

"Formulaire de l'Électricien." By E. Hospitalier. (Paris: G. Masson.) Eleventh annual issue.

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COMPANIES' MEETINGS & REPORTS.

City of London Electric Lighting Company (Limited).

The third ordinary general meeting of this Company was held at Winchester House, Old Broad-street, yesterday, under the presidency of Sir David L. Salomons, Bart.

The SECRETARY (Mr. J. Cecil Bull) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: Every meeting of this Company I regard as adding a fresh chapter to the history of the lighting of the City by means of electric energy. It is, after all, nothing more or less than a series of events that form a history, which no doubt will be remarkable in its way when we get to a conclusion of it, as has been the history of the companies that have gone before it. In the case of the London Company you have a history which we have made use of, as other companies have done. That Company has paid penalties in creating its history which we shall try to avoid, but I have no doubt that we shall make errors, which cannot be avoided in dealing with a new state of things. We intend to put before our shareholders, not only in this room, but to those who are absent, the position of our affairs, and we shall furnish a report in which we shall give them all the information in our power. I do not believe in making mystery when it does not exist. There are always negotiations going on in companies which it is not wise to divulge until they are concluded. You have that in your private business just as much as in companies, but it is our desire that you should know everything possible that is being done. At the last meeting a set of accounts was issued which was criticised, though I will not say adversely. They were, however, only incomplete accounts, but still they gave you a general knowledge of what was being done with your money. The Board of Trade have certain forms which they require to be filled up at the end of every year to December 31st, and the accounts which we present in accordance with the form prescribed by the Board of Trade you have just taken as read. I do not know if the form could be improved or not, but it is the form prescribed by Act of Parliament. I think that, taking it all round, the form is understood by the majority of people. I am now going to make a few remarks which will give you the history and position of the Company up to to-day, as far as that can be done. A report can never contain what you can say in a few words. Before proceeding with these remarks I must express our great regret that we have lost a valued colleague, one who took the greatest interest in this Company, not only in the Board room but also outside. I refer to the late Duke of Marlborough. I expressed our regret on the last occasion that Mr. Charteris, one of our Directors, was then absent, and I regret to say that he is still an invalid, but we hope he will be amongst us again soon. Mr. Charteris has served his country well under arms, and I am sure you will agree with us in extending his leave of absence. Two of our Directors retire. They have to do so by rotation, and the two gentlemen who have offered to retire are Mr. Braithwaite and Mr. Reynolds. They have rendered such valuable services to the company that you will be asked, by-and-by, to place them on the Board again, as they are eligible for re-election. Mr. Braithwaite is now Chairman of the Brush Company. The fact that he is a Director of that company might, in the sight of many be considered a disadvantage in connection with his being on this Board as well ("no, no"). I did feel a little before the Company started that it would be disadvantageous for a gentleman who was connected with the contractors to be on the Board of this Company, but I have altered my opinion completely since then, for I have found that they have served your interests most faithfully, and the contractors are tied down in their agreements to us. As regards the officers, including the engineer and manager, our secretary, the engineer of buildings, and numerous other members of our staff, I cannot say more than this—that they have have worked extremely hard to promote your interests—much more than could have been expected from them for the pay they have received or that may be accorded them in the future. Statistics are very dry, I known, but at the same time I am going to trouble you with a few figures. When they appear in print you will have an opportunity of studying them and comparing them, and thus of seeing how far the Company has progressed or whether it has gone back. In the half-year ended December 31st last £96,000 was expended on capital account, made up as follows: Machinery and plant £16,070. The plant in position at December 31st last was sufficient in boiler power for 63,000 8-c.p. lamps, in engines and dynamos for 37,500 8-c.p. lamps, and in transformers for 36,000 8-c.p. lamps, with all necessary accessories. On conduits and re-paving (including £17,268 for telephone tubes) £34,044 was expended in the half-year; while on cables, house services, meters and sundry expenses the outlay was £16,900. The work carried out in connection with the last-mentioned sum includes 183,686 yards of ways laid in 24,810 yards of trench, and the cables reach a total of 32,455 yards high-tension and 24,633 yards low-tension. The public lighting absorbed £8,176; tools and plant £298, office furniture £245, management and general expenses £1,037, and on land and buildings the outlay was £19,169. This makes the total expenditure £95,939. That was to the end of last year. On April 12th we stood thus: Total ways laid by the Company, 427 miles; cable drawn high-tension 60½ miles, and low-tension 35½ miles. The number of lamps applied for during the six months ended December 31st last was 21,000 8-c.p., and the number connected up during that period was about 8,400. The additional plant which is now down has enabled the Company to connect 18,000 lamps since the beginning of this year, a result which is very satisfactory. The total number now supplied from the Company's mains is 38,200. It must be borne in mind that the supply of current until now has been a source of great anxiety. The demand has been continuous, and we are still running off the pioneer stations which the Company took over when it was formed. In order, however, to get over some of our difficulties we have ordered, and are now running, two large half-units, each of which supplies over 6,000 8-c.p. lamps—that is, between 12,000 and 14,000 extra 8-c.p. lamps can be supplied more than when the pioneer station was running by itself. These are now assisting that station, and have removed a great deal of trouble with which we had to contend. Everyone was grumbling because he was not put on first, but that state of things is sobering down gradually. These half-units are driven by ropes, but the permanent machines will be worked by direct ribbon. The Board have made a contract with the Brush Company, to the effect that when these two machines are not required any more they can be taken out, and they will be replaced by direct-ribbon machines. There are some very large units on order now from the Brush Company and from the Laing, Wharton and Down Syndicate. Of the two first great units in course of construction by the Brush Company, the first one is completed, and has been tested at the works by the contractors. The final results are not yet known to us, but it ran very well as far as could be judged at the time. In about six weeks this large unit will be running at our station, or ready to run. The second and third units are well advanced in their manufacture. These machines will each give a current to supply about 14,000 8-c.p. lamps. The Laing, Wharton, and Down Syndicate are to supply two large units, which I understand are now ready in America. They have been made there, and that accounts for some delay, but we hope shortly to have them landed at our works on the Thames. We are making every endeavour, so that by the end of the year we shall be able to supply 130,000 8-c.p. lamps, if not more. I think that the great difficulties have been got over in this Company. After mature consideration, the Board came to the opinion that it would be desirable to give up the station at Wool Quay. It would have been a very expensive station to construct, and we should have had to incur considerable expense in keeping the place dry. There were, in fact, great risks and expenditure to be faced in continuing that station, and it would also be inconvenient, and certainly not economical, to have a double staff—one at Bankside and the other at Wool Quay. We therefore came to the conclusion that it was more economical to have this station by the side of the existing station at Bankside. The buildings are being erected in sections, so that one section after another may be built as the demand upon us increases. It is no use building up a great station some four times larger than you require, and it would be loading your capital if we did so. It is much better to go on meeting the demands gradually. A number of the new wires do not meet the specification required, and, as you know, a great many hesitate putting in the electric light until they see what the experience of their neighbours is. I have no doubt, however, that in another year the results shown will surprise many of you, judging what has taken place at the West End and in the rest of London. One section of our building is practically completed and partly in use, and another section will very shortly be finished. There are a few diagrams on the wall, and I desire to call your attention to one of them in particular. We requested our engineer and manager to draw up a area diagram showing graphically how our capital was divided up. Such a diagram tells you more than the most elaborate and eloquent speech or the most carefully audited accounts, for you have the whole concern under your eye at a glance. You will observe two area diagrams: both illustrate the same point, but they are drawn upon a different plan. In the one, the oblong is divided up into partitions, and in the other, every partition is made with an equal base. Some gentlemen are accustomed to one kind of diagram and some to the other, and in order to meet the two cases it was thought desirable to give two representations of the same thing. The Chairman then pointed out the chief features to be learned by an inspection of the diagrams, adding: The whole of the area represents our capital authorised of £1,200,000. A large margin is left for the purchase of land, buildings, plant, machinery, and transformers. On the other hand, you will observe that nearly the whole of the estimated expenditure for placing conduits under the streets has been made. In other words, we shall shortly be in a position to supply every place in the City, and I hope in Southwark also, but the latter district is a very small affair. We hope, however, before long to have Southwark in the same condition as the City, but we only got the Provisional Order for that comparatively recently. Of the cabling to be done a large amount remains. This, however, is only natural, as the cables will be drawn into the conduits as the demand requires, a very short space of time being necessary for this operation. The same remarks apply equally to the meter service, &c. The lamp-posts in the streets, with a few exceptions, are completed. As regards the lesser streets, there is a difference in the contract as between the main thoroughfares, which are now practically completed. The difference is that in the main thoroughfares the lighting is by the arc system, and the lesser streets it was proposed should be lighted by incandescent lamps. We were to light the main street straight away, but as regards the lesser streets we had to wait until we received orders to light them. At the present moment two of the lesser streets are being prepared for the City Commissioners to see, and if they approve of the lighting we hope to get authority to proceed with these streets. I would like now to say a few words with respect to telephone tubes. This is a question of great importance to all London, and a great deal has been said in the papers on the subject from time to time. When the Company was formed, power existed for laying any number of spare tubes—we could lay as many as we wished. The Company knew at that time that Parliament would shortly be asked to give facilities for the laying of telephone tubes underground, and the Board were rightly informed in this respect, because a very short time after that—last year—an Act came into force enabling the electric lighting companies to lay tubes for telephone companies or to lease spare tubes they might have. The Directors were too well aware of the enormous inconvenience which the public must suffer during the time the trenches are open in the street, the traffic being impeded, and foot passengers being obliged to take to the road. In fact, no one blesses the Electric Lighting Company when they are operating in the

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streets. You have only to picture to yourselves what would occur if, after pulling up the streets for our purposes, they had to be pulled up a second time. We hesitated to take such a responsibility, and we therefore laid in a very large number of spare tubes, believing that they would be required in a very short time. They were laid in not only with the desire to spare the City a great deal of trouble in the future, but they were laid in also with the knowledge of the City Commissioners. When the Act of Parliament was passed it became necessary to see if we could not utilise these spare cables. We had a provisional or informal agreement with the New Telephone Company with regard to these tubes. The agreement could be completed for their use to draw in the twin wires, but this could not be done without the consent of the City Commissioners, the Post Office, and the Board of Trade. So far, we have failed to get the consent of the City Commissioners, and I regret this very much. The whole of the lighting of the City has been done in a satisfactory manner, and at all events there has not been much to complain of, and if our temporary arrangements are so good, I think that the permanent ones which will shortly come into play will enable us to beat the other companies, or, at all events, to be equal to the best of them. Any income that may be derived from these telephone tubes will not go into the shareholders' pockets directly, though, no doubt, it will do so indirectly; but it will assist in bringing the sliding scale for the price of current into force at an earlier date. Your Board would not be true to their trust if they attempted to lower the price of the current in the City before they saw that your interests would be secured, and any facilities which the City Commissioners may give us to make the Company a success and allow us to reduce the price, will not only be benefiting you as shareholders (which, after all, is not their business), but the very people they look after in the City. As regards the telephone tubes again, there exists now underground a complete system, and they have been laid at a price very much lower than could have been done had we waited until we were asked to put them in, for the reason that when the trenches were open all the tubes were put in at once. This saved a great deal of expense and avoided a very considerable amount of inconvenience to the traffic. There is a complete system now underground, as I have said, which will enable a most efficient telephone service to be given. I trust that the time will not be long distant before the City Commissioners may say that these tubes may be used. Meantime, they may not be aware that the overhead wires are being doubled—a proceeding greatly to the disgrace of London and the danger of the public, and if it goes on as in the early days of electric lighting there will be a great outcry, great expenditure, and a vast amount of inconvenience. Although the Commissioners have not met us on this particular point, they have given us facilities which in other ways have enabled us to supply the current to the satisfaction of most of our customers, and for this we are very grateful to them. There are some persons who imagine that our Board have been very slow in getting on with this work. It will, however, be two years next August when this Company first came into existence. Now, the first six or eight months is practically lost by a company in settling plans, but since then very great progress has been made, as you see by the plans and diagrams here. As regards the permanent machinery, special machinery had to be made and put down. This is now all done, the plant is all down, and these big machines are being turned out as rapidly as could be expected. There has been a good deal of difficulty in purchasing a large number of small bits of land, and this has caused delay. Besides all this we have had the London County Council, the City Commissioners, Local Authorities and others to deal with, but one delay after another has been got over. It is suggested by your Directors that since the Board of Trade requires a special form of accounts to be delivered once a year—to December 31st—it will be convenient for the Company to issue their accounts yearly in accordance with this form. We propose to adhere, therefore, to this form in the future, and to hold half-yearly meetings in order that you may know what is going on. A great deal takes place in this Company in the first six months of the year, and you will like to have half-yearly meetings to know the progress that has been made. At that half-yearly meeting, however, there would be no accounts issued, as that would entail a great deal of work and it would not be satisfactory to you. We propose, therefore, to issue the accounts in full in accordance with the Board of Trade form, as on the present occasion, and to hold half-yearly meetings as soon as possible after January and July, if we cannot do so in those months. These are all the remarks which I have to offer beyond any information that I can give you afterwards in reply to questions. I now beg to move—

"*That the Directors' report and statement of account and balance-sheet to the 31st of December, 1892, be, and the same are hereby, received and adopted.*"

Mr. J. B. BRAITHWAITE, jun., in seconding the motion, said that the progress which they had made, in view of all the circumstances which the Chairman had brought before them, could hardly fail to be satisfactory to them. When it was considered that in undertaking the electric lighting of the City of London they were undertaking, probably, the largest task of the kind ever undertaken by a private company.

In answer to Mr. CUTCLIFF, the CHAIRMAN said that each lamp had earned practically 14s. a year, so far. The average number of lamps connected in the six months ended December 31st last was 15,000.

Mr. GEORGE HERRING said he thought that the reference by the Chairman to the source of revenue they had in the telephone might be misunderstood. The Chairman stated that this revenue would not go directly into the pockets of the shareholders. He (the speaker) concluded by that that this revenue would only help in the future lowering of the price per unit.

The CHAIRMAN, in answer to other questions, stated that the contract with the City was for 21 years, but it could be terminated in 7 years. It did not at all follow that because there was a loss now on the public lighting there would always be a loss on it. They lost at the outset on the private lighting.

The resolution was then carried unanimously.

On the motion of the CHAIRMAN, seconded by the Earl of SUFFOLK and BERKSHIRE, and supported by Mr. B. H. VAN TROMP, the retiring Directors were re-elected, as were also the auditors, Messrs. W. H. Pannell and Co.

The CHAIRMAN, in answer to a further question, stated that the presentation of half-yearly accounts would cause many difficulties, but figures would be given at such meetings, and there was nothing to prevent the declaration of half-yearly dividends.

Mr. HERRING then proposed a vote of thanks to the Chairman and Directors. He pointed out that it was very easy to pass such a vote when Directors paid good dividends, but he reminded them that Directors really had more work to do when a company was not earning dividends. He, therefore, thought that the Directors should be all the more warmly thanked for the work they had done, and what they still had to do. He did not think it was thoroughly understood that from January 1st the Company had been earning a fair and good profit, and when they considered that that was upon an average of from 20,000 to 25,000 lamps, and that they hoped eventually to supply nearly 400,000 lamps, he did not think the shareholders need have much doubt of their future. Then, they had not been benefited in the half-year by the revenue to be obtained from the telephone tubes; and as regarded the public lighting, they need not anticipate the continuance of loss. He might also point out that in connection with each of the public lights, a great part of the work that was done would have to be done for the private lighting. The loss, therefore, was not so absolute as might appear.

Mr. JOHN NEWTON seconded the motion, which was carried unanimously.

The CHAIRMAN, in acknowleding the vote, said that he never liked to state anything that might lead to speculation, but if he had desired to do so, he could have made statements which would have made things look very much more *couleur de rose*. He added that every pound that would now be spent would bring in revenue.

The proceedings then terminated.

Metropolitan Electric Supply Company (Limited).

The following is the report of the Directors, to be presented to the sixth ordinary general meeting, to be held at Winchester House, E.C., on Friday next, the 21st inst., at 12 o'clock:—

The capital expenditure, which at the end of 1891 amounted to £486,926, now stands at £550,859. 16s. 11d. This increase is chiefly due to the laying of additional mains, and to the works in connection with the new station at Paddington, which, it will be remembered, was not contemplated in the original estimates. For the purpose of completing the Company's present system it will be necessary to issue the balance (£50,000) of the £100,000 debentures already authorised.

The gross revenue for the year amounted to £54,571. 19s., as against £43,747. 1s. 3d. in 1891, or an increase of £10,824. 17s. 9d. It will, however, be remembered that the revenue of that year included a special item of £3,027. 1s. 3d. paid by the contractors. The actual increase, therefore, amounts to £13,851. 19s.

The balance to the credit of the revenue account, before providing for depreciation, is £18,168. 1s. 1d. The Directors have set aside £4,000 as a Depreciation Fund, carrying to the credit of the net revenue account the sum of £14,168. 1s. 1d. which, with the balance brought forward from the last account, and other receipts, makes a total of £15,144 11s. 3d. After deducting bank charges, debenture interest, &c., there remains a balance of £12,558. 18s. 1d., of which the Directors have appropriated £1,000 in reduction of the preliminary expenses account, which will now stand at £4,052. 10s. 4d.

The Directors recommend that a dividend of 4s. per share be now paid, which will absorb a sum of £9,980, carrying forward the balance of £1,578. 18s. 1d. to the next account.

A comparison of the present revenue account with that for 1891, will show that the Directors' anticipations as to the increase in percentage of net profit are being fulfilled, and they look forward with confidence to a continuous increase in the proportion of net profit to gross revenue in the future.

The number of 8 c.p. lamps supplied by the Company, which at the end of 1891 was 82,000, increased during the year 1892 to 124,000. The number at the present date amounts to 134,453. It will be noticed that the rate of increase is constant, and the applications continue to show steady progress.

The generating station at Paddington is completed, and in regular and satisfactory operation. A report from the Company's chief engineer to the effect that the stations, machinery and plant are in a satisfactory condition is attached to the Directors' report.

The Directors have appointed Sir Eyre Massey Shaw, K.C.B., to a seat on the Board. In accordance with the Articles of Association the following Directors, viz.:—Sir John Pender, G.C.M.G., M.P., Sir James Anderson, and Sir George Elliot, Bart., retire from the Board, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths and Co., retire, and offer themselves for re-election.

The Telephone Company of Egypt (Limited).

The tenth ordinary annual general meeting of this Company was held on Tuesday, April 11th, at the offices of the Company, 14, Austin Friars, so that the Directors' report and the accounts for the year ended December 31, 1892, might be submitted, a dividend declared, and the ordinary business of the Company transacted.

General Alexander Fraser, C.B., R.E., the Chairman of the Company, presided.

Mr. ALEXANDER B. CHALMERS (the Secretary) read the notice calling the meeting.

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The CHAIRMAN said: Well, gentlemen, as the report has been issued to all the shareholders, I presume you will take it as read. Well, gentlemen, I have not much to say to you beyond what is stated in the report, and I think there is no need to go into detail respecting the irregularities of the late representative of the Company at Cairo, beyond saying that Mr. Begni, the said representative, has disappeared from Egypt, and the Directors are consequently prevented from taking any criminal proceedings against him, and they feel bound to write off—as stated in the report—those losses. We then thought it necessary to depute our able secretary, Mr. Alexander B. Chalmers, to go to Egypt to inquire into matters connected with the irregularities, and with the consent of the chief shareholders he was employed there about a month, with the satisfactory result that, from his report, the Board has been able to put the management on what it hopes will be a safer basis by the introduction of new blood, in placing Mr. Evans our general manager at Cairo, which is now the seat of Government and is more promising in respect of extension of business than Alexandria now is, and by the introduction of certain safeguards in respect of the local control of the business by Mr. Chalmers. Then Mr. Chalmers also suggested certain improvements in the construction of the works at Cairo, which the Board has thought it well to adopt, and, on the whole, the Board is of opinion that the result of Mr. Chalmers's deputation to Egypt has been highly satisfactory, while through him the Board has been brought more directly in communication with its *employés* in Egypt. I do not think that I have anything more to say. I shall be glad to answer answer any questions that any shareholders may desire to ask, and I will now move:—

"*That the report and accounts for the year ended December 31, 1892, be, and are hereby, approved and adopted, and that a dividend of 6 per cent. be declared on the preferred shares, free of income tax.*"

Mr. THOMAS LLOYD: I beg to second that.

No questions were put, and the resolution was carried unanimously.

The CHAIRMAN proposed the re-election of Mr. Thos. Lloyd as a Director, which was seconded by Mr. HENRY GREWING, and carried unanimously.

The auditors, Messrs. Price, Waterhouse, and Co., were also re-elected, and a vote of thanks to the Chairman terminated the proceedings.

The following is the report of the Directors referred to above:—

The revenue account for the year ended December 31st last, shows a balance to credit of £4,079. 3s. 4d., after providing for interest on debentures; and including the amount of £1,414. 17s. brought forward from 1891, there is a balance for disposal of £5,494. 0s. 4d. This the Directors propose to deal with as follows:—To pay a dividend of 6 per cent. on the preferred shares, free of income tax; to appropriate £426 7s. 4d. in reduction of capital expenditure and depreciation of stores; and to carry forward £1,446. 7s.

The Directors regret to report serious irregularities on the part of the late agent at Cairo, who had been in the employment of the Company for about ten years. The losses consequently sustained, being in the opinion of the Directors irrecoverable, they decided to deal with the matter at once by writing them off; but for these losses, the result of the year's working would have been more favourable. The head-office of the Company in Egypt has since been removed from Alexandria to Cairo, with Mr. Evans in charge, and it is hoped that the other arrangements which have lately been carried out in connection with the management and control of the business will lead to increased prosperity.

The gross revenue of the Company on January 1st last was £12,225, and the total number of lines, exchange and private, 1,138. The increase of business for the first quarter of the current year has been fairly satisfactory.

Eastbourne Electric Light Company (Limited).

The annual general meeting of the shareholders of this Company was held at Eastbourne on Thursday last week, the Mayor (Alderman George Boulton, J.P.), who is Chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report (which appeared in our last issue), congratulated the shareholders upon the fact that the Company was progressing, and that the Directors could at last offer them a dividend on their shares—not a large one, but one they were likely to improve upon. The number of 10 c.p. lamps actually fixed was 7,667, and they had on order 353. The number of 10-c.p. lamps fixed last quarter was 623, the approximate value of the installation work done during that period being £605. They had a total of 10¼ miles of circuit. It was proposed to move in the direction of Upperton, whose residents wanted the electric light, but the expense would be about £6,000, to provide for which the Directors must, of course, obtain fresh capital. He would not go into details in regard to the future, but congratulated them on the dividend they were enabled to declare, and for which the shareholders had waited patiently 12 years.

Mr. J. G. LANGHAM, in seconding the motion, said that the Company was not instituted originally with a purely commercial motive, but with the hope of promoting the benefit of the town and advertising it effectually to the outside world. Commercial interests, although not foreign to the consideration of the shareholders, was certainly a secondary matter. Therefore they had none of them grumbled very much so long as they were effecting that primary object, the advance of Eastbourne, and they had been content to wait for a dividend until now. At the same time, the Directors could not forget the interests of the shareholders, and it was an immense satisfaction to find that, after sticking to the concern all these years, they had brought the Company to that state which allowed of a dividend being paid.

The motion having been carried unanimously, the Chairman was re-elected a Director, and the auditors were re-appointed; and £100 having been voted to the Directors for their services, the meeting closed with the usual complimentary resolutions.

Bournemouth and District Electric Supply Company (Limited).

The second annual general meeting of this Company was recently held at the offices, Bournemouth, under the presidency of Mr. Aymor H. Sanderson.

The CHAIRMAN, in moving the adoption of the report and accounts for the year ended December 31st, said that the Directors considered they had every reason to be well satisfied with the progress made by the Company during the past year, the result of the year's business showing a net profit of £327. 18s. 7d. The development of the Company's business was specially marked during the latter half of 1892, the larger portion of the 3,438 lamps added during the year to the Company's mains having been connected during that period. The number of lamps now connected was equivalent to 9,700 lamps of 8 c.p. Careful attention had been given to the details of the business, and the system of management had be enthoroughly overhauled and rearranged. It was hoped and believed that the station would be worked still more economically in the future, and would show further improvement as well as earn increased profits during the year 1893. Considerable additions and extensions had been made during the year to buildings, machinery, and plant at the lighting station. With regard to the issue lately made by the Company of £10,000 Six per Cent. First Mortgage Debentures, he was glad to inform the shareholders that £7,250 had been already applied for and allotted, and he had no doubt the remainder would be very soon taken up; these were actually mortgage debentures forming a first charge on the whole of the property of the Company, and they could not place any prior charge in front of them.

The Directors' report and accounts were then approved and adopted; and the retiring Directors and the auditors having been re-elected, the proceedings terminated.

Hastings and St. Leonards-on-Sea Electric Light Company (Limited).

The annual meeting of this Company was held on Friday, at Hastings, Mr. H. M. Baker presiding.

The CHAIRMAN, in giving a short retrospect of the history of the Company, said there was a time when they were opposed and laughed at; notice was given them by their bankers to pay off their mortgage; the Gas Company threatened to have a writ issued unless their unfortunate Chairman became personally responsible for the amount owing to them. Against all those things in the past, they now had the best public and private lighting business of any provincial town in England; they had got machinery which was second to none; they were one of the best customers of the Gas Company; they had reduced their mortgage from £4,000 to £3,000; and their bankers were pleased to take 4 per cent. interest instead of 5. Last, but not least, the Town Council were then confirming an agreement entered into by the Corporation with the Company for lighting the whole length of the front line with electricity. He alluded to the sad death of Mr. Mercer, their late manager, and said that while suggesting that £50 be voted towards the fund being raised for his widow and family, the Directors left the matter in the hands of the shareholders. He then moved the adoption of the report, which having been seconded, was carried, with the substitution of £75 for £50 for the Mercer fund.

The retiring Directors and the auditors having been re-elected the proceedings terminated.

The following is the Directors' report alluded to above:—

The Directors regret that some delay has taken place in issuing the report and balance-sheet for the past year, which is due to their having to wait for the accounts to be audited by the Board of Trade in accordance with the Provisional Order.

The sad death of the late engineer and manager (Mr. E. T. Mercer) is deeply regretted by the Directors, who had the highest opinion of the value of his services. He has left a widow and four young children unprovided for, and the Directors feeling that the shareholders would desire to recognise the valuable services rendered to the Company by the late Mr. Mercer propose to submit a resolution to vote the sum of £50 towards the fund being raised for the benefit of Mrs. Mercer and her family.

The past year has been one of steady progress in the prosperity of the Company, and the additional machinery which has been provided and which can be worked with greater economy of fuel, as well as the increase in the number of customers, must ensure satisfactory results in the future.

The accounts show that after paying all working expenses, and charging to that account repairs, interest on mortgage and debentures, there remains a net profit of £755. 8s. 2d., including the balance brought forward from the last account. The Directors propose to pay out of this sum a dividend of 5 per cent., which will absorb £569. 2s. 11d., leaving a balance of £186. 5s. 3d.

Messrs. F. J. Parsons and F. Noakes retire from the directorate by rotation; they are eligible, and offer themselves for re-election. The auditors, Messrs. Hart Brothers, Tibbetts, and Co., also retire, and offer themselves for re-election.

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Elmore's Patent Copper Depositing Company (Limited).

An extraordinary general meeting of this Company was held on Friday, at Cannon-street Hotel, E.C., to receive the report of the shareholders' Committee appointed on the 16th ult., and to take such action thereon as might be deemed advisable. Mr. J. J. Atkinson presided.

Mr. TODHUNTER (the Chairman of the Committee) stated that they had received every assistance from the Board and managers of the works in investigating the Company's affairs. They had investigated the affairs of the Company so that no part of its past career had been passed over. The Committee's report is as follows :—

We find that the promoters took the lion's share of the money paid for the purchase of patents, &c. ; that the vendors' shares were divided practically between the present Directors (excepting Messrs. Hooley and Johnson) ; that, in fact, the Messrs. Elmore have received only a very small proportion of the purchase price, either in money or shares. We find that the sale of the licence to the Wire Company gave a net sum of £103,675. 10s. 9d. to this Company, of which only £20,000 was written off the original purchase money, and £70,000 divided in a dividend of 50 per cent., the then Directors taking a sum of £3,930. 13s. 1d. as their share of the profit. (Altogether the Directors have been paid £9,182 2s. 11d.) We consider that it was most imprudent and suicidal to distribute this large sum, which, in our opinion, was wrongly credited to income. We find that the Company in 1890 entered upon a land speculation, purchasing Haigh Park for £67,887. 16s. 8d. This transaction has helped, naturally, to hamper the finances of the Company. We find also that £11,938. 9s. was expended in the market purchase of shares in the Wire Company, presumably to bolster up the market, and that this is treated as a good asset in the balance-sheet, although the shares cost about £4 each.

We find that the defects in the engines, the leakage in the tanks, and the difficulties with the iron mandrels were the main causes of delay in the manufacture.

The Committee find that there are present liabilities of £7,327. 14s. 3d., besides a mortgage of £35,000 on the land, and a contingent liability of £1,000 on an acceptance of the Wire Company, discounted at the rate of 20 per cent. per annum. There is also a sum of £4,000 required to complete the needful machinery, and a further sum of £1,600, unless the buildings, &c., used jointly with the Wire Company continue available.

There is (by the works account) a stock of finished tubes of a sale value of £5,559. 4s., and of raw copper in the tanks, &c., of £2,487. 11s. 10d., together £8,056. 15s. 10d. We saw tubes in every stage of manufacture, and they appear perfect in every way. We examined into the orders received and those executed, and were gratified in finding that customers come again with frequency, and that there seems always a sufficiency of orders on the books for more than the present output. There has been produced since July 1, 1892, only 102 tons of tubes, and, by the detailed accounts rendered of cost and prices of sale, there is apparently a gross profit of about £14 per ton on the manufacture ; but, as this is at the rate of only about 1½ ton per week, the cost is naturally much more than it would be were the factory working up to its full capacity. At present the outturn looks like three tons per week, and it is stated that the present tanks at full work will produce 20 tons per week. The machinery was being worked by electric motor (during the temporary removal of the engine owing to a giving way of the foundation), so that we were unable to make any investigation on this point.

We believe that Messrs. F. Elmore and S. Elmore's services are of great value to the Company. They have held all shares allotted to them and increased their holdings, and we may say that all the Directors have fully retained their original interest in the shares of the Company.

In conclusion, we are strongly impressed with the value of the business, and advise that a strong effort should be made to provide the means for carrying it on. We deem it advisable that a new Board of Directors (preferably local men) be found to conduct the the affairs of the Company, composed of men of good business capacity (including one engineer) ; otherwise, that it would be needful, with a London Board, to have a managing engineer at Leeds, who would carry out their views and report constantly to them on the state of the work and the finance of the Company.

We think that the needs of the business would be fully met by a sum sufficient to clear off liabilities and give a clear £10,000 for the purchase of raw copper, say £17,000 in all. This being done, we think that a satisfactory and profitable business would be quickly established, with, as a result, the reinstatement of credit and clearing away of future difficulties.

We think that the launching of the Wire Company was a great mistake, and established a false financial position ; also that the prices of the licences and of the land sold to the Wire Company were unreasonable, and not justified by any evidence or examination, being practically a transfer from one Board to another Board consisting of nearly the same members.

One means of raising the required capital is the issue, as Ten per Cent. Preference Shares, of the 8,800 unissued ordinary shares, such shares to be cumulative as to dividend and preferential as to capital ; and this commends itself to us rather than other expedients which would deprive the shareholders who are willing to subscribe of their first pull at the profits.

With regard to the land, we advise, upon the authority of Mr. Gore—than whom there can be no better judge—that certain portions be put up for sale at once and disposed of, so as to relieve the Company of the charge of interest on the mortgage.

Mr. TODHUNTER added that either the shareholders had to find the money, or the Company would have to go into liquidation. He believed the business was a good one if conducted on sound principles.

The SECRETARY having read reports by Messrs. Jones and Davidson on the engineering works, by Mr. Gore on the land, and by Messrs. Ford, Rhodes, and Ford on the accounts, in verification of the statements in the Committee's report,

The CHAIRMAN said that none of the present Directors were the promoters of the Company. As to the third paragraph in the report, at the time the dividend was paid the Company had what was thought an abundance of working capital, and the dividend was passed at the general meeting of shareholders almost unanimously, and it was thought by all concerned that there would be no difficulty in earning another 50 per cent. during the twelve months which followed the payment of the dividend. As to the amount being credited or not to income, the Board was advised by its technical experts and accountants. As to the amount which was paid by the Copper Company for the Wire Company's shares upon the market being set in the balance-sheet as a good asset, he read a letter from Messrs. Price, Waterhouse, and Co., drawing attention to their certificate appearing on the Company's last accounts, which said that the accounts were correct, "subject to provision for any depreciation which may have arisen in the value of the patents (to the account of which the laboratory salaries and expenses have been carried) and in value of the investment in the shares of Elmore's Wire Manufacturing Company (Limited)."

In reference to the sum of £9,128. 2s. 11d. set down as having been paid to the Directors, the CHAIRMAN said that this sum had been divided over a period of three and a quarter years amongst eight Directors, and it included the sum of £3,930, which was the Directors' share of the profits upon the dividend actually paid to the shareholders, so that that worked out, excluding the share of the profits, to some £200 a year each. Since the date of the last report and statement of accounts, during which time the Company has been in a financial strait, the Directors have served without payment in any form. As to the land, he had at various times explained why the Company became the purchaser of its estate. He however, briefly recapitulated the circumstances, and said he was sure that, after mature consideration, and in view of the future requirements and development of business by the granting of licences for the application of the process for purposes outside of tube-making and the manufacture of sheet, it would be seen how very valuable the estate would be to them as a parent company. The Copper Company's liabilities were covered by the present stock of manufactured and raw copper and the customers' book debts. The Company had been actually making profit after payment of works charges since the date of the June report, although its output had been exceedingly small, owing to want of raw material, and he quite agreed with the Committee that when the factory was working up to its full capacity the present cost per ton would be naturally greatly reduced. That was, in fact, the point of the whole business. There was a certain fixed charge below which they could not go, and every ton of output over and above that which was necessary to cover this charge showed a large clear profit. The Directors agreed with the Committee that a sum of £17,600 additional capital would be sufficient to meet all future requirements for this business, and that this would enable them to pay for £10,000 worth of additional raw copper, which would allow them to turn out twenty tons per week. They adopted the suggestion of the Committee to issue the remaining 8,800 ordinary shares as preference shares. It was, of course, important to them to have the money immediately, and he ventured to say that there would be no difficulty in placing the small number of shares. In conclusion, he said that, notwithstanding all the difficulties and delays of the past, they had a sound and profitable undertaking in their hands, and now that the commercial working of the process had been established with certainty, future success was assured, provided that they had the necessary raw material to enable them to execute the orders of their customers. The Chairman then proposed

"That the 8,800 unissued ordinary shares of the Company be issued and be called preference shares, entitling the holders thereof to a cumulative preference dividend of 10 per cent, per annum, the said preference shares to have preference not only as to dividend, but as to capital in the final distribution of assets."

Mr. TODHUNTER seconded the resolution, which was carried unanimously.

Mr. ELMORE proposed :—

"That the Committee of shareholders, consisting of Messrs. J. Todhunter, A. Pritchard, Squire, and Owen Jones, be continued as a consultative committee, to co-operate with the present Board in making an issue of the new capital referred to, with power to accept the resignation of all or any of the present Directors, and, in conjunction with the present Directors, to nominate new Directors, and generally to advise the Board and report to a future meeting, to be called on the 28th inst."

Mr. HAYS seconded the resolution, which was carried unanimously.

A vote of thanks was then given to the Committee, and the meeting separated.

Elmore's Wire Manufacturing Company (Limited).

An extraordinary general meeting of this Company was subsequently held to receive a report of the shareholders' Committee appointed on the 16th ult., Mr. J. J. Atkinson presiding.

The Committee's report was as follows :—

"We find that an excessive price was paid for the licences, which, moreover, were accompanied by restrictions and royalty ; that the land was charged to the Company at double its cost price ; that the works have been well built, but out of all proportion to the means of the Company; and that capital has been expended both upon land, buildings, and plant, without any regard to prudent financial considerations. Consequently, three-fourths of the buildings would be practically unused, even with an output of 35 tons per week. The engines and chimney are magnificent, but far beyond any probable requirements. We believe that there is no doubt at all about the efficacy of the process, or that the difficulties

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of manufacture have been overcome, and we think that there is a demand for the copper strip produced at a highly remunerative price, if the production is on a large scale. The mandrels being uniform in size, there is great simplicity in the working, once the routine arranged. This seems to us to accentuate the folly of erecting at the outset works of such enormous size, as there would have been no difficulty whatever in making additions. The accounts show liabilities £21,963. 7s. 10d., all of the most pressing kind. Expedients have been adopted, we hear, by the Messrs. Elmore to stave off proceedings, but it is evident that a settlement must be made, or the property will go out of the control of the Company. The reasons which have led up to this condition of affairs are patent from the foregoing statements, and it remains to be considered whether money can be raised, not only to meet the liabilities, but to buy sufficient raw material. We find that a sum of not less than £50,000 would be required, and that the efforts of the Directors have failed to bring an offer of more than £17,000 from those to whom they have applied for assistance, offering the security of the whole property, and these offers, in our opinion, were on ruinous terms. So it resolves itself into a question of the shareholders finding the money, or the Company being liquidated. We certainly believe that there is every prospect of success under prudent management; and if the shareholders decide on raising the money, it would, in our opinion, be in their interest to have a small Board of Directors of men of business ability and experience, who would be likely to manages the finance of the Company with prudence and economy. The inevitable alternative involves, we believe, the loss of the whole of the share capital subscribed, as under a forced sale the land, works, and machinery would not be likely to realise much more than enough to satisfy the creditors.

There is, however, another possibility by the raising of a sufficient sum to pay off the liabilities and complete the plant—say, £25,000 on debentures—and by the establishment of a Copper Supply Company, with a capital of, say, £25,000 paid up, to supply this Company with copper, together with the cost per ton for manufacture into strip, the Supply Company taking the finished strip and sheet and selling it to customers, and handing over to this Company the difference, after deducting their commission, the copper remaining the property of the Supply Company during the whole of the time. Obviously this would involve no risk to the Supply Company, and would furnish the Wire Company with raw material and working charges. We incline to advise the adoption of this latter proposal, for the following reasons :—

It necessitates only the raising of £25,000, instead of £50,000, by the shareholders, and provides good security (in the land, works, and plant) for the amount of debentures to be subscribed even in the event of failure.

The CHAIRMAN said that he had some notes to read in answer to the committee's report; but he thought he might save the time of the meeting by immediately proposing a similar resolution to that put to the parent Company.

The motion was seconded by Mr. J. W. DALE, and carried unanimously.

A vote of thanks to the Committee, and a recommendation to adopt their report, and "in view of the evident commercial success of the Elmore process" to promptly subscribe the new capital required, was carried.

Elmore's (French) Patent Copper Depositing Company (Limited).

The adjourned extraordinary meeting of this Company was held on Monday at Winchester House.

Sir JAMES MACKENZIE presided, and said that he had to begin by apologising for the absence of Major Jones, who was confined to his bed, and also for Mr. Carson, who had been unable to attend. The meeting was called in accordance with the decision arrived at at the last meeting, to consider further the prospects of the Company as opposed to the proposal of voluntary liquidation. It was considered by the minority that the only way to save the interests of the Company was by liquidation, but he did not think it was fully recognised or understood by those gentlemen who proposed liquidation what the effect of such a course would be in France. The Board knew, from what the French lawyers told them, that the interests of the shareholders and the debenture holders would be most seriously damaged, and they were quite certain that to attempt such a course at the present moment would be most disastrous. It was objected at the last meeting that the Board had nothing definite to lay before the shareholders, and therefore they asked for an adjournment, in order to see if they could not get further details. Mr. Duncan had just returned from Paris, and as he had been successful in obtaining some definite arrangement, he would call upon that gentleman to address the meeting.

Mr. DUNCAN said that he did his best to come to some arrangement with M. Sécretan by letter and telegram, but he found that that was impossible, and they were drifting further apart rather than getting nearer, and he therefore made up his mind to go at once to Paris. He had brought back with him something in the form of a definite proposal from M. Sécretan, which read as follows :—

"In presence of the present grave financial position, and with the object of avoiding an irremediable catastrophe, I beg to offer to undertake the following negotiation :—

"I propose to buy all the assets of the Company in consideration of the following :—

"1. £60,000 in First Mortgage Debentures, in payment of the present mortgages, entitled to receive £4,000 per annum interest, and sinking fund included.

"2. £20,000 in cash within three months, in order to pay off the creditors, £10,000 for the English and £10,000 for the French.

"3. £60,000 in founders' or ordinary shares, to be given to the English holders.

"I would raise a new capital of £100,000, of which £80,000 would be represented by cash and £20,000 by fully-paid shares, to be given to the French shareholders and founders. Of the £80,000 to be subscribed in cash, the right of subscription would be reserved to the present English shareholders up to one-half of the amount. If this proposal, which I only make with the object of saving the Elmore Company from a disaster caused by its financial position for which I am not responsible, is accepted, I have no doubt of being able to give effect to it. If this proposal is accepted, the present Company would be transferred into a French commandite company, under the name of E. Sécretan and Co. As soon as I receive your reply in this sense, I will have the articles of the new Company drawn up, and will submit them for your examination. It is understood that the payment of £140,000 above mentioned would entitle the new Company to all assets without exception or reserve, and that in consideration of this payment the present Company would have to make its own settlement for all liabilities without exception and reserve."

M. E. Sécretan in sending those new proposals undertook to get them accepted by his friends, subject only to the understanding that reasonable time should be given to give effect to the proposals, and also that he was furnished in the meantime with the means of keeping the factory going until the end of May, if necessary. In a subsequent letter M. Sécretan further stated that the Board of Supervision of the new Company would be composed of five members, of which two would be representatives of the English interests—one to devote himself to the business details of the concern, and the other to be, if possible, a chemical engineer, who would take up more especially the technical side of the business.

Continuing, Mr. DUNCAN said a certain time would, of course, have to transpire to allow of the examination of the documents in connection with the matter, and in the meantime the works must, of course, be carried on. Unless he, as Receiver, was prepared to carry them on in a much more enterprising way than had been the case up to that date, there must be some loss in keeping the factory going. The list of creditors in Paris had been larger than was expected on this side, and he had, therefore, increased the sum which he had allowed for the extinction of those liabilities from £8,000 to £10,000. There were also one or two other points with regard to the proposal to which he would like to allude. In the first place, the shareholders would remember that he represented that they would receive £60,000 in First Mortgage Debentures, entitled to 6 per cent. interest, which would produce £3,600. The people on the other side, however, understood that it was to be 5 per cent. interest and 1 per cent. sinking fund, but they had now agreed to give £4,000, which would amount to 5½ per cent. interest and ½ per cent. sinking fund. It was also proposed that they should receive 10 per cent. on the founders' or ordinary shares, but that went altogether against the grain of the finders of the new capital. He was glad to say, however, that they ultimately agreed to allow them 7½ per cent. The French had very substantial ideas with regard to reserve funds, and satisfactory reserves would be built up out of the profits of the Company. M. Secretan, under his original agreement with the Company, was entitled to receive 20 per cent. of the profits instead of salary, but that had now been changed to £800 a year and 10 per cent. of the profits. He was sorry to say that on this side they had not yet got rid of the creditor who was petitioning the Court, and the first necessity was to make some arrangement with regard to that matter, as it would be extremely difficult to keep the thing going in France if anything in the shape of liquidation should supervene here, and the appointment of the liquidator in France would stop all the work of the Company.

Mr. STETTELL said that at the last meeting the shareholders had two schemes laid before them—liquidation or the buying out by the French Company. He wished on that occasion to lay before them another alternative. The shareholders had received ample proof that the Elmore process could be worked successfully and with high profits, and the experts' opinions had shown the soundness of the Company's patents. He proposed that the Company should be wound up voluntarily with a view to reconstruction, and that a committee of shareholders should be appointed to draw up the prospectus of the new Company. In the scheme which he had to suggest the capital of the new Company would be the same as the old, namely, £243,782, and divided into preferred, ordinary, and deferred shares. Each holder of a £2 preferred share in the old Company would receive one £1 ordinary share in the new, and each holder of the £2 ordinary share would have one £1 deferred share in the new. The balance of capital, £121,891 in 10 per cent. preference shares of £1 each would be offered to the public, and there was, he thought, every reason to believe that the debenture holders would take up a part of that capital. He concluded by alluding in detail to the out-put of the works and the amount of dividend which might be expected upon the shares in the new Company.

Mr. STOREY, M.P., said that unless they did something that afternoon with regard to the petition against the Company, the position would be bankruptcy. He would like to know if the Chairman or Directors had any proposals to make.

The CHAIRMAN said that the Directors did not recommend liquidation, they suggested the alternative course as set forth by Mr. Duncan.

Mr. STOREY, M.P., said that the Court would take no more notice of an offer from M. Sécretan than they would of an offer from Mars. He proposed that the Directors and secretary should pay off the petitioner out of their salaries, as he thought that they were the only ones who had received anything from the Company. If they paid the one amount off every other creditor would take the same course. The Directors had been chosen by the Company, and were paid by the Company, and he considered that they ought to lay some proposal before the shareholders.

Mr. MADDISON said that he thought if the meeting were postponed till five o'clock he might be able to make some arrangement.

After some discussion several shareholders subscribed various amounts in order to delay the petition, and the meeting was adjourned.

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At 5 p.m. the proceedings were resumed, and Mr. MADDISON stated that he had been able to get the petition postponed for a month. There was another amount of £250 behind the first petition, and £64 behind that, but he was pleased to say he had been able to come to a satisfactory arrangement.

After some further discussion the following resolution was proposed by Mr. MADDISON, seconded by Mr. STOREY, M.P., and carried unanimously :—

"That this meeting taking favourable note of the proposal of M. Sécretan as reported by the Receiver, it is resolved that the meeting stands adjourned until May 8th at two o'clock, at Winchester House, and that a committee be appointed to confer with Mr. Baker as to the best method of carrying out arrangements with M. Sécretan, or otherwise doing what is best for the interests of the Company."

Messrs. S. Storey, M.P., J. Wood, J. Heal, F. Stettell and Colonel Shepherd were elected a committee.

Mr. STOREY, M.P., moved that a special extraordinary meeting should be summoned to be held after the adjourned meeting, which was carried.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

The following is the report of the Directors for the half-year ended December 31, 1892, to be submitted to the thirty-ninth ordinary general meeting, to be held at Winchester House, E.C., on Wednesday, the 19th inst., at 2 p.m. :—

The gross receipts, including Government subsidies for the half-year ended December 31, 1892, have amounted to £247,766. 19s. 1d., against £243,658. 8s. 10d. for the corresponding period of 1891.

The working and other expenses, including £38,103. 1s. 1d. for cost of repairs to cables and expenses of ships, absorb £91,768. 18s., against £74,314. 9s. 5d. for the corresponding period of 1891, leaving a balance of £155,998. 1s. 1d. From this is deducted £6,030. 8s. 3d. for income-tax, and £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, leaving as the net profit for the half-year £118,072. 12s. 10d., which, with £70,271. 1s. 9d. brought forward from the previous half-year, shows an available balance of £188,343. 14s, 7d.

One quarterly interim dividend of 1½ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on the 20th inst., making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1892. The balance of £75,843. 14s. 7d. has been carried to the general reserve fund, which, after being credited with interest received on investments, now stands at £509,732. 19s.

The alterations of tariff with the Australasian colonies, to which reference was made in the last report, came into force on January 1st last, and the result so far is encouraging.

Since the close of the half-year, the tariffs at the stations affected by the serious depreciation in the silver currency have also been adjusted, so as to avert, as far as possible, the loss on exchange from which the Company has so long suffered, and which during the past six months amounted to the large sum of £11,692.

In accordance with the provisions of the trust deed dated May 15, 1879, 353 of the Company's Five per Cent. Australian Government Subsidy Debentures, amounting to £35,300, were drawn by lot on the 6th instant for payment at par on July 1st next. The numbers of the drawn debentures are given on page 12 of the report.

The Company's maintenance ships have as usual been employed on various repairs during the half-year under review, but, owing to most of the cables being duplicated, the traffic has not been materially affected.

In accordance with the Articles of Association, Sir John Pender, G.C.M.G., M.P., and Sir James Anderson retire by rotation, and, being eligible, offer themselves for re-election. The retiring auditors, Mr. Henry Dever and Messrs. Welton, Jones and Co., also offer themselves for re-election.

WOODHOUSE AND RAWSON UNITED (LIMITED).

As intimated in our issue of the 7th instant, a special meeting of the debenture stockholders, debenture holders, and trade creditors of this Company was held on Monday last, at the Cannon-street Hotel, under the presidency of Sir Rawson W. Rawson.

The CHAIRMAN said : Gentlemen, my co-trustee, Mr. Samuel Pope, Q.C., and myself have felt it our duty as trustees for the debenture stockholders of this Company, to call you together, and at the same time to invite all those who have an interest in Woodhouse and Rawson United to come to the meeting to-day, to consider their position, and to take such action as they shall agree is for the greatest interest of the Company, and which will give them the largest amount of return possible from the assets of the Company, and not allow those assets to be dissipated either by interested or hostile parties. The circumstances are set forth in a circular which has been addressed to you by Mr. Pope and myself. A few weeks ago a receiver was appointed upon the application of a gentleman largely interested in the Company, and who certainly bears the Company no ill will, and in taking that action he has no desire whatever to injure anybody else concerned in the Company. Since then the general meeting has been held—which I was unhappily unable to attend—and at that meeting it was decided that we should go into voluntary liquidation, and at that meeting a liquidator was appointed. The Directors were of the opinion that that arrangement was the best in the interest of all parties concerned. You will bear in mind that this meeting is called by the trustees, and not by the Directors. It happened—and I think Mr. Pope regrets it equally with myself—that two or three years ago he and I, although Directors of the Board, were also appointed trustees. It would have been better if the offices had been separated. But I can tell you this, that in our position of trustees we have not neglected the interests of the debenture holders. Now, as regards the question of liquidation, we believed that voluntary liquidation would be the best course to pursue in the interests of all concerned. Well, since then, actions have been brought against the Company, as stated in our circular. One of these actions has been brought by a debenture holder for an amount of £250, and the other from a creditor of £185—small matters—and each individual has thought that he was consulting his own interest best in forcing the Company into compulsory liquidation. Those motions will come on for hearing to-morrow, and the object of the trustees in calling you together to-day is to get an opinion from the debenture holders, the debenture stockholders, and the creditors in the Company, as to whether they considered it in their interest to liquidate the Company voluntarily, as already arranged, or to be forced into compulsory liquidation. Voluntary liquidation would, of course, be under the supervision of the Court ; there would be no objection to that. Therefore, the question that we desire any expression of opinion upon is whether we shall take action to resist these motions for voluntary winding up. You are aware that in the case of compulsory liquidation, the assets of the Company are thrown upon the market whether there be any demand for them or not, the object of the official liquidation being to wind up the Company as speedily as possible, without reference to what might be obtained by a little time and a little patience. The assets of this Company are specially liable to depreciation by a compulsory liquidation, because they are not articles of great demand, and the present time certainly is not the time to put upon the market electrical apparatus, electrical stock, and electrical plant, or the goodwill of the business—the trading business of this Company. There is every reason to believe that in a short time some improvement will arise, but it is certain that the present time is about the worst that could be chosen to force a compulsory liquidation. We believe that voluntary liquidation is advisable under some such arrangement as was suggested at the general meeting, for reconstruction or otherwise, so that the assets of the Company might be secured in the best possible way in the interest of all those who are entitled to share in them. It is for that purpose that Mr. Pope and I have invited you to meet us here to-day to consult upon that point, and, if you are agreed, to give expression to your opinion that it is not desirable to submit to compulsory liquidation, but that it is desirable to proceed to voluntarily liquidation. I regret that for the past month or two it has not been possible for me to attend to these matters as I could have wished, but Mr. Pope and the Managing Director (Mr. Rawson) will give you any further information that you may require, and then you will act upon your own judgment, and I hope that it will result in the meeting determining that voluntary liquidation is the course to be adopted.

Mr. SAMUEL POPE, Q.C., said he was rather anxious that they should carefully understand what they were met to discuss that morning. Unfortunately, as they knew, Sir Rawson W. Rawson and himself were Directors of the Company. Whatever blame, in the judgment of some, might be attachable to the management of the Company, they, as Directors, must bear their share of ; but they were also trustees for debenture holders, and that had been the reason why they had called them together that day, in order that they might make up their mind as to which course was the best to pursue in the interest of all the creditors of the Company. Putting aside for a moment the interest of the Directors and the shareholders, what was best to be done for the debenture holders, the debenture stockholders, and the creditors of the Company ? It would be recollected, he dared say, what took place at the meeting in December. It was at that meeting that the unfortunate balance-sheet which had been the cause of all these subsequent events was presented to the shareholders. He desired as much as possible to keep the business of the day to the matter in hand, and would not, therefore, with the permission of the meeting, refer to the position of the shareholders and their interests, although he held a very strong view as to what would be the best thing for the shareholders to do. He was quite sure the interest of the debenture holders, for which he was more immediately responsible, was to secure the best possible realisation of the assets of the Company, which were held as their security. It seemed to him that they could not adopt a more ruinous course than to force these assets upon the market at a "break-up" price. He regretted the course that had been taken by those who had brought actions against the Company for compulsory liquidation. It was, therefore, for that meeting to decide whether they would allow the proceedings to be conducted voluntarily, or whether they would put the Directors to the disagreeable alternative of having to submit themselves to the examination of the official receiver. As to the possibilities of a satisfactory realisation of the assets if care and patience were exercised, the Committee of shareholders had—although he did not agree with the low valuation they put upon the assets—said that even at the low value at which they had taken them they would, if intelligently realised, be, they believed, sufficient to meet the liabilities of the Company. The question of a reconstruction could not, of course, be gone into in any detail at that meeting. Having explained a mistake he made at the last meeting in attributing to the general manager, Mr. Stutchbury, the statement that the profits from the industrial part of the undertaking would be £30,000 a year, and explained that the sum should have been £10,000 to £14,000.

A SHAREHOLDER asked what would be the position that the unsecured creditors would occupy in a reconstruction scheme.

Mr. POPE : The scheme, as I understand it, is to leave them exactly the security that they have at present.

A VOICE : They have none.

Mr. POPE said that in that Company there were three classes of liabilities that took preference of the shareholders, viz., the debenture stock-

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holders, the stockholders, and the unsecured creditors. He concluded by moving the following resolution :—

"That this meeting of debenture-holders, debenture stockholders, and creditors of the Company approve of liquidation under supervision of the Court with a view to reconstruction, and do not approve of compulsory winding up."

Mr. DODSON proposed as an improvement on the Chairman's resolution the following, which was accepted by the trustees, viz. : —

"Resolved : That, in the opinion of this meeting, it is undesirable for the Company to go into compulsory liquidation, and that Mr. Alexander Young, of the firm of Turquand, Youngs and Co., be retained as voluntary liquidator under the supervision of the Court, with a view to carrying out a scheme of reconstruction."

Mr. ACKWORTH seconded the resolution.

Mr. STUTCHBURY (General Manager) then addressed the meeting. He said that he could endorse every word that he said at the meeting in December. As he said then, the falling off that they suffered from they had suffered from in common with other concerns. Their industrial business was good, and since the appointment of Mr. Leslie as Receiver their position had been furthered strengthened, and they were receiving constant inquiries from every part of the world, and satisfactory orders were coming in ; their various agents were doing good business, and only that morning some good orders came in from South Africa, and these orders gave a very satisfactory profit.

Mr. LESLIE (Receiver) endorsed the remarks of the general manager. When he took possession of the business on March 10th he found the management in an almost chaotic state. He had cut down the weekly wages from £138 odd to about £95, equal to a saving of £2,200 a year ; he had closed one house, saving thereby some £600 in rent ; he was endeavouring to have all contracts carried out thoroughly ; he had visited the various works, and was leaving that evening for a further inspection ; he believed that with business-like management they had the nucleus of a very good business, and he believed they would succeed ; but if a compulsory liquidation was forced upon them, he did not believe they would pay 10s. in the £ to Debenture Stock holders. Therefore it was evident that compulsory liquidation would be a very great mistake.

Mr. RAPHEAL said they had received no particulars as to any reconstruction, and no details of what it was proposed should be done.

Mr. POPE said that it would be the duty of the Receiver to bring forward any scheme of reconstruction that might be deemed advisable. They could not, of course, say what that gentleman might elect to do, but the rough outline of the proposed reconstruction scheme was contained in the Trustees' circular [published in our last issue].

After some noisy discussion, the resolution which had been moved by Mr. DODSON and seconded by Mr. ACKWORTH was put to the meeting and carried with only one dissentient.

Mr. MADDISON then expressed the opinion that it would be desirable to appoint a committee to confer with the receiver on the question of the realisation of the assets.

A discussion ensued upon this, and eventually it was decided that Messrs. Dodson (of Reuter's Telegram Company), Benage, White, and a representative of Henley's Telegraph Works Company should be appointed a committee to confer with Mr. Leslie (the Receiver) upon the question of the realisation of the assets of the Company.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

FOREIGN ELECTRIC DATE AND TIME STAMP COMPANY (LIMITED).—At meetings held on March 3rd and 20th resolutions were passed and confirmed—that it is desirable to reconstruct the Company, and accordingly that the Company be wound up ; that Richard Warner, 32, Walbrook, auditor, be liquidator ; and that the liquidator consent to the registration of a new company, to be named the Foreign Electric Date and Time Stamp Company (Limited).

NOTTINGHAM ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—At meetings held on March 11th and 29th it was resolved that the Company be wound up ; and that Walter Griffith, Low-pavement, Nottingham, be liquidator.

PLANET ELECTRICAL ENGINEERING COMPANY (LIMITED).—The annual return of this Company, made up to July 26, 1892, has been filed. The nominal capital at the time of making up the return was £20,000 in £5 shares (since increased to £30,000 in £5 shares), and 3,382 of these shares have been taken up. Of these 800 have been issued as fully paid, while upon the remaining 2,582 shares the full amounts have been called, and all calls (£12,910) paid. The principal shareholder is Mr. R. W. Wallace, who holds 1,050 shares.

PYKE, HARRIS, AND COMPANY (LIMITED).—Particulars have been filed of the sale to and purchase by this Company of the business of electrical engineers carried on by Lazarus S. M. Pyke and Edward Harris, of 34, New Tothill-street, Westminster, S.W. The vendors agree to sell their businesss, together with their interest in patents—Nos. 11,503 (1888), 3,900 (1890), 4,004 (1890), 22,785 (1891), 21,541 (1891), 17,818 (1891) and Provisional Protection 19,222 (1892), for £2,000 in cash, and the allotment of 3,600 fully paid up "B" shares of £5 each.

SCARBOROUGH ELECTRIC SUPPLY COMPANY (LIMITED).—The statutory return made up to March 24th has been filed. Of a nominal capital of £50,000, in £10 shares, 1,980 have been taken up. Upon these shares a call of £4 per share has been made, resulting in the payment of £7,912, leaving £8 arrears.

UNITED ELECTRIC TRAMWAYS (LIMITED).—The statutory return o this Company, made up to March 6th, has been filed. 157 shares have been taken up out of a total of £30,000, in £5 shares, and the full amount has been called. The calls paid amount to £35, while these in arrears amount to £750.

WALSALL ELECTRICAL COMPANY (LIMITED).—An agreement dated March 8th last between Frederick Brown, of Walsall, electrical engineer, and the Company states that, by an agreement of December 9th last between the same parties, it was agreed that the vendor, Mr. Brown, should sell to the Company the goodwill of the business carried on by him at Walsall and Birmingham under the style of "The Walsall Electrical Company," together with the benefit of certain inventions and letters patent, for the sum of £1,000, and the plant, &c., for £1,450, and the same agreement appointed the vendor Managing Director of the Company with a salary of £350 per annum, and 25 per cent. of the net profits, and and also stated that the purchase consideration should be paid £450 in cash and £2,000 in fully paid shares. The present agreement determines that 200 shares, each considered as fully paid, shall be allotted to the vendor, and that the cash payments due shall be immediately satisfied by the Company.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED).—The annual return of this Company, made up to March 31st has been filed. The nominal capital is £100,000, divided into 7,000 ordinary and 3,000 preference shares of £10 each. 6,837 ordinary and all the preference shares have been taken up, the full amount called, and all calls (£98,370) paid.

MISCELLANEOUS.—BEESTON FOUNDRY COMPANY (LIMITED), iron and brass founders, electrical and mechanical engineeers, &c. ; capital, £15,000 in £10 shares.——FOSTER AND PEARSON (LIMITED), heating, electrical, and general engineers, iron and brass founders, &c. ; capital, £15,000 in £10 shares.——PICKERING, SWAIN, AND CO. (LIMITED), steam, pneumatic, hydraulic, electrical, mechanical, and general engineers and metal workers ; capital, £10,000 in £1 shares.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—Notice is given that the seventh drawing for payment of the Five per Cent. Debentures (1884 issue) will take place on Monday next, at noon, at the offices of the Company.

BRIGHTON EIFFEL TOWER AND WINTER GARDENS (LIMITED).—A supervision order in the winding up of this Company has been granted, the voluntary liquidator being instructed to inquire into the matters alleged in the petition, and make a report to the Court.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended April 9th were £842, as against £742 for the corresponding period of last year, being an increase of £100. The total receipts for half-year amount to £12,856 against £11,761 in the corresponding period of 1892, being an increase of £1,095.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—Our advertisement columns contain a list of 353 Five per Cent. Australian Government Subsidy Debentures of £100 each, drawn by lot on April 6th last at the offices of the Company. These debentures will be paid off at par on July 1st next, at Messrs. Barclay, Bevan and Co.'s bank, 54, Lombard-street, E.C., interest ceasing after that date.

INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company, after adding £10,000 to the reserve fund, have determined, subject to audit, to recommend the payment of a dividend for the six months ended December 31, 1892, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. per year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year. The dividend and bonus will be payable on and after May 1st next.

HOBART TRAMWAYS COMPANY (LIMITED).—A meeting is to be held at College Hill-chambers, E.C., on Monday, the 24th inst., at 2.30 p.m., for the purpose of confirming the resolution passed at the meeting held on the 6th inst., altering the name of the Company to The Hobart Electric Tramway Company (Limited).

MIX AND GENEST (BERLIN).—At the fourth annual meeting of this Company, recently held, a dividend was declared for 1892 of 6 per cent.

NATIONAL TELEPHONE COMPANY (LIMITED).—The Right Hon. Lord Balfour of Burleigh has joined the Board of this Company, and will assume the position of Vice-President of the Company.

STOCK EXCHANGE NOTICES.—The Committee of the Stock Exchange have ordered the further issue of 4,120 ordinary shares, Nos. 454,748 to 458,867 of the National Telephone Company (Limited), to be quoted in the Official List.

SUBMARINE CABLES TRUST.—Notice is given that a payment of £1. 10s. will be made on account of the coupon due on April 15th on and after that date, by Messrs. Glyn, Mills, and Co., of 67, Lombard-street,

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London, E.C., between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment. They will be stamped with the words "£1. 10s. paid," and returned to the holders.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended April 7, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,692.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 5.		Price Wednesday, Apr. 12.		Rate per Cent. Yielded	Dividend Due.	Business Done During Week Ending Apr. 12.	
								£ s. d.		Highest	Lowest.
			TELEGRAPHS								
£1,247,720	Stock	17/6	Anglo-American	52½	53½	53	54	5 1 10			
£2,876,140	Stock	35/0	Do. Preferred	93	94	93	94	5 17 0	Ja..., Apr., July, Oct.	53⅜	53
£2,876,140	Stock	5/0	Do. Deferred	12¾	13¼	12⅞	13¼	..	" "	94	93¼
£250,000	100	4%	African Direct, Telegraph 4% Debentures	101	104	101	104	3 16 11		13	
130,000	£10	3/0	Brazilian Submarine xd	11½	12	11½	12	5 8 ⅔	January and July	..	..
£68,200	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	Mar., June, Oct., Dec	12	11⅞
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	105	109	105	109	4 11 9	January and July	100¾	←
$7,716,000	$100	$1¾	Commercial Cable Capital Stock	178	182	165	170	4 2 4	June and December	..	..
16,000	10	8/0	Cuba Submarine	11⅛	12¼	11½	12⅛	6 8 0	Jan., Apr., July, Oct.	..	..
6,000	10	10%	Do. Preference 10%	18	19	18	19	5 5 3	February and August	..	..
12,931	5	4%	Direct Spanish (£4 paid) xd	2½	3⅛	2½	3⅛	4 11 5		..	..
6,000	5	10%	Do. Preference 10% xd	9	10	9	10	5 0 0	April and October	..	..
60,710	20	3/6	Direct United States xd	11⅝	11¾	11⅝	11¾	5 18 2		..	..
400,000	10	2/6	Eastern	14⅞	15⅛	15	15¼	4 5 3	Jan., Apr., July, Oct.	11⅞	11¼
70,000	10	6%	Do. 6 per Cent. Preference	16	16⅜	16¼	16¾	3 11 8	" "	15¼	
£1,294,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113	116	114	117	3 8 5	" "	16⅜	16⅛
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107	110	107	110	4 10 11	May and November	115⅜	114¼
250,000	10	2/6	Eastern Extension	15⅝	15⅞	15½	15¾	4 8 11	February & August	..	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112	115	112	115	3 9 7	Jan., Apr., July, Oct.	15⅛	15⅜
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	February & August	114½	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor Deb., 1900	102	105	102	105	4 15 3	January and July	105½	
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101	104	101	104	3 16 11	" "	..	..
180,227	10	1/3	Globe Telegraph and Trust	9⅞	10⅛	9⅞	10⅛	4 8 11	February & August	..	..
180,042	10	6%	Do. 6 per Cent. Preference	15⅜	15⅝	15⅜	15⅝	3 16 10	Jan., Apr., July, Oct.	10⅛	9⅞
150,000	10	5/0	Great Northern	19¼	19⅞	19¼	19⅞	4 6 1	" "	15⅝	15⅜
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	104	107	105	108	4 12 7	Jan., April, and July	19⅜	
17,000	25	12/6	Indo-European	44	46	43	46	5 8 8	March & September	106⅜	106
38,348	10	4 0	London Platino-Brazilian	4	6	4	6	6 13 4	May and November	45½	42
£100,000	100	6%	Do. 6 per Cent. Debentures	106	109	106	109	5 10 1	" "	..	..
10,802	8	4/0	Reuter's	7	8	7	8	..	March & September	..	..
3,381	£100 Cert.	30 0	Submarine Cables Trust 6%	118	123	120	125	4 16 0	April and October	..	..
15,609	10	5/0	West African Telegraph	6½	7½	5½	6½	7 13 10	" "	121½	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	January and July	..	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	March & September	..	..
£150,000	100	8%	Do. Debentures 8% 1902	105	109	105	109	7 6 10	January and July	..	..
88,321	10	6d.	West India and Panama	1⅛	1⅜	1⅝	1⅞	..	June and December	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	11¼	11⅝	11⅜	12	5 0 0	" "	1¼⅛	1⅛
4,669	10	6%	Do. 6 per Cent. 2nd Pref	9	10	9½	10½	5 14 3	May and November	11⅜	1.⅞
£30,000	100	5%	Do. 5 per Cent. Debentures, 1917	108	111	108	111	4 10 1	..	..	..
64,242	15	3/0	Western and Brazilian	7⅜	8¼	7⅜	8½	5 9 1	June and December	..	..
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5¾	6¼	5¾	6¼	6 0 1	May and November	8¼	7⅛
33,129	7½	4/6	Do. 6 per Cent. Deferred	2	2½	1⅞	2¼	..	" "	6⅛	5⅝
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105	108	105	108	5 11 1	" "	1¼⅛	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105	108	105	108	5 11 1	February & August	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120	125	120	125	5 12 0	" "	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	101	104	101	104	5 15 5	May and November	..	..
									March & September		..
			TELEPHONES.								
40,000	£5	10/0	Chili Telephone (fully paid) xd and rights	3	4	3	4	..	..	..	..
22₁,800	14/0	1½d.	Consolidated Telephone Const. & Maintenance	¼	⅜	¼	⅜	1 13 4	May and November	..	..
220,000	£1	4⅜d.	Oriental (11s. paid)	⅜	½	⅜	½	7 18 2	Yearly	..	..
454,747	5	2/6	National	5¼	5⅜	5¼	5⅜	5 9 1	June and December	5½	
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	15½	15	15½	3 17 6	" "	..	5⅝
15,000	10	6%	Do 6% Cumulative 2nd Pref	14¼	14⅝	14½	14¾	4 1 4	" "	14¼	..
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref (£3 paid)	5⅛	5⅜	5⅛	5⅜	..	..	5⅜	11⅜
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	113	116	1 3	116	3 17 7	January and July	114¼	5½
48,000	£10	..	New Telephone, Limited (£4 paid)	..	..	..	..	..	..	..	113⅜
58,000	5	1/0	United River Plate	2½	3	2½	3	..	January and July	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	6 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
30,152	£10	..	City of London Electric Lighting (fully paid)	11½	12	11¾	12⅛	..	–	12⅛	11¼
20,000	£10	..	Do. 6 per Cent. Preference	10	10½	10¼	10¾	..	..	10½	10⅜
19,900	£5	..	Electricity Supply Co. of Spain	..	..	..	..	..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..	..	..	..	..	..	..	..
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..	..	..	..	..	..	..	..
8,332	£5	..	House to House Electric	..	..	..	..	..	..	..	..
15,000	£5	..	Kensington & Knightsbridge El. Light (fully pd.) xd	..	..	..	..	..	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid) xd	..	..	..	..	..	..	..	..
30,000	£5	3/4 '92	Liverpool Electric Supply (£3 10s. paid)	4⅛	4⅜	4⅛	4⅜	..	January and July	..	..
10,000	£5	5/0 '92	Do. (fully paid)	5 1/16	5 1/8	5⅛	6⅛	..	March	..	..
111,000	5	..	London Electric Supply	1	1¼	1	1⅛	..	March	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	6¼	7	7¼	7¾	..	–	–	..
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102	105	102	105	4 15 3	–	7⅜	7
6,318	10	..	Notting Hill Electric Lighting (fully paid)	5⅜	6⅜	5⅜	6⅜	..	June and December	..	..
18,680	£5	9½%	St. James' and Pall Mall	8	8⅜	8	8⅜	..	–	–	..
7,900	£5	7%	Do. 7% Preference	8	8⅜	8	8⅜	..	–	8¼	8
12,853	5	2/0	Westminster Electric Supply (fully paid)	5½	6	5½	6	4 2 4	–	8 1/16	8
								2 18 4	–	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	1/3	Brush Electrical Engineering	3	3¼	3	3½	..	–	3⅜	..
69,996	2	6%	Do. 6 per Cent. Preference	2¼	2⅜	2⅜	2⅝	5 1 1	–	2⅜	2⅜
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	103	105	105	107	4 4 1	–	..	2⅛
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼	5⅝	5¼	5¾	..	..	105½	104¼
12,139	5	..	Edison and Swan United	..	..	..	..	..	January and July	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..	..	..	..	..	–	..	..
45,000	10	12/0	Electric Construction	2⅜	3	2⅜	3	..	–	..	..
70,000	2	10/0	Elmore's Patent Copper Depositing	¼	⅜	5/32	⅜	..	..	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1	2	1	2	..	–	2 13/16	2 11/16
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	22½	23½	22	23	5 8 8	–	1/16	1/16
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	February & August	22¾	22¼
11,334	£10	6/4	International Okonite Limited Ordinary	2½	3¼	2½	3½	..	March & September	..	..
11,334	£10	8/0	Do. Preference	6	7	6	7	..	..	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0	6/0	5/0	6/0	..	December and June	..	..
78,949	5	4/2½	Swan United (£3. 10s. paid)	3	3¼	3	3½	..	..	..	..
37,350	12	24/0	Telegraph Construction and Maintenance	33	36	32	35	10 0 0	May and November	8¼	3
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	101	104	5 2 2	March and July	34⅜	33½
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..	..	..	..	4 16 2	January and July	..	..
..	£5	..	Do. Preference (fully paid)	..	..	..	..	..	–	..	..
									–	..	..
			RAILWAYS AND TRAMWAYS.								
63,000	£10	..	City and South London Railway	..	..	..	..	..	–	–	–
600,000	Stock	3%	Do. Stock	37	39	37	39	2 17 8	May and November	..	..
										..	..

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NOTES.

So much attention has been given, of late, to central station work, that the design and management of comparatively small isolated plants has been left rather to rule of thumb. One great advantage of the best class of rule-of-thumb work is that breakdowns and hitches are eliminated. By rule of thumb we understand a common sense following of tradition, founded on experience. Whatever has been found to work well is retained, and whatever has led to failure is rejected. Progress, however, under this rule is very slow, and some care should be given to examine what is really meant by working "well." Lamps marked for 100 volts run well at 100 volts, but Mr. Kapp in his lecture at the Society of Arts on Wednesday showed how £21 per annum might be saved by running 100 lamps, used 100 hours a year, at 3 watts instead of $4\frac{1}{2}$ watts per candle, and how when gas engines are worked with expensive gas a similar course should be adopted. The introduction of a new or somewhat modified definition of the term "load factor" in the course of Mr. Kapp's lecture is rather unfortunate. It is quite possible that Mr. Crompton's original definition is not easily applicable to isolated plants, but inventors of new definitions should supply new names. These modifications will result in somebody speaking of the ratio of the number of lamps he has got in his house to the number he would like to have, as his load-factor. Storage batteries are a serious burden on the cost of lighting. If it were not for the heavy first cost, maintenance, and skilled labour which batteries entail, an isolated plant could beat a supply company for all sizes down to one or two hundred lamps. An interesting table of costs of electric lighting in various private houses, clubs and Government buildings was given by Mr. Kapp.

An unusually interesting collection of exhibits was shown at the Institution of Civil Engineers on Tuesday, at the monthly reception by the President and Council. *Apropos* of the Paper under discussion, the engine on which Mr. Willans' non-condensing trials has been made was shown cut in half, displaying the pistons and central valves, thus allowing the course of the steam to be easily traced. Parts of a 60 I.H.P. Willans engine, all, in fact, except the base, were also shown. This engine had been driving the dynamo for electric lighting and power at Thames Ditton since July, 1889, and had run for a period equivalent to about five years of ordinary work. The wear had been very small indeed. This engine was stopped at 1 p.m. on Tuesday last, was removed during the dinner hour, replaced by another erected from parts taken from store; the latter was started at 2 p.m. while the former was exhibited on the same evening at Great George-street. Close to this engine was the trunk of a fan-engine from the Woodthorpe Colliery. This engine, as was mentioned in our obituary notice of Mr. Willans, had run for as long as nine months without being stopped, and was locked up by itself at night. This trunk showed no perceptible wear and has a fine dark polish. Americans and others fond of big things may be interested to hear that this trunk had made 1,600,000,000 strokes. Besides the Willans exhibits were a number of standard parts of G.E.R. locomotives, the valve gear of a London, Tilbury and Southend locomotive, and numerous models. Among these was a working section of an ingenious engine designed by Mr. Grafton, and which is being made by Messrs. Easton and Anderson; it has pistons which approach and recede from each other in the same cylinder.

Among the regulations and conditions which the Board of Trade are empowered to make under the Electric Lighting Acts is one which prescribes that in high-pressure supply, where a transformer is provided on the consumers' premises, some means or apparatus approved by the Board of Trade shall be provided which shall render it impossible that the low-pressure service lines and consumers' wires shall be at any time charged to a dangerous difference of potential from the earth, owing to accidental contact with, or leakage from, the high-pressure conductors, either within or without the transformer. The best-known types of apparatus which have been proposed for this purpose are the Cardew and the Drake and Gorham devices, differing, indeed, but little from each other, and depending on the static attraction of an aluminium leaf, the Ferranti device of a fuse and suspended contact plug and that of Sharp and Kent, an earthed metallic separation. This consisted originally of a sheet of metal between the primary and secondary windings of a transformer; but it has more recently been modified, and the sheet is replaced by a winding of wire, open circuited, of course, and put to earth. This, and certain other regulations, have offered a fine field for an ambitious inventor, who, it is conceivable, might have covered the whole ground in each case by one or more wide-reaching patents. With the exception of a patent for sealing meters, no attempt appears to have been made to take advantage of these regulations in any such manner. It is not often that the inventor is offered opportunities of this kind; he

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generally has to seek for, or to artificially create, the long-felt want. The Sharp and Kent device for meeting this particular regulation has met with the approval of the Board of Trade, but not, we understand, to the exclusion of others. There is a good deal to be said for the use of separate apparatus which may be attached to existing circuits, for it is too much to expect that consumers on high-pressure circuits, who are already mulcted by rentals for transformers, should be asked to take them out and have them re-wound according to this ingenious and approved method.

THE Metropolitan Electric Supply Company, the annual general meeting of which takes place to day, is the biggest of our electricity supply concerns, and for that very reason its operations do not easily admit of comparison. Its five generating stations supply current to 134,463 lamps spread over an area of more than 4½ square miles, the district being of a peculiarly varied character. The dividend is not exactly handsome, but the accounts show that, like the rest of the London companies, the Metropolitan has increased its lamp revenue and decreased the absolute cost of production of the Board of Trade Unit. In 1891 the sale of current brought in £37,767, disregarding the odd shillings and pence; last year the figure was £50,852, an increase of some 34 per cent. On the other hand the total generating expenses have only grown by about 3 per cent., all items save coal and repairs actually showing a decided diminution. In a continuance of this process lies the financial success of the undertaking.

THERE is an almost irresistible tendency to take a semi-jocular view of the municipal electric light deputations which have of late been so frequent. If, however, they all bear as good fruit as has been the case with the Special Electric Lighting Committee of the Vestry of St. Mary, Islington, whose voluminous report lies before us, it is time we took these tours seriously. Disregarding a report advising the adoption of a low-pressure system for Islington, the Committee proceeded to pay the usual round of visits to central stations. The net outcome is a well-argued recommendation to the Vestry—a recommendation which was adopted on Tuesday—to undertake the electric lighting of Islington itself, to lay down a 20,000-light alternate-current central station, and to obtain borrowing powers to the extent of £60,000. We feel that we are not sufficiently well acquainted with the district in question to endorse the Committee's estimate of its suitability for electric lighting, but taking that estimate as correct, the anticipation of the Committee that the venture will be "an assured commercial success," will in all probability be fulfilled. The noteworthy feature of this particular report is the unusually accurate appreciation of the relative merits of the various systems which this non-technical Committee arrived at, the "diverse and contradictory" opinions of advocates notwithstanding.

UPON glancing through the pages of a well-illustrated pamphlet sent us by the Durham College of Science and addressed to its "Governors and other friends," we are inclined to think the finance of this institution as venturesome as its intentions are good. The existing buildings at Newcastle were, it appears, erected and equipped at a cost of about £24,000; "of this sum £17,000 has been borrowed, and the interest is a standing charge against the revenue of the College;" the shell of the buildings now in course of erection is estimated to cost about £20,000, "towards which about £10,000 is in hand." Since the cost of equipping the new Engineering Laboratory will need £12,000, about £22,000 is "*immediately required*, if the new buildings are to be opened in October efficiently equipped without increasing the liability already existing upon the College." The suggestion is made that gifts in kind will be as acceptable as money, and that if no single firm or individual will present the new laboratory with the set of quadruple-expansion marine engines designed by Prof. WEIGHTON, a number of engineering firms might each contribute a portion—crank-shaft, cylinders, valve-gear, &c., &c., Prof. WEIGHTON undertaking the responsibility—which would certainly be no light one—of converting these assorted contributions into an engine. In addition to all this, we are told that £90,000 should be forthcoming "at no distant date," to complete and equip a new wing and to clear off existing liabilities. In conclusion, it is stated that during the last three or four years "the College income has nearly balanced the expenditure" though this has only been brought about by the teaching staff "placing the financial interests of the institution in front of their own," that is to say, by their surrendering fees and providing laboratory apparatus.

WHETHER or no the Durham College of Science is all that it should be from the point of view of financial management, the product that it turns out, and its adaptation to its environment we know not; but we do not hesitate to say that no institution of the kind should be permitted to continue to drag out an existence by such self-sacrificing devices on the part of its professorial staff. We are constantly being told that every loafer—we beg pardon, we mean labourer—is worthy of his hire, and we know of no reason why the term "labourer" should not include, "professor," even if he "plays" for six months in the year. Education has always been an object of endowment, and in an engineering centre like Newcastle an institution giving instruction in the science of the engineering profession should surely not be stinted in funds, if it has a right to exist at all.

Nelson.—The Local Government Board have sanctioned the borrowing by the Corporation of £6,000 more to complete the electric lighting scheme.

Burton-on-Trent.—On Thursday last week a Local Government Board inquiry was held to consider the borrowing of £11,500 for electric lighting.

Cable Interruptions and Repair—

Cables.	Date of Interruption.	Date of Repair.
Gibraltar-Tangier	February 18th	April 1st
Para-Maranham	March 20th	—
St. Thomé-Loanda	April 11th	—
Accra-Grand Bassam	April 11th	—
Paramaribo-Cayenne	April 15th	—

Marine Electric Lighting.—Our contemporary *Electric Plant* has published a digest of current information on the subject of electric lighting on board ship, in the shape of a profusely

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illustrated special number. The compilation ought to prove of service to firms desirous of pushing their ship-lighting departments.

Municipal Electrical Engineers.—Frankfort-on-the-Main is to have a municipal electrician, with a salary of £500 a year and a share of the profits of the electric-lighting station. These figures are an improvement upon the market rate obtaining at home.

The Brighton-Rottingdean Electric Railway.—The National Telephone Company, who were the only opponents to this Bill, have given notice of the withdrawal of their opposition, the promoters having agreed to insert a clause for the protection of their wires. The withdrawal of this petition leaves this projected railway entirely unopposed.

Electrical Communication with Lighthouses.—The Royal Commission inquiring into the best possible means of electric communication between lightships, lighthouses, and the shore at various points on the British coast, will commence a second series of visits to the most dangerous parts of the coast on July 10th. The exact route has not yet been settled, but it is understood to embrace the north and west coasts of Scotland and England.

Mr. Falkenstein's Paper on Electricity in Tanning.—A supplementary note at the end of Mr. Falkenstein's Paper, which we printed last week, referred to a diagram A_2, showing the relation of rate of flow with current. The vertical scale of this diagram, which was given on page 688, was lettered by a mistake of our engraver "differences of levels in millimetres" instead of "current in amperes," the horizontal lines denoting 0·005, 0·010 ampere, &c.

Tramways v. Telephones.—A Paper was read on this subject by Mr. S. Sellon at a meeting of the Tramways Institute at Liverpool on the 13th inst. The protection clauses of the National Telephone Company were discussed, and reference was made to the Leeds case and the Sandgate and Hythe case. The objects of the Electric Traction Association were explained, and an appeal was made for a strong combination to defend electric traction against the attacks of the Telephone Company.

Inter-Colonial Electric Lighting Conference.—A committee of experts appointed to draft a code of rules and regulations for electric light and power wires met at the General Post Office, Sydney, last month. The representatives were convened by Mr. Charles Todd, Postmaster-General of South Australia. The representatives of the various colonies were as follow:—Messrs. C. Todd, Postmaster-General and Superintendent of Telegraphs for South Australia; P. B. Walker, Secretary of Telegraphs for New South Wales (also representing Queensland); George Smibert, Electrician in the Victorian Telegraph Department; R. Henry, Superintendent of Telegraphs for Tasmania; also the following representatives of the electric lighting companies:—Messrs. O. Haes, of the Brush Electric Light Company; A. J. Arnott, City Electrician, Melbourne; and J. O. Callender, of Sydney.

Edinburgh.—The following memorial against the Town Council working the Electric Light Order themselves is being largely signed by the Princes street and other shopkeepers. It will be presented to the next meeting of the Town Council:—

> We, the undersigned citizens of Edinburgh, observing that the Lord Provost's Committee have decided to recommend the Town Council to take into their own hands the lighting of the city by electricity, humbly desire to express our conviction that such a course would be against the best interests of the city, looking to the fact that there is a thoroughly substantial local company willing to take the initiative risk. Some of the advantages which the citizens as a whole would derive, should the Town Council delegate the electric lighting to a local company, would be as follows:—(1) None of the citizens who are not consumers would be taxed for the introduction of this new illuminant; (2) a company is in a better position to carry through the undertaking more satisfactorily than the Town Council, seeing that the members of the latter are already overtasked; (3) a company would be more popular with all classes of the community, and consequently would be able to secure a very much larger number of consumers.

A special meeting of the Town Council has been called for to-day to decide as to what steps shall be taken in regard to electric lighting.

The Gilgit Telegraph Line.—There seems, says the *Indian Engineer*, every prospect of a good working line of telegraph being established this summer between Srinagar and Gilgit. Before winter set in, an experimental wire was laid from a point 12,000ft. high on the passes into Srinagar, a distance of 42 miles. Tests have shown that this has stood the trying ordeal of heavy snowfall and severe frost, the insulation being quite satisfactory. When the hot weather has set in, work on the line will be proceeded with as quickly as possible, and by the end of next autumn the line should be completed through. Then Gilgit will no longer be cut off from telegraphic communication with India for months together, as is now the case. Mr. Olphert will have charge of the construction, a special sub-division being formed to facilitate operations. A second wire, it may be added, is being laid from Srinagar to Mari by the Indian Telegraph Department, which took over the Durbar line a few months ago.

Transmission of Indian Telegrams.—Referring to the Indo-European Department, and the change by which it will again have a Director-in-Chief of its own, it may be noted, says the *Indian Engineer*, that the direct administration of the line has been most successful. The arrangement, in fact, might well have continued had it not been that the extra duties thrown upon the Indian Telegraph Department were excessive, particularly as the growing telegraphic wants of this country had to be attended to in the first instance. The Indo-European cables and land lines were always well found, and the superintendence was extremely good under the original system of management. What the Indian Telegraph Department has done has been to quicken the rate of transmission, and thus bring Europe and India more in touch. The number of words signalled in 1888-89 was 3,870,000, and the mean of the time taken in signalling each message was 14 minutes; in 1891-92 the words had risen to 4,587,000, and the mean rate had dropped to seven minutes only. Thus, though the work had increased by 730,000 words, each message was disposed of in half the time formerly taken. A great advance this, and one which reflects the highest credit upon the Indian Telegraph Department.

Bradford.—A special meeting of the Gas and Electricity Supply Committee was held on Friday last to consider what steps should be taken during the summer months to extend the Electrical Works so as to cope with an increased demand in the winter. Alderman Priestman presided. He said the main point to which the Committee should direct their attention was whether they should extend their plant on the two-wire system, or start afresh and employ the three-wire system. Mr. Sydney W. Baynes, Electrical Engineer to the Corporation, presented to the Committee an exhaustive report on the subject. He stated that the pressure throughout the area lighted was very unequally distributed. The demand for light and motive power was now growing so rapidly that the distributing mains were inadequate. To double the present two-wire mains would cost £9,630. 10s. Mr. Baynes estimated the cost of the three-wire system at £5,970. 3s. 4d., a capital saving of £3,660. 6s. 8d. There would also be a saving in working expenses of £424. 10s. To meet the demand for next winter he estimated that 200 to 300 additional horse-power would be required. The Committee spent upwards of two hours in considering the question, and finally decided that a sub-committee should be appointed to go into the whole question, and bring up a further report.

The London County Council Technical Education Board.—The following are the names of the members of this Board:—Earl Compton, Messrs. Spicer, Hogg, Bayley, Webb, Collins, Beachcroft, Ward, Forman, Wood, Stuart, Crooks, Orsman, H. R. Taylor, Leon, H. P. Harris, Fardell, Steadman, Chatterton, and Roberts, representing the London County Council. From the various bodies having representation on the Board the following 13 nominations had been received:—School Board for London (three), Mr. J. R. Diggle, General F. J. Moberly, and the Hon. E. Lyulph Stanley; London Trades Council (three), Miss Frances Hicks, Mr. G. Courtenay, and Mr. G. Shipton; City and Guilds of London Institute (three), Mr. H. C. Saunders, Q.C., Sir O. Roberts, and Dr. W. J. Russell, F.R.S.;

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trustees of the London Parochial Charities (two), Sir Philip Magnus and Mr. C. J. Drummond; Head Masters' Association (one), the Rev. G. E. Mackie; National Union of Teachers (one), Mr. T. A. Organ. All these were duly elected. To fill the places of the remaining two members (one, at least, of whom, by a resolution of the Council, should be a woman), Mr. H. Llewellyn Smith and Mrs. Sophia Bryant, M.A., D.Sc., were elected. By a further resolution the Board thus constituted will continue for one year with all the powers of the Council under the Technical Education Acts, 1889 and 1891, other than that of raising a rate.

The Electrical Trade Section.—The following paragraph from the Eleventh Annual Report of the Council of the London Chamber of Commerce, referring to the past year's work of the Electrical Trade Section, may be of interest :—

During the year this Section has held three meetings, in addition to a considerable number of meetings of special committees appointed to deal with various subjects. One of the most important matters dealt with was the County Council Bye-Laws for the Regulation of Overhead Wires under the Act of 1891. A special committee was appointed to take what action might seem necessary in regard to the bye-laws, and, as a result, a petition was prepared and sent to the President of the Board of Trade, pointing out the impracticable nature of many of the proposed bye-laws. This was followed up by a deputation to Sir Courtenay Boyle at the Board of Trade, and it is satisfactory to state that the bye-laws were ultimately settled to the general satisfaction of the industry. An attempt was made to organise a representative electrical exhibit for the Chicago Exhibition, but as the suggestion did not meet with sufficient support, the matter was allowed to drop. A special committee was also appointed to consider the possibility of reconciling the rival claims of the traction and telephone companies as to the "use of earth." A number of gentlemen were appointed arbitrators to act in the settlement of any disputes arising in the trade under the rules and regulations of the London Chamber of Arbitration. The Section has agreed to follow the precedent of other Sections by abolishing its Standing Committee, and convening the whole of the membership to all future meetings. Other questions discussed included the relation of the Association for the protection of telephone subscribers to the Chamber, electrical communication on the coasts, merchandise marks, standardising of electrical machinery, and uniformity of prices."

The Future of Arc Lamps.—There is no mechanism used in electric lighting so little studied as the arc lamp, says *Industries*. The average electrical engineer knows less about the underlying principles and the actual working of arc lamps than of any other part of his business. No good work has been written on the subject, the nearest being an able Paper by Prof. S. P. Thompson. The full theory of the arc lamp, and the design of dynamos and arc lamps to work on series circuits, have never been discussed. The properties necessary for success in parallel running have never been formulated. The alternating arc lamp has received even less attention. All this is apparently because some ten years ago it was the fashion to talk of arc lamps as out of date in comparison with the more modern incandescent lamp. Here we have a comparison drawn between two lights which cannot be said to compete, because neither can replace the other. The incandescent lamp got the best of the foolish battle, and the arc lamp has remained very much where it was twelve years ago. The senseless feud between the advocates of alternating and direct currents is now producing equally disastrous results. It is quite time engineers studied arc lamps seriously, designed them to suit modern distribution systems, and arranged them to burn cheap carbons without "pumping" and without getting out of order. Mr. Crompton prophesies a great future for arc lamps, and it is certainly curious that the arc is least used in the only country where the incandescent lamp is expensive. Insular prejudice—or, what is much the same thing, insular ignorance—is still extant in this country.

Brisbane.—The South Brisbane Municipal Council have accepted a tender to light the borough by electricity. About a fortnight ago, says the *Brisbane Courier* of the 27th ult., the Lighting Committee were instructed by the Council to take the matter of substituting the electric light for gas in the streets of the municipality into consideration, and they entered into negotiations with Messrs. Trackson Bros. and Messrs. Barton and White (the latter firm representing the Crompton Supply Company of Australasia). The Committee were empowered to enter into a contract with Messrs. Barton and White for three months. An agreement was drawn up, but Messrs. Barton and White did not offer to sign the contract. In the interval one of the Directors of the Crompton Company had arrived from the south, and had raised an objection to the short period the Council were prepared to allow for the supply of electric light to private establishments. The firm subsequently sent in another tender, one of the conditions of which was that the time allowed for private lighting should be extended to either five or seven years. The Lighting Committee did not consider they would be justified in conceding the terms asked for by the firm. They then consulted with Messrs. Track on Bros., who had also sent in a tender for the lighting of the municipality, and that tender was considered at a special meeting of the Council. The meeting lasted for three hours. The question arose as to whether the lighting of the borough by electricity was a matter of emergency, and it was declared to be so. It was finally agreed that a contract should be entered into with Messrs. Trackson Bros. for the lighting of the borough by electricity for three years, the number of lamps to be 250, with the option of a further term of two years upon the basis laid down in the tender.

Electric Railroad Building in the United States.—The following extract from an American "Monthly Investment Circular" may be of interest :—

An interesting feature of the growth of electric power as applied to transportation is the establishment of connecting lines between near-by cities and towns, many of such lines being designed as carriers of light freight as well as passengers. The increased economy of operation by electricity rather than by horse power, and the greatly improved service thus attained, have been amply demonstrated for purposes of street railway traffic, and the field of operation is now being enlarged in such a manner as to make serious inroads upon the local business of steam roads between prosperous adjacent points. One of the earlier inter-urban lines was that between St. Paul and Minneapolis, which has been a very marked success. The electric line between Boston and Lynn was recently acquired by a syndicate at high figures. The proposed electric road between Baltimore and Washington (40 miles) has so far progressed that bids for the road-bed construction have been invited. A line of 40 miles is projected from Springfield, Mass., to Athol, passing through several important towns and following the highways. This line, if built, will carry passengers and light freight which now goes by the Boston and Albany. The Consolidated Street Railway Company of Worcester, Mass., has applied for franchises for over 40 miles of new roads, extending to a large number of the manufacturing towns in that vicinity. The street railways of Norwich and New London, Ct., are being consolidated and it is proposed to connect the two cities by a 15-mile road, competing with the Vermont Central for this local business. Wilmington and New Castle, Del., are to be connected by a new electric line of 8 miles. An electric road, 70 miles long, is proposed from Lancaster, Pa., to Bryn Mawr. A 25-mile electric line is proposed between Harrisburg and Mechanicsville, Pa. A company has been incorporated to build an electric road of 80 miles from Northumberland to Scranton, Pa., and to furnish light, heat and power to intermediate towns. In Ohio a trolley railroad is projected about 100 miles in length, extending from Toledo to Findlay, and designed for freight as well as passengers. A company has been incorporated in New Jersey under the name of the New England Street Railway Company for the purpose of acquiring the street railways in a large number of the cities and towns of the New England States, and operating them as one great concern. It is supposed to be a part of the plan to connect many of these places by electric railways, and the scheme is one of the most extensive in this line. Another great combination has been formed designed to connect Newark, Jersey City, Elizabeth, Plainfield, Orange and other cities in New Jersey and bring their traffic to the Hudson River. A line to be operated under a new storage system, instead of by trolley, is proposed between Cincinnati and Dayton, O. It is claimed that a speed of 30 miles, and over, an hour will be practicable under this system. The most ambitious project of all is the building of an air-line electric railway between Chicago and St. Louis, concerning the construction and success of which there is much natural scepticism. These citations are given merely to indicate the constantly growing importance of electric transportation. It is a factor in the railroad situation which cannot be ignored. It is a question if this business is not being pushed too fast. The fact that electric street railways have been uniformly successful does not prove that it is wise to try to cover the country in competition with steam roads. As in all other desirable investment lines, careful discrimination is needed here. There are fields for profitable lines where towns are not far apart and traffic is heavy, but many an ambitious trolley line through long stretches of thinly populated country will come to grief. The Railroad Commissioners of Massachusetts give a warning against indiscriminate buying of electric railway securities. The last report of the New Hampshire Railroad Commission argues against the granting of franchises for electric lines along public highways connecting different towns. It says there is no good reason why steam roads should be required to buy right of way, to construct bridges and stations, and to maintain a roadbed, and electric roads be furnished these things at public expense. The report says: "We hope to see established in New Hampshire the rule that all railways which are designed to do a through business from one town to another shall keep out of the public thoroughfares, pay for the land they occupy, and build their own bridges, fences and stations." A bill will be introduced in the next Connecticut legislature prohibiting the building of street or electric railroads to parallel existing steam roads.

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ELECTROMAGNETIC THEORY.—XLVIII.

BY OLIVER HEAVISIDE.

(*Continued from page 650.*)

§ 195. Next consider the effect of a conducting medium upon the total displacement. We know that the latter decreases with the time, and the law of decrease may be readily found from the theory of a single conducting plate. We found that when its conductance exceeded a certain value, the loss of displacement exceeded the original. But, in regarding the action of a homogeneous conductor upon a wave as the limit (in the gross) of that of an assemblage of parallel plates in which the conductance is localised (which process may not seem unassailably accurate beforehand, but which is justified by the results), it is easy to see that we have merely to deal with plates of such very low conductance that the loss at each is extremely small, so that the above-mentioned difficulty does not enter. Thus, let the loss at one plate be such as to reduce the initial displacement D in a wave to mD, where m is a fraction nearly equal to unity. Here mD is the sum of the displacements in the transmitted and reflected waves, the latter being very small and of the opposite sign to the initial D. As these waves separate, they reach other plates and are split anew. If these plates have each the same conductance as the first, the total mD is further attenuated by them to m^2D when the two waves become four. Next, when these four waves are split into eight by the next plates that are reached, the total displacement becomes m^3D ; and so on. These successive displacement totals decrease according to the law of a geometrical series. It follows that, in the limit, we shall have the total displacement represented by an exponential function of the time, say by

$$\mathrm{D} = \mathrm{D}_0 \epsilon^{-nt}, \quad \ldots \ldots \quad (1)$$

where D_0 is the initial value, and D what it becomes at time t. To find the value of n, we have merely to examine the form of the fraction m, observe how it depends on the conductance of one plate, and proceed to the limit by making the number of plates infinite, whilst their conductances are infinitely small. The result is that the constant n has the value k/c, where k is the conductivity and c the permittivity of the homogeneous conducting medium.

In the irrational units of the B.A. Committee this quantity is represented by $4\pi k/c$, which is, of course, nonsense, like the quaternionic doctrine about the square of a vector. They are both going to go. The above reasoning applies to any initial distribution of displacement in plane layers, instead of merely one elementary sheet. Therefore, equation (1) shows that the total displacement subsides according to the time-factor $\epsilon^{-kt/c}$. Now, this represents Maxwell's law of subsidence of displacement in a conducting condenser (apart from "absorption" and hysteresis), or of the static distribution of displacement associated with electrification in a conducting medium. We see that the law has a far more general meaning. The initial displacement need not be static, but may be accompanied by magnetic induction, and may consequently move about in the most varied manner, whilst its total amount decreases according to the static law. A homogeneous medium is presupposed, and modifications may be introduced by the action of boundaries.

Passing next to the analogous case of a magnetic conductor, in which the total displacement remains constant whilst the total induction subsides, it is unnecessary to repeat the argument, but is sufficient to point out the law according to which the subsidence occurs. If B_0 be the initial total induction, and B what it becomes at time t, we shall have

$$\mathrm{B} = \mathrm{B}_0 \epsilon^{-gt/\mu}, \quad \ldots \ldots \quad (2)$$

where g is the magnetic conductivity and μ the inductivity. The time-constant c/k of the former case has become μ/g.

Returning to the former case, it should be noted that when the initial distribution is of the static nature, unaccompanied by magnetic force, it retains this property during the subsidence. For, since the displacement subsides everywhere according to the same time-factor, its distribution does not alter relatively, or it remains similar to itself. Since, then, there is no magnetic force, there is also no true electric current. There is also no flux of energy. That is, the electric energy is converted into heat on the spot.

A considerable extension may be given to this property. If there be a conducting dielectric in which the permittivity varies from place to place, containing a static distribution of displacement, then, if the conductivity vary similarly from place to place, so that the time-constant c/k is the same everywhere, the displacement will subside everywhere alike, without magnetic force or flux of energy, and with purely local dissipation of the electric energy. For the solution is represented by

$$\mathbf{E} = \mathbf{E}_0 \epsilon^{kt/c}, \quad \mathbf{H} = 0,$$

where $\mathbf{E}_0$ is the initial electric force of the static kind, having no curl, and $\mathbf{E}$ that at time t. Both the fundamental circuital laws are satisfied, the first because the true current is the sum of the conduction and displacement currents, and the second because $\mathbf{E}_0$ has no curl and k/c is constant. If it were not constant then, obviously, the property considered would not be true ; there would be different rates of subsidence at different places, and the distribution of displacement would change, along with magnetic force, electric current and transfer of energy.

The corresponding property in a magnetic conductor requires the constancy of the time-constant μ/g. Then, whether μ and g are themselves constant or variable from place to place, a static distribution of induction subsides everywhere alike, and without the generation of electric force.

Returning again to plane strata of displacement in an electrically-conducting homogeneous dielectric, it may be inquired how the property (1) of the subsidence of the total displacement will be affected by the simultaneous existence of magnetic conductivity. This will undoubtedly affect the phenomena in detail, but will have no effect on the property in question. Similarly, the law (2) of the subsidence of total induction will not be affected by the presence of electric conductivity. That is, in general, when there are both conductivities present, and both the fluxes displacement and induction present, the total displacement subsides according to one law and the total induction according to the other, without interference. These properties have their parallels in the theory of telegraph circuits, as we shall see later.

It should be remembered that we are dealing always with matter in the gross, and not with molecules at all ; or, equivalently, we assume a homogeneous constitution of the elements of volume. Thus, when displacement subsides in an electric conductor without generating magnetic force, the possibility and necessity of which are clearly indicated by the two circuital laws, it may be that if we go in between the molecules there is magnetic force. It is, in fact, difficult to conceive how displacement in a heterogeneous medium of molecular constitution could be done away with without the generation of magnetic force, considering that the energy of the displacement is converted into heat energy.

This matter, however, does not belong to the skeleton theory of electromagnetism, but is rather to be considered as a side-matter involving physical hypotheses to account for the influence of matter upon the electromagnetic laws.

§ 196. Besides the above simple laws relating to the subsidence of the total fluxes (sometimes true for the elementary parts) there are equally simple laws relating to the subsidence of the fluxes at the front of a wave advancing into previously undisturbed parts of the medium, which sometimes admit of extension to the body of the wave. To understand this it may be mentioned first, that the front of a wave in a non-conducting dielectric is always pure ; that is, the electric and magnetic fluxes are in the wave-plane, and are perpendicular and in constant ratio. The body of the wave need not be of this pure type, owing to the change of form of the wave-front and other causes, but the property of purity always characterises the wave-front. This may be disguised in the case of a thin electromagnetic shell, when this is regarded as the front, for the shell itself may be complex. Then the mere front of the shell may be the only quite pure part. But taking cases free from this complication, we should next note that the

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introduction of conductivity into the medium makes no difference in the form of the wave-front or its position at a given stage of its progress, provided, of course, that the two quantities upon which the speed of propagation depends—the inductivity and permittivity—are not altered. Now, as has been already explained in connection with the theory of a thin conducting plate, as the wave advances through a continuously conducting medium its successive layers are being continuously subjected to a reflecting process, a minute portion of every layer being thrown back, whilst the bulk is transmitted. In the body of a wave, therefore, there is a mixed up state of things. At the very front, on the other hand, there is no such mixture, for the disturbance consists wholly of what has been transmitted of the front layer. We may, therefore, fully expect that the law of its attenuation in transit is of a simple nature.

To find it, locally condense the conductance into that of any number of equal conducting plates. Let any one of these plates attenuate a wave traversing it from E to mE. If initially pure it emerges a pure wave, and passes on to the next plate, where it suffers a second attenuation—viz., to m^2E, and again emerges pure. At the third plate it becomes m^3E, and so on. The reflected portions we wholly ignore at present. The limit of this process, when the plates are infinitely closely packed and of infinitely small conductance, so as to become a homogeneous dielectric possessing finite conductivity, is that the time-factor of attenuation takes the exponential form. The result is

$$E = E_0 \epsilon^{-kt/2c}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

E_0 being the initial, and E the value at time t. The time-constant $2c/k$ is just double that of the subsidence of total displacement. Whilst, for example, the total displacement in a plane wave attenuates to, say, $\frac{1}{100}$ of its initial value, the disturbance at the wave front has only attenuated to $\frac{1}{10}$ of its original value.

The property (3) applies to the magnetic as well as to the electric force and flux. It does not apply merely to plane waves, but to any waves, because the superficial layer only is involved, and any elementary portion thereof may be regarded as plane. So it comes about that the exponential factor given in (3) makes its appearance in all investigations of waves in electrical conductors when the permittivity is not ignored. It is a more fundamental formula than the previous one with the time-constant c/k, which is the final result of the complex process of mixture of reflected waves, or is equivalent thereto.

The corresponding property in a magnetic conductor is that the disturbance at the front of a wave is attenuated in time t according to the time-constant $2\mu/g$. Thus,

$$E = E_0 \epsilon^{-gt/2\mu}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Here the time-constant is twice that of the subsidence of the total induction. Like the former formulæ, these modified ones, (3) and (4), have their representatives in the theory of a telegraph circuit, in spite of the absence of magnetic conductance. It is replaced by something that produces approximately the same result.

In a conductor possessing duplex conductivity, electric and magnetic, their attenuative actions at the wave-front are independently cumulative, or additive. The attenuation is expressed by

$$E = \mu v H = E_0 \epsilon^{-(k/2c + g/2\mu)t}. \quad . \quad . \quad . \quad (5)$$

It is really the attenuative actions of a single conducting plate that are additive. This applies separately to every successive thin conducting layer through which the front of the wave runs, with the result (5), where the time-factor is the product of the two former time-factors of (3) and (4).

In the theory of coils and condensers, not only do we meet with the time-constants L/R and S/K, the ratios of inductance to resistance and of permittance to conductance, but also with the double values. Their ultimate origin may be traced in the theory of the effect of a thin conducting plate upon a wave.

The exponential time-factors concerned in (3) and (4), and the more complex one in (5) also make their appearance in connection with the disturbance in the body of a wave, though in a less simple manner. This will be returned to.

§ 197. Coming now to the influence of conductivity on a wave elsewhere than at its extreme front, where we have recognised that the influence is simply attenuative, the easiest way of treating the matter is not to pass from the known to the unknown, but to reverse the process and pick out the cases which theory indicates are most readily understandable. This is to be done by a process of generalisation. The theory of a conductor with duplex conductivity is, in a certain case, far simpler than that of a real electric conductor. We have already mentioned that the reflective actions of two plates, one an electric the other a magnetic conductor, are of opposite natures. The first reverses the displacement, and the second reverses the induction when throwing back a portion of the wave. The joint action of the two plates when coexistent and coincident, or the action of a single plate with duplex conductance, results in a complete disappearance of the reflected wave when the conductances are in proper ratio and the plate is infinitely thin. We then have transmission with attenuation but without reflection. This occurs, in a homogeneous medium, when $k/c = g/\mu$. Reflex action being abolished, we are reduced to a kind of propagation of unique simplicity.

To see the full meaning of this, start from any initial distributions of induction and displacement in a non-conducting dielectric. Imagine that we have obtained the full solution showing the subsequent history of the disturbances. Now, if we introduce only one kind of conductivity, we shall, with the same initial state, have a profoundly different subsequent history. Again, with magnetic conductivity alone, we shall have a course of events different from both the previous. But if we add on magnetic conductivity to previously existent electric conductivity, we shall partly counteract the distorting influence of the latter. This counteraction becomes complete when the value of the magnetic conductivity is raised so high as to produce equality of the time-constants of attenuation due to the two conductivities separately. Further increase of the magnetic conductivity will overdo the correction and bring on distortion again, though of a different kind.

Similarly, the distortion due to magnetic conductivity alone is diminished by introducing electric conductivity, and becomes completely abolished when there is enough of the latter to equalise the time-constants. Further increase brings on the distortion again, which is now of the electric kind.

When the state of balance occurs, and the distortion is wholly removed, the course of events following any initial state is precisely the same as in a non-conducting medium, but with a continuous attenuation expressed by equation (5) above specialised to suit the equality of the time-constants. That is, the time factor of attenuation is now $\epsilon^{-kt/c}$. This removal of distortion applies to every kind of wave.

This distortionless state in conducting media furnishes a sort of central basis for investigating the more recondite effects accompanying distortion. Nevertheless, its consideration would possess only a theoretical value, on account of the non-existence of the second kind of conductivity involved, were it not for the remarkable practical imitation of the distortionless state of things which is presented in the theory of telephone and other circuits under certain circumstances. If we abolish the fictitious magnetic conductivity throughout the medium traversed by the waves, we should, to have distortionless transmission, also abolish the electric conductivity. This is only to be attained by using wires of no resistance to guide the waves through a non-conducting medium. But they have resistance, of greater or lesser importance according to circumstances. Of what nature, then, is the distortion of waves produced by the resistance of a wire along which they run? The answer is, that it is approximately of the kind due to magnetic conductivity in the medium generally. On the other hand, the different kind of distortion due to electric conductivity in the medium generally remains in action, being the effect of the leakage-conductance of the insulating medium surrounding the wire, or the average effect of other kinds of leakage at distinct and separate spots along the circuit. Thus we obtain an approximate reproduction of the theory of magnetic conductivity acting to neutralise the distorting effect of electric conductivity. The time-constants μ/g and c/k become L/R and S/K in a telegraph circuit,

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L being inductance, R resistance, S permittance, and K leakage-conductance. Their equalisation produces the distortionless circuit, which may turn up again later on. In the meantime I may remark that if the reader wishes to understand these things, he must give up any ancient prejudices he may be enamoured of about a "KR law" and the consequent impossibility of telephoning when "KR" is over 10,000. When pointing out, in 1887, the true nature of the telephonic problem and the absurdity of the "KR law" applied thereto generally, I predicted the possibility of telephoning with "KR" several times as great. It has since been done. In America, of course. A short time since, in noticing the KR = 32,000 reached by the New York-Chicago circuit, I further predicted that it would go up a lot more. It did very shortly after. The record is now about 50,000 (Boston-Chicago) for practical work, I believe. It means a good deal more for possible work. But there is no need to stop at 50,000. That can be largely exceeded in an enterprising country.

(*To be continued.*)

SOME APPLICATIONS OF ELECTRICITY TO CHEMISTRY.*

BY JAMES SWINBURNE.

It would be quite impossible to give any adequate idea of the applications of electricity to chemistry in three short lectures. Now that dynamo-electric machines are made which give high efficiencies, and which are low in first cost, the applications of electricity to commercial chemistry are increasing, we may truly say, every week, and the future development of electro-chemical work will be so enormous that even a bird's-eye view of the subject ought to prove interesting. It will be unnecessary to go into commercial questions; what will be attempted is a glance at the scientific basis of some of the more interesting and more important applications of electricity to chemical industry.

Most of the applications depend on the electrical decomposition of saline solutions, or electrolytes. When electricity is passed through an electrolyte it is split up into two components of which one is in a higher, and the other in a lower, state of oxidation. In the simple case, for instance, of passing electricity through water, oxygen is produced at one pole and hydrogen at the other. Again, if, for instance, chloride of copper is electrolised, chlorine comes off at one pole and copper at the other. The copper is said to be reduced, as chloride of copper, though it contains no oxygen, is considered to be in a higher state of oxidation than the original copper, because the chlorine takes the place of oxygen. Similarly, chlorine is in chemical language in a higher state of oxidation than a chloride, because it is obtained by oxidising a chloride; for instance, by treating it with sulphuric acid and manganese dioxide. These terms are, unfortunately, very loose, and it would be much better to speak of salts, and of electro-positive and electro-negative radicles, the radicles being the components of the salt that are separated by the passage of electricity. As the terms oxidation and reduction are already so extensively, though loosely, used, and as they apply also to chemical actions performed on bodies which are not electrolytes, it will be better to adhere to their use.

A glance at the work of the chemist shows that a very large proportion of his labours consists in oxidising or reducing the various substances with which he deals. Sometimes he is making changes or substitutions, but his chief work is oxidising and reducing. Here, then, we have at once the reason why electricity is becoming so important. Consider for a moment the advantage of the electrical over the chemical method. Take the case of water already mentioned. To reduce it to hydrogen it would have to be, let us say, heated in contact with iron, carbon, or something which has enough affinity for oxygen to abstract it from the water. In this case, the hydrogen is set free but the oxygen is not; it is combined with another body. Again, to oxidise the chloride some such treatment as that with manganese dioxide and sulphuric acid is necessary. By electrolysis, however, the oxygen and hydrogen, or the copper and chlorine, are produced direct without any complications and without introducing foreign substances. When it is remembered that many of the ores from which metals are obtained are oxides, and that the smelting of these consists of reduction only and is carried out in a manner which gives impure metals, and that the remaining ores are mostly sulphides, which are roasted into oxides and then reduced, it will be realised that electricity has a magnificent future in metallurgy. This is not by any means all. The important alkali industry consists of splitting up common salt into caustic soda and chlorine, and the process of manufacture, as at present carried on, is a bewildering maze of oxidation, reduction and substitution. In making alkali and bleaching powder by the Leblanc-Weldon processes, beginning with salt and pyrites and ending with caustic and chlorine, there are, taking it favourably, four oxidations, one reduction and three substitution processes. By electrolysis, salt is decomposed into caustic soda and chlorine at one operation without the aid of any other chemicals, and without any waste, loss, or by-product. Direct electrolysis of solutions of salts is by no means the only process available; fused salts can be electrolised, and aluminium is reduced extensively from its salts by this method. It is probable that sodium and potassium will soon be produced from their fused salts in the same way.

Electricity provides the chemist with still another powerful method for treating refractory substances. If electrical energy is spent rapidly in a confined space, so that the heat produced cannot escape easily, any temperature may be reached short of the melting or volatilising points of the materials employed. This is the electrical furnace, which will be dealt with in a later lecture.

The oldest, and by no means the least important, application of electricity is electro-plating. The process of electro-plating with silver, gold and nickel is so well known that it will be better not to devote the short time at disposal to their consideration, except to mention a few recent developments. Electro-plating with silver containing a small percentage of cadmium or "Arcas" plating is a recent improvement. The sulphide of cadmium is yellow, and as it combines with sulphur more readily than silver, it is said to absorb the sulphur and to form a thin coating of cadmium sulphide, which protects the silver so that it is not blackened by fumes of sulphuretted hydrogen. Prof. Silvanus Thompson strongly advocates the substitution of cobalt for nickel, as it does not tarnish so easily and does not become yellow. Mr. J. W. Swan has also recently developed processes for rapid deposition of copper for electrotype and such purposes.

The metal deposited by electrolysis is, unfortunately, in a crystalline condition, and this is frequently a source of trouble. As a striking example of abnormal molecular state, Gore's explosive antimony may be mentioned. This is electrolytically-deposited antimony, in which the particles appear to be under constraint, or in a state of unstable equilibrium. If the metal is touched with a hot wire it undergoes an internal change by which it developes so much heat that it rises to a high temperature. A rod of tin which has been thickly coated with a deposit of antimony can be melted if the antimony is discharged. The metal here almost seems to be in an allotropic state, as in the well-known cases of plastic sulphur, or iodide of mercury. Several metals are deposited in trees or masses of fine crystals, which are so bulky that they cannot be dealt with practically. This is the case, for instance, with lead in acid solutions. In alkaline solutions the deposit is closer. Many of the more easily oxidised metals, such as sodium and potassium, cannot be deposited by electrolysis from aqueous solutions, as the metals themselves decompose water. It is curious that they can be deposited into mercury, forming an amalgam. The amalgam itself will, in some cases, decompose water, but more slowly, and the attraction of the mercury for the sodium or potassium seems to partly counteract the tendency to form the hydrate. The affinity of mercury for these metals is so

* A course of three "Tyndall" lectures at the Royal Institution.

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strong that they flash when they make contact with mercury. It is a remarkable fact, however, that in some cases the metal seems to be deposited not in the mercury but on its surface, amalgamation taking place afterwards. This can be seen easily in the case of lead. Lead trees can be formed on the surface of the mercury, but the least vibration will cause the mercury to amalgamate the tree and draw it in. A slender tree a few inches long will be drawn in, and amalgamated so quickly that the eye cannot follow the motion. The amalgam of aluminium is instructive. When it is exposed to the air, the aluminium oxidises and produces a sort of white fur of alumina. The combustion of the aluminium is sometimes rapid enough to cause considerable rise of temperature. This shows that aluminium does not really remain clean and bright, but that the surface oxidises and a thin protective layer of oxide is formed which prevents any further action. It is this layer which prevents the metal being soldered easily, especially as there is no flux which will dissolve alumina without attacking the aluminium. In the case of amalgamation, the oxide does not protect the metal from further action, as it cannot adhere to the surface of the mercury; the oxidation, therefore, goes on till the aluminium is all oxidised. Electro-deposition is now largely practised in copper refining. Crude copper is cast into anodes and placed in vats of sulphate of copper with thin sheet copper cathodes. The copper is dissolved off and deposited on the thin cathode plates. The silver and gold fall to the bottom, with various impurities, such as antimony and arsenic. The silver and gold are thus completely separated, and the crude copper is changed for the much more valuable pure product. Lead would be treated in much the same way, if it were not that it is apt to deposit in a loose spongey form, instead of in a coherent mass. Electrical processes are also coming into use by which many of the ores are merely roasted to convert them into oxide, and then dissolved in acid, the solution being electrolised to yield the metal in a state of almost perfect purity.

One of the most important applications of electricity will be, as already hinted, in the manufacture of soda and bleaching powder direct from salt. If a solution of salt is electrolised, caustic soda is produced at the cathode and chlorine is given off at the anode. The chief difficulty is to find a good material for the anodes. No metal will do, for all metals would be attacked by the chlorine, chlorides being formed. Carbon is the only material available. It is attacked to some extent, not by chlorine but by oxygen; but electrolytic soda has now reached a stage in which this last difficulty may be said to be overcome by using a form of carbon which is so cheap that its corrosion does not much matter. At Snodland there is a model caustic plant at work which has been making soda and bleaching powder by the ton for some time. The solution of caustic made by the process described contains a great deal of undecomposed salt, which is a drawback, and to overcome this difficulty a very ingenious arrangement has been recently proposed by Kellner and by Vautin. As has just been explained, sodium can be deposited into mercury, and this property is utilised in a curious way. The anode is in one chamber and the cathode in the other, and the two are separated by a partition of mercury. Two complete cells are thus really produced. In the chlorine cell the carbon is the anode and one side of the mercury is the cathode. Sodium is deposited into the mercury. In the caustic compartment the other side of the mercury forms the anode, and the sodium is dissolved out hydrogen coming off at the cathode. By this means the caustic is obtained pure, without the admixture of salt.

If, on the other hand, the caustic is allowed to mix with the rest of the liquid, chlorine is no longer given off, but the salt is changed to hypochlorite of soda. This may be used for bleaching. If the operation is now carried on at a higher temperature, chlorate is formed. Chlorate of potassium is now manufactured on a large scale from the chloride in this way.

So far, we have chiefly considered the commercial applications of electricity. It must be remembered that it was by electrical means that sodium, potassium, magnesium, lithium, strontium, barium, and calcium were first produced. All these metals, with one exception, were first isolated by Sir Humphry Davy, Professor of Chemistry at the Royal Institution. More recently, electrolysis has been used in the endeavour to isolate fluorine, by electrolising fluoride in a vessel made entirely of a fluoride. In chemical analysis, again, electricity can be a great help. By its means metals can be separated which are troublesome to deal with by purely chemical methods. As an example of the application to analysis, testing for arsenic in forensic cases may be mentioned. It has been usual to evolve hydrogen from zinc, the hydrogen being contaminated with arseniuretted hydrogen if arsenic is present. Unfortunately, zinc is apt to contain arsenic, and where the life of a human being may depend on the result of a test it is most important to avoid all chances of error. The hydrogen should, therefore, be evolved electrically from a platinum plate, so that at least one source of error is eliminated.

One of the most complicated branches of the study of chemistry is the formation of dye stuffs. Oxidation and reduction can frequently be carried out by electrolysis without introducing special oxidising and reducing agents. Here, then, is a wide field for scientific research. Dr. Goppelsroeder has done a great deal of work on the subject, but it is well worthy of further attention. Whether such a process is valuable commercially is a matter of doubt, but it provides the chemist with a new method of investigation, and may lead to important discoveries in this branch of organic chemistry.

Electricity also derives benefits from chemistry. Faraday discovered that the quantity of metal deposited was strictly proportional to the quantity of electricity passed through the solution. This has provided electricians with a very exact method of measuring quantities of electricity. Lord Rayleigh has made very careful determinations of the exact weight of silver deposited by a unit quantity of electricity, and this measurement now serves as the practical standard for the measurement of electricity, and hence of electric currents.

[Various experiments were made during the lecture, showing the decomposition of water, the translation of copper from one pole to the other, the production and properties of sodium and aluminium amalgams, the production of caustic and bleach, the production of oxygen and hydrogen by electrolysis, and the production of aniline colours.]

A COLLECTOR OF ATMOSPHERIC ELECTRICITY.*

BY L. PALMIERI.

The apparatus is based on the principle that as a conductor is raised in the open air it collects positive electricity (in ordinary weather), and that then after discharge it collects negative elec-

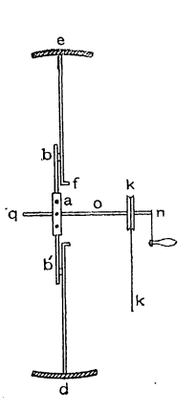

FIG. 1.

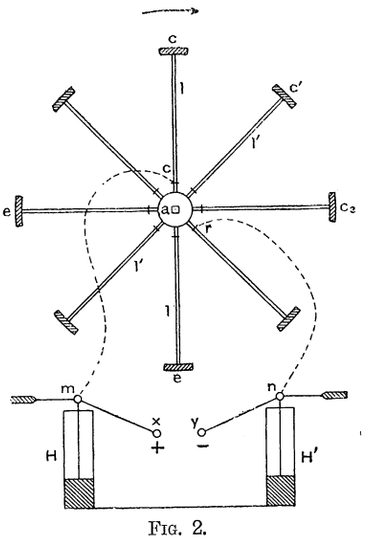

FIG. 2.

tricity as it descends. Since 1850, the date at which I undertook the study of these phenomena conjointly with those of the ascending and descending liquid vein and others, again, which I called

* From *La Lumière Electrique.*

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phenomena of approach and recession, I conceived the idea of constructing a rotary electrical machine which became a source of electricity on fine, calm days. I made an entirely rough piece of apparatus, which is shown in several editions of my "Leçons de Physique," but it was always my intention to give it a convenient form and to add a suitable condenser. It is this rough piece of apparatus which is shown diagramatically in the accompanying illustrations.

Let *a* (Figs. 1 and 2) be a modern disc, upon the circumference of which are fixed eight insulated rods *b b'* (Fig. 1). These rods carry an equal number of conductors *l l'*, terminated at the top by narrow strips *c c'* of any convenient length; at the bottom the rods are terminated by little elbows *f*. Both wheel and spokes can be made to revolve rapidly round the axle *q n o* (Fig. 1) either by means of a handle or an endless cord *k*. A spring or strip of metal touches the projection *f* of each spoke as it reaches a vertical position, and a second one presses against the spokes as they come to the diametrically opposite position, so that positive electricity is collected at *c* and negative at *r*. At H and H' are placed two Leyden jars similar to those used in the Toepler and Holtz influence machines, *x* being the + terminal and *y* the − terminal of the machine.

Such is the collector in all its simplicity. In this note I only wished to describe its principle, and will say something at another time about the effects it enables one to obtain.

THE FUTURE OF PLATINUM.*

The fact that one of the greatest electric light companies has introduced a lamp that contains no platinum, the use of which has been considered indispensable, makes pertinent the query: What will be the future of this metal?

Since the introduction of the incandescent electric lamp in 1880 the consumption of platinum, not only in the United States, but also in Europe, has increased rapidly, although improvements made from time to time have greatly reduced the amount used in each lamp. In 1886-7 the Edison 16-c.p. lamp contained one grain, and the Sawyer-Mann lamp two grains; at present the Edison lamp contains but one-seventh of a grain, and the new Sawyer-Mann lamp none at all. In England the Edison-Berliner lamp, and in Germany the Siemens-Halske lamp have likewise had the amount of platinum reduced to a minimum, owing, as in this country, to the use of a shorter wire of a smaller diameter. Notwithstanding this, however, the gross amount of platinum used in this country and Europe in the manufacture of electric lamps has steadily increased from nothing in 1880 to about 55,000oz. in 1892. If the new Sawyer-Mann lamp should prove to be a success, of which, however, there is yet no proof, it might eventually replace all the other kinds of lamps now in use, and consequently this particular demand for platinum would cease.

On the other hand, however, it is to be observed that all the manufacturers of incandescent lamps have large plants already established, and that the amount of platinum used per lamp has been reduced to a minimum, so much so that its value forms less than 5 per cent. of the value of the lamp. Consequently it is quite probable that platinum will continue to be used in electric lamps, and that the amount so used will continue to increase with the growth of the industry.

There are, moreover, two other uses for platinum, which are even more important than its use in electric lighting, namely, the construction of stills for the concentration of sulphuric acid and the wires by which artificial teeth are firmly fastened to a plate. The amount used for stills varies widely from year to year, being greatly dependent upon the number of new plants started each year, but it has been estimated that the average amount so used during the last few years is about 80,000oz. The manufacture of sulphuric acid is bound to increase, and although glass concentrating vessels are now being used to some extent, it is believed that this industry will continue to supply a constantly increasing demand for platinum. For dental purposes platinum will always continue to be used, being the only metal which possesses the required properties of infusibility, ductility and strength. In the United States 35,000oz. and in England 25,000oz. are annually used in this industry, and this amount will probably increase at the rate of 2 or 3 per cent. per annum. The other uses of platinum, such as chemists' crucibles, jewellery, plating, &c., consume about 20,000oz. annually, making the entire consumption about 215,000oz. or 6,680 kilos. Of this amount from 30 to 40 per cent. is old or scrap platinum, which leaves from 4,000 to 4,676 kilos to be annually supplied by the mines.

For many years the Siberian Urals have supplied the greater part (92 per cent.) of all the platinum used in the world, but it is questionable whether its output can be maintained at its present high level for many years. According to the official statistics of the Russian Department of mines, the output of platinum in that country reached its maximum, 4,400 kilos, in 1887, following which it dropped to 2,700 kilos, and so remained until 1891, when, owing to the abnormally high price of the metal, the production amounted to 4,226 kilos. Many of the old placers are now worked out, and it is believed that the above figure represents the maximum possible output of the country. If, then, the demand should continue to increase, as seems possible, it will be necessary to look for other supplies of the metal. Next to Russia the most important sources of platinum, so far as known, are Colombia, British Columbia, and the United States. At present Colombia produces but 125 kilos of platinum per annum, entirely the result of native washing. The platiniferous area, although of low grade, is, however, quite extensive, and in part suitable for hydraulic mining. A considerable amount of American capital has already been invested there, and it is quite probable that Colombia will become an important producer of the metal. The only platinum deposits of importance in British Columbia are found on the Talameen River. Recently a company has been formed to hydraulic these gravels, but so far the output has been small. The total production of British Columbia is about 65 kilos. In the United States much prospecting has been done to find platinum in paying quantities, but so far without success, and up to the present time all the platinum produced has been incidental to the production of gold from various auriferous gravels in California and Oregon. If the laws prohibiting hydraulic mining in California should be repealed, that State may become a more important producer of platinum.

* From the *Engineering and Mining Journal* of New York.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, April 21st.

INSTITUTION OF MECHANICAL ENGINEERS.

7.30 p.m. Ordinary General Meeting.

BALLOON SOCIETY.

8 p.m. Address at St. James's Hall: "Telephonic Communication in the United Kingdom," by A. H. Hastie.

OLD STUDENTS' ASSOCIATION.

8 p.m. Smoking Concert at Masons' Hall Tavern.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Possible and Impossible Economies in the Utilisation of Energy," by Prof. A. B. W. Kennedy, F.R.S.

SATURDAY, April 22nd.

ROYAL INSTITUTION.

3 p.m. Tyndall Lecture (2): "Some Applications of Electricity to Chemistry," by James Swinburne, M.Inst.E.E.

TUESDAY, April 25th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "Steam-Engine Trials," by the late P. W. Willans, M.Inst.C.E.

WEDNESDAY, April 26th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Optical Correction of Photographic Perspective," by H. Van der Weyde.

THURSDAY, April 27th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "The Atmosphere," by Prof. Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be further discussed: "The Distribution of Power by Alternate Current Motors," by Albion T. Snell, M.Inst.E.E.

FRIDAY, April 28th.

PHYSICAL SOCIETY.

5 p.m. Paper to be discussed: (1) "Experiments on the Viscosity of Liquids," by Prof. J. Perry, J. Graham, and L. W. Heath. Paper to be read: (2) "On Luminous Discharges in Electrodeless Vacuum Tubes," by E. C. Rimington.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Students' Meeting. Paper to be read: "Fire-Risks of Electric Lighting," by H. W. Handcock, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Transmission of a Nervous Impulse," by Prof. F. Gotch, F.R.S.

SATURDAY, April 29th.

ROYAL INSTITUTION.

3 p.m. Tyndall Lecture (3): Some Applications of Electricity to Chemistry," by James Swinburne, M.Inst.E.E.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not late than Thursday, 6 p.m.

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MATHEMATICS IN PLACE AND OUT OF PLACE.

Mathematicians in search of new pasture, and practical men anxious to see what will happen when the "professor" is eliminated, should peruse a Paper on transmission of power, recently read before the National Electric Light Association by Mr. L. B. STILLWELL. "We may conveniently construct an algebraic skeleton," says the author, and he forthwith proceeds to do so. Whether this skeleton is to be kept in a cupboard, and only taken out at Institution meetings from which the professors will have already been eliminated, we are not informed. Here is the skeleton, or a small part of it:—"Fh—First cost of hydraulic plant, including turbines, dams, flumes, &c. Ph—Percentage covering interest upon and maintenance of hydraulic plant. Oh—Cost of oil and waste per annum for hydraulic plant." And so on, and so on. Then we arrive at the following mathematical equation, which, at first sight, we took to be a chemical equation in which iron and carbon, oxygen and nitrogen, and several unknown elements—which, doubtless, were the undiscovered members of MENDELEJEFF's celebrated cycles—had got considerably mixed up :—"PbFb + Cb + PhFh + Oh + Ch + AN + PeFe + Oe + Ce + PlFl + Cl = annual charges." "And now," continues the author, "what have we accomplished?" What, indeed? As a piece of anatomical mathematics this cannot compare with the efforts of the man who can cover the Institution blackboard with formulæ three times, before members have had time to get their pencils out of their

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pockets; but as a piece of practical intelligence, it is a mere string of laboured nothings, calculated to "amaze the unlearned and make the learned smile." Let *Sh* be the shovel at the station, *Sw* the switchboard, and so on; then the equation to the station is $Sh + Sw + MeN + BeEr + BaC^2y$ + &c., which is a parallel piece of mathematics.

If electrical engineering cannot get along without mathematical treatment, then, *pollice verso*, let the mathematician live, and let us employ him to do the necessary work. But if, forsooth, it can, where is the advantage in this spurious semblance of mathematical form, which is the mania of some un-mathematical men? The pressing of mathematics into places where they are not needed, is as foolish as their exclusion from places where they are essential. Undoubtedly, there is an unfortunate tendency now-a-days to overburden every branch of electrical work with mathematics, to the detriment of practice. Other subjects, other industries, might equally well be mathematically treated. We have seen a series of elaborate equations, involving trigonometry and the theory of impact and elasticity, explaining a game of cricket; and it would be quite possible to write a book full of triple integrals and slant coefficients in three dimensions, to explain the operations involved in carving a statue. Mathematical form, unless there be in it the breath of practical life, is, indeed, a skeleton; and it would be labour ill-spent to try and galvanise it into living activity. There is not the least objection to the application of mathematics to cricket; but they remain mathematics, they do not become cricket. Prof. TAIT has indeed not only applied mathematics to golf, but has done much better service in applying golf to mathematics, and with most interesting results. But these results were no longer within the province of golf; they formed a valuable contribution to our knowledge of elastic bodies and impact. To deny that mathematics are essential to progress in the higher branches of engineering, is to confess ignorance of those branches; but to burden elementary work with abstruse calculations and with pedantic definitions, is likely to bring about contention between the practical man and the theorist. A pedant is all very well in his place, but he should not come into the workshop and snub the man at the vice.

A distinction should be observed between accuracy of elementary knowledge, and high theoretical attainments. It is important that every engineer should have exact and clear ideas as to the relations between force, power, work, and energy, and the electrical engineer must be familiar with other electrical relations. These elementary laws have an apparent connection with mathematics, because mathematicians have defined them. But the mathematics of Ohm's law go no farther than the rule of three. If some of the simple facts of engineering and of electrical science could be divested of the mathematical garb in which professors delight to clothe them, the beginner would advance with much less hesitation. He is too often presented with a fact swathed in algebraical attire, bound with many a hard and knotted formula, and decked with streaming expanded terms, tasselled at the end with "+, etc." He ultimately makes acquaintance with the fact itself, and this acquaintance continues long after the mathematical millinery has been discarded by the mind.

A sailor has a good deal to learn before he need trouble himself about taking lunar distances; and a soldier must be familiar with squad drill before he makes an acquaintance with brigade drill, and he may do excellent service as a tactician without aspiring to strategical accomplishments. Every French soldier is told that he carries a field-marshal's *bâton* in his knapsack, and, with hardly more sense of fitness, young engineers and electricians are encouraged to equip themselves with a mathematical armoury such as might enable them, if they had the wit, to take a hand in original research of a high order. That is where the waste and the pedantry come in. Theory, and, if need be, mathematics, in healthy co-operation with practical work, are to-day essential for real progress. The rule-of-thumb man progressed, it is true, but not fast enough for to-day. The ready mathematician, on the other hand, is apt to ignore essential conditions and to rush on wildly with loose assumptions, conjectural data, and vague hypotheses, imagining all the time that he is an engineer.

THE CONSTRUCTION AND USES OF PROJECTORS.*

The great modern development of the projector is due to the extensive use which will be made of it in both naval and military war operations, where the power of rendering visible distant ships or bodies of men will be of enormous value. The most essential part of a projector consists of an optical means whereby the rays of some source of light are collected by reflection or refraction, and projected in the form of a beam towards the distant object which it is desired to illuminate. The efficiency of a projector depends (1) on the size of the "useful angle"—that is, the angle contained by the rays which are reflected or refracted by the extreme edges of the projector, this angle being a measure of the amount of the radiation which is effected by the projector; (2) on its capacity to transmit the radiation collected with the minimum of loss to the object to be illuminated; (3) on the nature of the source of illumination. The most important point is to determine the efficiency of the various optical devices possible with respect to the two former of the above considerations.

The original use of projectors was for lighthouses, and the most obvious method was employed, namely, the use of parabolic mirrors of metal, these mirrors converting the rays falling on them into a parallel beam. The objections to these mirrors were firstly, difficulty of construction, secondly, the fact that the polish is soon lost, and thirdly, the low reflecting power. Researches by Prof. Potter gave a loss of 31 to 35 per cent. for "mirror-metal," and Stephenson found for polished silver and an angle of reflection of 45° that the loss was about 44 per cent. Silvered glass is much better, but it was found impossible to make sufficiently accurate parabolic mirrors out of glass. Later on spherical mirrors were used instead of parabolic, which led to the difficulty that the "useful angle" was small; for if the angle used be too great, the dispersion becomes so great that no advantage is obtained.

Fresnel was the first to introduce great improvements in lighthouse apparatus; his system has been applied also to projectors. A convex lens forms an admirable means of refracting rays coming from its focus in such a manner as to forward the rays in an approximately parallel beam so long as the diameter of the lens is small compared with the focal length; but it follows that only a limited proportion of the radiation can be utilised. If the useful angle be increased, the spherical aberration begins to become important and destroys the parallelism of the beam, and in addition to this the light becomes more split up into a spectrum, and the absorption increases in consequence of the increased thickness of glass. In order to avoid these drawbacks, Fresnel built up his lenses of concentric rings, and he surrounded these in addition with a system of completely-reflecting prism rings, in order to collect the light falling outside the lenses as well. In this manner he was able to diminish the spherical aberration by choice of suitable radii of curvature, and the absorption in consequence of the diminished thickness of glass. The total reflection prisms also constituted a most valuable reflecting device; but in spite of these improvements, which still make the Fresnel apparatus the best for lighthouse work, the instrument is not entirely the most suitable for projector work in view of later inventions. It is difficult to make the

* Abstract from a Paper presented to the Verein Deutscher Ingenieure by F. Nerz.

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glass rings so exactly that the foci of all are coincident, and they still retain spherical and chromatic aberration, and if the light gets displaced from the focus the reflected and refracted rays deviate in opposite directions from parallelism with the axis, and thus a considerable diminution of intensity is produced—*see* Fig. 1.

A great step forward was made in the construction of projectors when Mangin showed that in spherical concave mirrors the deviation from parallel reflection could be almost entirely eliminated, if the inner surface has its centre of curvature nearer the mirror than the outer and reflecting surface (Fig. 2). By making it thus lenticular in form, the ray which falls on the mirror and is reflected by its convex side is

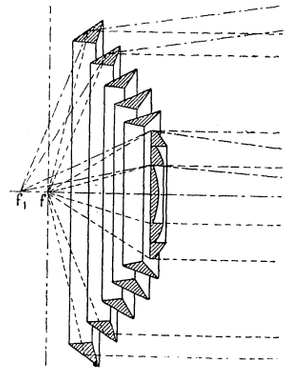

FIG. 1.

refracted at the concave surface by an amount which can be made, by suitable adjustment of the magnitudes, to very nearly compensate for the loss of parallelism by spherical aberration of the reflecting surface. The law was determined by Mangin, who found that the spherical aberration could be considered as eliminated when the diameter of the mirror was not greater than its focal length. In Fig. 2 is shown a mirror constructed on this principle in 1876; the radii were 120·0 centimetres and 160·0 centimetres for the concave and convex surfaces respectively, and the focal length was 101 centimetres. This mirror possessed the property of reflecting light emitted at its focus in a parallel beam in the highest degree up to that date attained. On the other hand on account of the great focal length, it could only use a source of illumination to a certain limited extent, its "useful angle" being about 60°. The next improvement made by Mangin

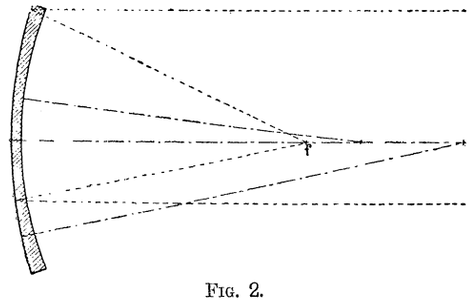

FIG. 2.

and Messrs. Sautter, Lemonnier and Co. was to put lenses between the light and the mirror, and the useful angle was thus increased to 100°; but the improvement was not very practical and was soon given up, the focal length was reduced by choice of suitable glass, and the makers contented themselves with an approximation to the law given by Mangin.

Tschikolew, of St. Petersburg, was working at the same time on reflectors for projector work and returned to parabolic mirrors; but since these could not be constructed whole out of glass, he built them up of spherically-ground rings, whose centre of curvature lay on the point of intersection of the axis with the radius of curvature of that piece of the parabola which they were intended to replace; while Siemens and Halske attempted to improve on these by making the two centres of curvature as nearly as possible coincident. The construction of such mirrors is a matter of considerable difficulty; and they have, in common with the Fresnel apparatus, the drawback, that the foci of the component parts are not easily made coincident, and further, that at the joints considerable portions of the mirror are always rendered useless; and in consequence of these defects these mirrors, though they surpass the Mangin type in the proportion of the light reflected, are inferior in general utility.

The first rival to the Mangin mirror which really surpassed it was that of Schuckert, who in 1886 succeeded in evolving, in common with Prof. Munker, a process for making parabolic mirrors in glass out of one piece, and thus practically solved the question for all time.

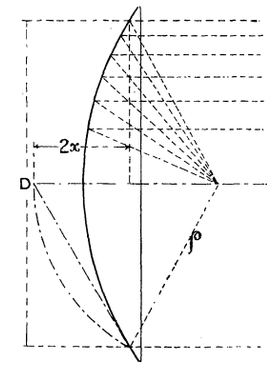

FIG. 3.

Let us consider first a luminous point in the focus of a true parabolic mirror; all rays falling on the mirror will be reflected in a direction parallel to the axis (Fig. 3). If the light is of the intensity J, then the amount of light gathered by the mirror is $= 4\pi J \rho x$; where ρ is the radius vector of the edge of the mirror, and $2x$ is the subtangent of the corresponding point on the parabola (*see* Fig.). The light so gathered by the mirror would be reflected as a perfectly cylindrical beam, and in a non-absorbent medium would travel to infinity without any diminution of intensity; at any given distance a circle of the size of the mirror would be illuminated, and if any object were brought into the beam, a true shadow picture would be projected to any distance. If the focal length be made shorter, the light can be taken up

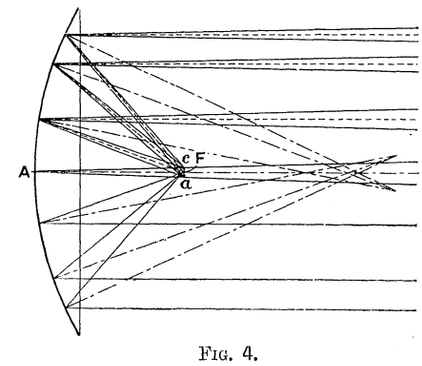

FIG. 4.

by a mirror of smaller diameter, and consequently since the area of the beam would be diminished, the intensity of illumination in it would be increased; but, of course, all this applies only to a perfectly parabolic reflector. Both Mangin mirrors and those constructed of spherical rings give, in consequence of their spherical form, a deviation from parallel reflection, and make a conical instead of a cylindrical beam, which produces a diminution of intensity with distance proportional to the increase in the area of the beam. A source of illumination confined to one point does not exist, and has no practical value. Even were it possible to recognise objects 1,000 yards distant, of which a surface equal to that of the mirror was illuminated, and if this surface could be sufficiently examined in one second, it would take about two hours to examine the whole horizon.

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Every source of light has sensible dimensions. Suppose a spherical luminous body of intensity J in the focus of a parabolic mirror, then the light falling on the latter is

$$L = 2\pi J r h = 2\pi J r^2 (1 - \cos \phi/2) = 4\pi J r^2 \sin^2 \phi/4,$$

where r is the radius of the luminous sphere, and ϕ is the angle made by the rays falling on the edges of the mirror, or what we have called the "useful angle."

The average intensity (J_m) of the light measured at the mirror is given by

$$J_m = \frac{4\pi J r^2 \sin^2 \phi/4}{\rho_x^2},$$

where ρ_x is the average radius vector of the parabola.

If the source is not a sphere, but only a portion of one, and if the piece which enters into our calculation has the surface of diameter $d = a\,c$ (Fig. 4), and if f be the focal length of the mirror, then those rays which coincide with the radii vectores are reflected parallel to the axis, and the angle included between the rays aA and cA is a measure of the deviation from parallelism produced by the extension of the source of light, and gives the amount of (theoretical) dispersion, or the "illumination-angle" for a given source of illumination. The light is similarly dispersed at all points in the mirror, but the angle decreases as the distance from the centre increases; every point produces a cone of light whose axis lies parallel to that of the mirror. As all the axes of the cones lie in a cylinder whose diameter is that of the mirror, but the surfaces of the base of the cones at any distance have different diameters, the illumination produced by a projector must be most intense in the centre and fall off towards the sides. Since the several light rays can only at a considerable distance from the mirror be considered as coming from a point, but near it cross one another in endless number, objects placed near the projector cast no shadow, and the sharpness of the shadow increases with the distance. The largest angle of divergence of the light rays after reflection is called in this Paper the "angle of illumination," and is given by the formula

$$\tan \alpha/2 = d/2f.$$

At a distance e from the projector (e is supposed to be relatively large), a surface is illuminated whose diameter is

$$F = ed/f,$$

and this surface, if the mirror absorbs no light, is illuminated by the amount of light

$$L = 4\pi J r^2 \sin^2 \phi/4.$$

If there were parallel reflection, the surface illuminated would be

$$F = \pi D^2/4.$$

where D is the diameter of the reflector. Now the intensity of illumination J_2 of the field is diminished in the ratio of the squares of the diameter

$$D^2/F^2; \text{ and hence}$$

$$J_2 = \frac{4\pi J r^2 \sin^2 \phi/4\, D^2}{\rho_x^2 F^2}.$$

If for ρ_x we substitute its value

$$\rho_x = \frac{2f}{1 + \cos \delta/2} = \frac{f}{\cos^2 \delta/4},$$

where δ is the angle made by the average radius vector with the axis, and also for F^2 the value $\frac{e^2 d^2}{f^2}$, we have

$$J_2 = \frac{4\pi J r^2 \sin^2 \phi/4\, D^2 \cos^4 \delta/4}{d^2 e^2}.$$

If the surface of diameter F were directly illuminated by a similar source of light, no mirror being used, then the intensity would be

$$J_3 = \frac{4\pi J r^2 \sin^2 \phi/4}{e^2},$$

and the ratio of J_2 to J_3 gives a measure of the increase in illumination due to the projector (or what we may call its "ratio of intensification"); in this case

$$J_2/J_3 = D^2/d^2 \cos^4 \delta/4.$$

If the useful angle is the same for different sizes of mirror, then $\cos^4 \delta/4$ is a constant, and the intensity of illumination attained with such reflectors at any given distance is proportional to the square of the diameter of the mirror.

From the equation,

$$L = 4\pi J r^2 \sin^2 \phi/4,$$

which gives the amount of light gathered by the mirror, we see at once that the parabolic form surpasses the Mangin type, which has a longer focal length and consequently smaller useful angle. Comparing two mirrors of equal diameter of 60 centimetres, the Mangin form having a focal length of 42 centimetres and the parabolic reflector of 25 centimetres, the useful angles are 83° and 124° respectively; and this gives the amount of light gathered by each as 1 : 2·11; the parabolic mirror gathering, therefore, rather more than twice as much light.

(To be concluded.)

THE DISTRIBUTION OF POWER BY ALTERNATE-CURRENT MOTORS.*

BY ALBION T. SNELL, MEMBER.

Multiphase alternate-current working, although demonstrated at the Frankfort Exhibition, has not yet found favour either in England or America; but on the Continent the Drehstrom has been used with success for several important schemes, and larger applications lie in the near future. It has been pointed out, with justice, that multiphase alternate currents offer no real advantage in comparison with single-phase ones for merely the transmission, as distinguished from the distribution, of power. It is, perhaps, for distribution proper—*i.e.*, where a number of motors, varying in size, and lying over an extended area, have to be supplied from a common and probably distant source of power—that the multiphase systems find their field of usefulness. The object of this Paper is to discuss the various alternate-current motors now in the market, and, perhaps, to see how far they lend themselves to a system of distribution in which the principal conditions of supply may be stated as follows:—Firstly, the pressure in the transmission mains must be as high as possible; secondly, the pressure must be maintained fairly constant at the centre of distribution; thirdly, the pressure at the motor and lamp terminals must be comparatively low; and fourthly, the system must admit of lighting all over the area of distribution by the use of proper converters. These points are by no means easy to obtain, even singly, and when they must be concurrent the difficulty is much enhanced.

1.—*Single-Phase Synchronous Alternate-Current Motors.*

Single-phase synchronous alternate-current motors have been used since the memorable experiments at the North Foreland in 1884, but comparatively little progress has been made in their application to general commercial purposes; and the reason for this probably lies in the fact that the synchronous system is practically limited to a single pair of machines, for the starting of the motor by auxiliary power is not a prohibitive objection with one large machine, although out of the question with a number. On the other hand, the high efficiency of synchronous motors and their perfect regulation of speed with varying loads renders them especially suitable for a variety of purposes; and no efforts have been wanting on the part of scientists and engineers to place a self-starting single-phase motor in the market, but hitherto without success. It will serve no useful end to describe in detail all the various attempts, but the limiting conditions may be best gauged by a consideration of the difficulties involved, and by a few typical examples showing the directions in which solutions have been tried.

The following peculiarities are found in alternate-current working with single-phase synchronous generators and motors:—(*a*) The dynamos are always separately excited. (*b*) The motors are usually separately excited in order to save the complication of commutators. (*c*) The motors must be raised approximately to the speed of synchronism before the dynamo circuit can be closed. (*d*) The torque on any motor must not exceed a certain value, or the machine will stop. (*e*) The current lags behind the pressure by an angle which is a maximum when the motor is running light; and there may be a relatively large idle current, which, though representing little energy at the motor, causes a serious loss in the supply mains and dynamo armature. (*f*) Motors must be designed not only with reference to the pressure of supply, but also with regard to the

* Paper read before the Institution of Electrical Engineers, April 13th.

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frequency of the current, and hence are only suitable for working on particular circuits; and (*g*) alternate motors, excited by either a direct or by a single-phase alternating current, have dead points in each period of alternation.

The earliest attempt to meet these conditions was by laminating the field-magnets of an ordinary direct-current motor and modifying the winding so as to make the self-induction as small as possible. The results were not successful. With shunt windings it is found to be practically impossible to excite the magnets excepting with large currents and few turns of wire, and even then, owing to the difference of phase between the field and armature currents, the torque is insignificant compared with the current used, and the dead points may involve difficulties. The series winding is better, but still useless for commercial requirements; for though, by carefully adjusting the windings it is possible to obtain a smaller lag, the weight output is still very small and the dead points remain. The loss by hysteresis in each case is so great as to be probably prohibitive, even neglecting the other objections. The crux is the frequency. This would, most likely, have to be reduced to something of the order of 20 ∿ per second, and such a current would be useless for lighting, and would largely increase the difficulty from dead points. Indeed, from this aspect the frequency should be high and the armature heavy enough to act as a fly-wheel. The author has made a number of experiments in this direction, and finds that the eye can easily detect 30 ∿ per second, and he believes from this cause it would not be expedient to work at less than from 40 to 45 ∿.

Another method involves the transformer principle, but is really only applicable to small machines. It originated with Mr. Jacobi, when one of the author's assistants, and a few motors were designed by them conjointly. With this type the armature is wound in the usual way, drum or cylinder, and has a collector of the ordinary type. The field cores are laminated and wound with two windings, one of which is coupled to the supply mains and the other connected across the armature terminals, thus forming a secondary circuit. Such a motor gives a considerable torque, is self-starting, and has probably an efficiency of 60 per cent. in 1-H.P. machines. It has dead points in each alternation undoubtedly, but they are not very apparent. The chief difficulty is that owing to the configuration of the iron of both field and armature, and the air gap, the number of lines of force passing through the two circuits is not the same; and, moreover, there is a considerable lag between the primary pressure and current. And also, which is equally important, the primary and secondary currents are not in phase. With small armatures, having few turns per coil, the sparking is little, the best results being obtained when the axis of the armature field is at 90deg., or thereabouts, to that due to the exciting current. The armatures may advantageously be wound with two circuits so as to avoid short-circuiting coils beneath the brushes.

2.—*Use of Condensers.*

The next step in alternate motor design was the attempt to balance the self-induction of the shunt-wound field magnets by a condenser, placed in series with the windings. If the condenser be correctly chosen for the frequency and the capacity of the circuit, its E.M.F. will theoretically be equal and opposite to the counter E.M.F. of the magnets, and so the exciting current will only have to be driven against the ohmic resistance of the winding, and moreover the pressure and the field current will be in phase. The armature has but small self-induction, and so its current will be also nearly in phase with the field current, and the maximum magnetism in field and armature will occur at approximately the same instant of time. Therefore the energy absorbed by the motor can be very nearly gauged by the product of the number of volts and amperes. In practice, owing to the armature reactions, the condenser will most likely not exactly counteract the counter E.M.F. at all loads. And again, even assuming such machines to be commercially practicable, they would only be suitable for one periodic time. If condensers were applied to series-wound motors they would be coupled in shunt to the field windings; but the objections above mentioned are equally applicable. A most important point to be noticed in connection with condensers used in this manner is the relatively high pressure which might occur at the field terminals owing to fluctuations in the current. This difficulty can be obviated by arranging the condenser and windings in sections, but such a plan is open to objection on the score of complication. Messrs. Hutin and Leblanc* have recently patented several modifications of designs involving condensers.

An interesting modification of the shunt-wound single-phase motor has been designed by Messrs. Stanley and Kelly. It is well recognised that the lag of the armature current does not coincide with that of the field current in an ordinary shunt-wound motor supplied with an alternating current, and hence the torque is not proportional to the armature current, but has a maximum for some particular value which must be determined experimentally for each machine. To meet this difficulty these gentlemen place a condenser in series with the shunt coils, and put short-circuited coils in recesses cut in the pole pieces. These coils carry currents induced by, and therefore proportional to, the armature current, but always in such a direction as to tend to decrease the self-induction of the armature coils, and consequently the lag of its current also. The arrangement has the disadvantage of raising the interpolar resistance, and is likely to cause serious distortion in the main field.

It has also been proposed to supply the idle currents prevailing with alternate-current working by suitable condensers placed across the supply mains, preferably at the transformers substations.

3.—*Split-Current Rotary Field Motors.*

Another attempt has been made in the direction of splitting the main current into two separate branches with phase differences of 90deg., and so producing a biphase rotary magnetic field, the armature circuit being closed on itself, or through an external resistance, and carrying a current induced by the revolving field. In principle this machine is similar to a Tesla motor supplied with two separate currents, one of them lagging 90deg. If a current be divided into two circuits with different coefficients of self-induction, the current in one will lag behind that in the other; and if the one circuit have no self-induction but capacity, and the other have relatively a large self-induction, then the phase difference can be made as near 90deg. as desired. Such a machine has been designed by Messrs. Hutin and Leblanc, but the author does not know how far it has been successful in practice. The points gained by this arrangement, however, mark a considerable advance in the design of alternate motors for use off ordinary supply mains. The motor is self-starting, non-synchronous, if stopped through overloading will start again as soon as the excess of load is removed, and is self-exciting. But it appears to be still far from perfect; for, owing to the armature reactions on the field, it is difficult to see how the current, in the circuit containing the condenser, can be self-adjusting for varying loads with a fixed pressure of supply; and consequently the output of such a motor will probably be less than that of a Tesla one with two independent currents. The difficulties attending the condenser are precisely the same as those previously referred to with the synchronous type of motor.

Messrs. Stanley and Kelly have recently devised a quadrature motor which presents some interesting features. In one of the circuits is placed a solenoid with low ohmic resistance but large self-induction; and in the other circuit is a series of secondary batteries which have capacity, and, therefore, act as a condenser. The result arrived at is a lag of 45deg. in the current of the inductive circuit, and a corresponding advance in the capacity branch, the result being a total difference of phase of about 90deg. between the two currents. The battery does not need to have large storage capacity; and as the number of plates is arranged so as just to prevent electrolysis there will be no "forming." But lead plates used in this manner in diluted sulphuric acid rapidly sulphate, and hence are likely to give trouble. Iron plates in caustic soda are also rapidly affected, and even carbon soon crumbles away. Platinum seems to be the only reliable material, and this at its present price is too costly.

4.—*Multiphase Alternate Motors.*

Professor Ferraris, in 1885, experimented with multiphase currents, and published his results in March, 1888, at Turin; and in May of the same year Tesla showed a rotary motor running with four wires; and Bradley, Haselwander, Wenstrom, Elihu Thomson, Dobrowolski, Brown, and others have introduced various modifications and improvements. The first practical demonstration was made by Dobrowolski and Brown with the Frankfort Lauffen plant.

It should be noticed that in all rotary-field motors and dynamos, it is not the current, but the resulting magnetism, that rotates; thus, if there are two circuits and four poles, the magnetism will be displaced 90deg. with each wave of current. In order to see this more fully, a simple case may be instanced. Fig. 1 is a four-pole diphase motor of elementary type, with a closed-circuit armature, having neither brushes nor commutator. There are two alternating exciting circuits, A A_1 and B B_1, in quadrature. Suppose that A and A_1 be magnetised so as to cause lines of force to pass from A to A_1 through the armature C. Then B and B_1 will be neutral, for there will be no current in them at this moment. Next, the current in A A_1 will gradually die away and that in B B_1 will steadily rise in an equal and opposite ratio, until the magnetic flux is from B to B_1, and A and A_1 are neutral. This cycle will be repeated, but with one alteration—the current in A A_1 will rise to a negative maximum (assuming it to have been positive before), and the flux will be in the direction of A_1 to A and in the next wave from B_1 to B. Carefully noting these changes, it is seen that the magnetic field has rotated once for a complete ∿ in each of the circuits; and therefore the speed of the

* Under the auspices of Messrs. Rothschild, who have generously voted the sum of 175,000 francs to enable them to carry out experiments with alternate motors on a commercial basis.

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field rotation is N/n, where N is the number of $\sim$ per second, and n is the number of pairs of poles in one circuit. In the case referred to, since $n=1$, the revolutions of the magnetic field will be the same as the number of $\sim$. To make a diphase dynamo it is necessary to replace the closed-circuit armature by a suitable electro-magnet having as many free poles as there are poles in one of the alternate-current circuits, to excite this magnet with a continuous current, and to cause it to revolve.*

Then diphase periodic currents will be induced in the two circuits A A_1 and B B_1, the phase difference between them being 90deg. Mathematically the currents may be expressed thus:—That in A $A_1 = K \sin a$; that in B $B_1 = K \cos a = K \sin (a - \pi/2)$,

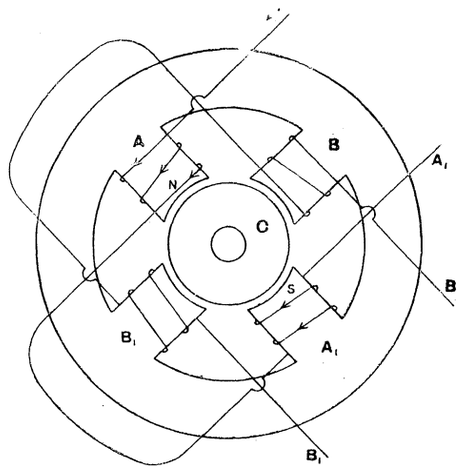

FIG. 1.—Four Pole Two-Phase Motor.

which shows the phase difference between the two currents. Now K is a constant for the particular machine, and a is a measure of the angular motion of the field. It will be seen that the current in A A_1 is a maximum when a is equal to $\pi/2$ and $3/2.\pi$, and is zero when a is equal to O and π; the converse of this is the case with the current in B B_1.

Diphase systems require either four wires—*i.e.*, two for each circuit—or else the cross-section of the common return must be increased by 1·4 times for the same loss. This is inconvenient on account of both cost and complexity; but a far greater objection for large plants seems to be the apparently excessive variation in the field excitation, yet this view is strongly combatted by many competent engineers. Let Fig. 2 be carefully examined. Curves A and B show the current-fluctuations in the two circuits, and D that in the common return.

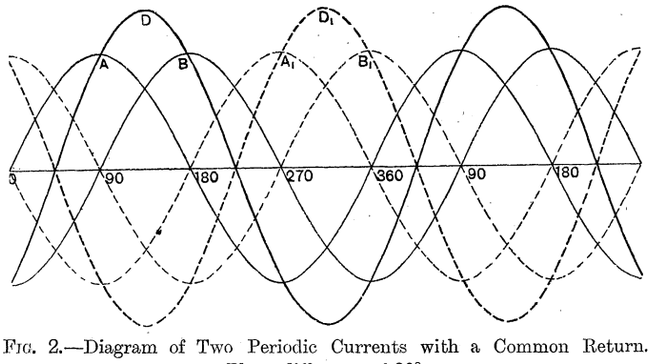

FIG. 2.—Diagram of Two Periodic Currents with a Common Return. Phase difference of 90°.

The magnetic field will be caused by A and B alone, and, therefore, will be proportional to their sum at any instant. When A is a maximum B is zero, and the induction at this moment is proportional to the current in A alone, and is equal to, say, $C \sin \frac{\pi}{2} = C$. When A and B are equal, as at 135deg. of field rotation, the induction is proportional to $2\,C \sin 135° = C\,1.4$. Thus the excitation varies between 1 and 1·4, the difference being nearly 30 per cent. of the highest value. The mean variation will be only about 15 per cent., it is true; but hysteresis and self-induction are proportional to the limiting values of the excitation, and eddy-currents approximately to the squares of these differences. Self-induction decreases the output for a given weight of material, and also by increasing the lag may largely augment the idle current for small loads.

To illustrate the fluctuation of the field excitation and consequent induction the sign of the negative curves in Fig. 2 may be changed, and they may be plotted above the time line as if they were positive in value; or two fresh complete curves may be drawn, as shown in dotted lines and marked A_1 and B_1 in Fig. 2, referring to the next two impulses of current immediately succeeding waves A and B. Both these diagrams are justified by the consideration that each circuit in the motor contains at least two coils wound in opposite directions, and thus produces poles of different signs; and, therefore, the magnetism rotates continuously.

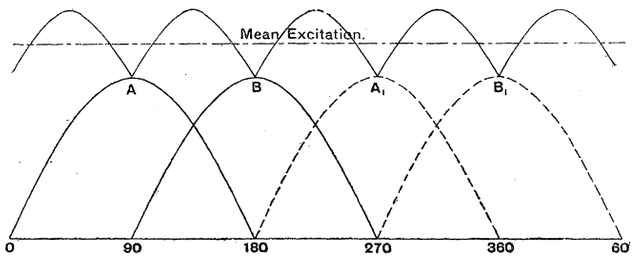

FIG. 3.—Diagram of Excitation Variation with Two-Phase Current. Phase difference of 90°.

In Fig. 3 the sign of the negative curves has been changed, and the excitation fluctuation is shown by the top curves, which may be regarded as having reference to one of the poles of the rotary field, say the North pole; while with the double arrangement shown in Fig. 2, since there are two sets of curves, one positive and the other negative, the variations of both poles are indicated. But as the fluctuations are sufficiently defined by the first method, the duplication involved in the latter seems to be unnecessary.

In the preceding considerations the armature reactions have been neglected. These are not easily estimated without some experimental acquaintance with the machine in question. But their effect will be a maximum at starting, and will decrease as the armature speed increases, and would be *nil* if the speed of armature and field coincided, *i.e.*, if the motor worked synchronously. The last condition is unattainable even with no load, for the friction of the bearings and air requires a certain amount of current in the armature to overcome it. Generally speaking, the armature reactions tend to weaken the resultant magnetic field, and also to lessen the torque for a given current.

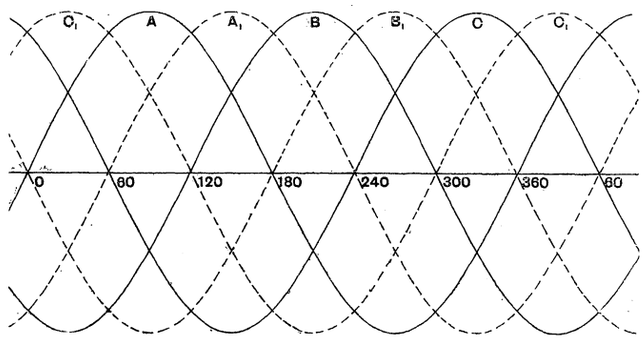

FIG. 4.—Three Periodic Currents separated by a Phase Difference of 120°.

5. *Triphase or Drehstrom Circuits.*

An inspection of Fig. 3 will show that in order to reduce the variation of the field magnetism it is presumably necessary to increase the number of circuits. Take four with phase differences of 45deg. The field excitation will be nearly constant, but eight wires will probably be required; for it is doubtful whether common returns similar to a direct-current five-wire system would be practicable. Yet the next advance in multiphase working was made by using three circuits with currents differing by 120deg. in phase.

* Rotary magnetic-field machines under certain conditions are reversible. See *Electrical Review*, February 10, 1893, in which an experiment is given showing the reversibility of a "three-phaser." Mr. Ernst Danielson, the experimenter and writer of the article, says that this depends on the fact "that when two single or multiphase machines are working synchronously, the current-phase is in advance of the pressure of the generator, while it lags behind that in the motor." In practice, however, up to the present, it has been found advisable to excite the field magnets of alternate dynamos with direct currents. In the future some means may be devised by which multiphase generators may be made self-exciting; yet it is questionable whether this is worth the trouble of any complication.

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Since the phase difference is increased, this does not seem a self-evident improvement; but on closer study it is seen that the excitation is more constant, and that the algebraic sum of the three currents is equal to zero.

In Fig. 4 let A, B and C represent three periodic currents separated by a phase difference of 120deg.; and let the instantaneous values of the currents be severally represented by C_1, C_2, C_3. Thus,

$$C_1 = K \sin \alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$C_2 = K \sin \left(\alpha - \frac{2}{3}\pi \right) \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$C_3 = K \sin \left(\alpha - \frac{4}{3}\pi \right) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

And $C_1 + C_2 + C_3 = 0$ by hypothesis. For

$$K \left\{ \sin \alpha + \sin \left(\alpha - \frac{2}{3}\pi \right) + \sin \left(\alpha - \frac{4}{3}\pi \right) \right\} = 0,$$

which is easily proved to be the case.

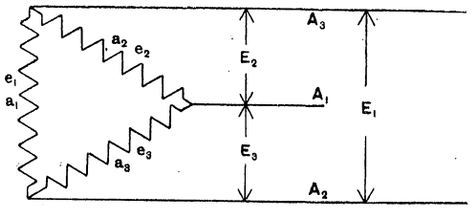

FIG. 5.—*Parallel*, or *Closed Circuit*, or *Triangle* Drehstrom Coupling.

Drehstrom working is accomplished by parallel or series coupling of the circuits, the two methods being severally known as the *star* and *triangle* systems. The author regards as the field magnet that part of the machine in which the rotary field is produced. In a triphase motor, then, the field magnet will be that part which receives the Drehstrom from the mains, regardless of whether it rotates or not. In the dynamo there can be no confusion, for the field magnets, in present designs at any rate, always rotate and are excited by a separate direct current. In this Paper large capitals are used to distinguish the mains carrying the Drehstrom, and italics to denote the three windings on the field-magnets of the motor or the armature of the dynamo.

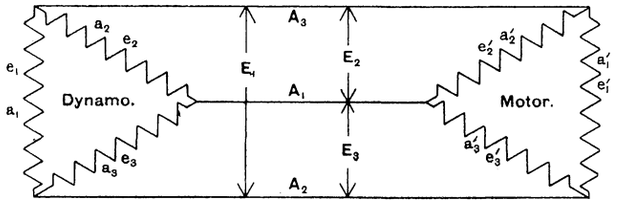

FIG. 6.—Drehstrom Dynamo coupled to a Motor.

Suffixes are used to mark the phase order of the circuits. It is also assumed that the effective values of the current are read by dynamometers, and that of pressure by voltmeters of the hot-wire or electrostatic type.

The *parallel* or *closed circuit*, or *triangle* coupling, is shown in Fig. 5. Let A_1, A_2, A_3 be the effective values of the several currents flowing in the mains, and a_1, a_2, a_3, the corresponding effective currents in the coils. Also, let E_1, E_2, E_3 be the effective pressures at the terminals of a_1, a_2, a_3. And assume $A_1 = A_2 = A_3$; then $a_1 = a_2 = a_3$, and $E_1 = E_2 = E_3$. And let there be no self-induction or capacity.

With these assumptions, since a is in phase with e, and A lies 30deg. removed from a, it follows, if the mains be fed with

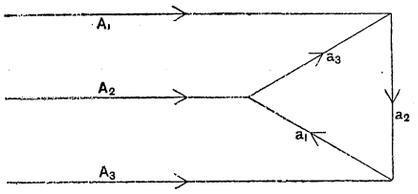

FIG. 6A.

a combined three-phase current, (as in Fig. 6), that the current in one main will differ in phase by 30deg. from the pressure between it and the two other mains. This is seen to be the case from the geometrical relationship of the coils and the mains. And it can also be proved that the effective value of the current in each of the mains is equal to 1·732 times the effective current in each of the coils, when the circuits are equally loaded. In Fig. 6A let the currents in the mains and in the coils be considered positive when flowing in the direction indicated by the arrows, and let the phase and magnitude relations of these currents be represented by Fig. 6B. Then if the diagram 6B be supposed to revolve uniformly around its centre, the length of the projections of the sides of the diagram on any straight line will represent the instantaneous values of the corresponding currents, for it is plain that these projections satisfy all the necessary conditions, viz.:—

$$\left.\begin{array}{l} A_1 = a_2 - a_3 \ldots\ldots \\ A_2 = a_3 - a_1 \ldots\ldots \\ A_3 = a_1 - a_2 \ldots\ldots \\ A_1 + A_2 + A_3 = 0 \\ a_1 + a_2 + a_3 = o \end{array}\right\} \text{All instantaneous values—}i.e.\text{, the lengths of the projections of the corresponding sides of Fig. 6B.}$$

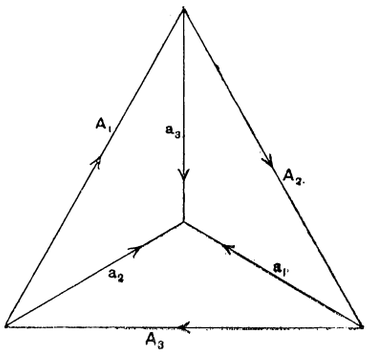

FIG. 6B.

Again, the sides of the diagram 6B are proportional to the effective values of the corresponding currents; and if the load be equally distributed between the three mains, then for effective values, $A_1 + A_2 + A_3 = 0$; and $a_1 + a_2 + a_3 = o$; and $A_1 = 2a_2 \sin 60°$; or, generally, $A = 1{\cdot}732\, a$.

The above demonstration was suggested by Dr. Sumpner.

By a similar diagram the relation between the effective pressures on the coils and mains in the *open* or *star* arrangement can be shown to be $E = 1{\cdot}732\, e$. See (*b*) of this section.

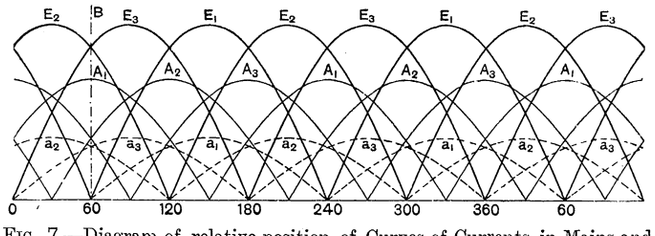

FIG. 7.—Diagram of relative position of Curves of Currents in Mains and Coils of a Closed-type combined Drehstrom Circuit with no Self induction or Capacity.

The relative position of the phases of currents and pressure in the mains and coils of a combined Drehstrom circuit of the closed type with no self-induction are shown in Fig. 7 (E and *e* have the same value, and coincide in phase). It will be seen that the maxima of the currents in the mains, A, are always midway between those of the coils, *a*, and that the phase difference between them is 30deg.

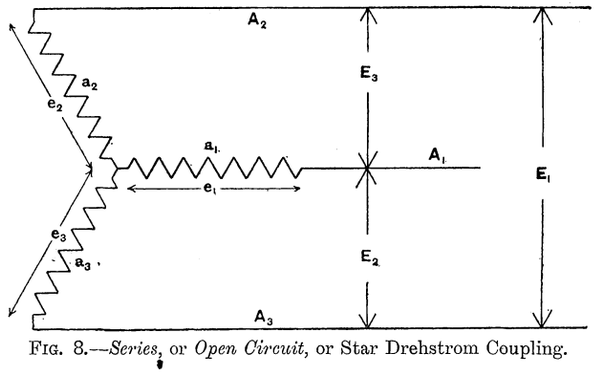

FIG. 8.—*Series*, or *Open Circuit*, or Star Drehstrom Coupling.

(*b*). The *series*, *open circuit*, or *star* coupling is shown in Fig. 8. As before, let there be no self-induction or capacity, and let $A_1 = A_2 = A_3$; $a_1 = a_2 = a_3$; and $E_1 = E_2 = E_3$. Now, since the mains A are in series with the coils *a*, and there is by hypothesis no self-induction or capacity, $A_1 = a_1$, $A_2 = a_2$, and $A_3 = a_3$. But the pressures between the mains are not the same as those at the coil terminals. And *e* will lag 30deg. behind E and will be numerically equal to E/1·732, or $e = E/2 \sin 60°$, and therefore $E = 1{\cdot}732\, e$.

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The phases of current and pressure in a combined Drehstrom circuit of the open type are shown in Fig. 9 (A and a have the same value, and coincide in phase).

The conclusions thus arrived at are true only on the assumptions (a) that the coils themselves have no self-induction, and (b) that both the coils and the mains are equally loaded. The first condition is never found in practice, and the second is only likely to obtain with small motors, and then only in an approximate degree. The effect of self-induction is to cause the current in the coils to lag behind the pressure at the terminals. To measure exactly the power in a Drehstrom system, then, is a complicated task ; but it can always be done by measuring the work performed in each of the separate circuits and adding the quantities.

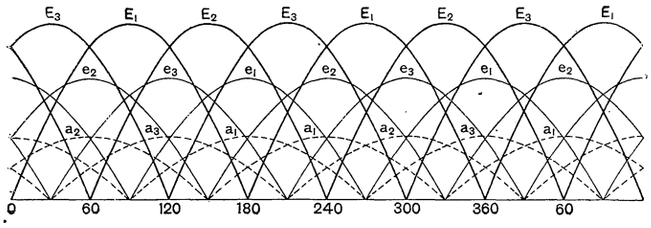

FIG. 9.—Diagram of relative Position of Curves of Pressures and Currents in the Coils and Mains of the *Open-type* combined Drehstrom Circuit with no Self-induction or Capacity.

In Fig. 5 the energy $=3\ a\ e=3$ E.A/1·732 $=$ E A 1·732 if the three circuits be equally loaded, and there be no self-induction or capacity. In Fig. 8, also, the energy $=3$ A $e=3$ A.E/1 732 $=$ E A 1·732 on the same assumptions.

So it appears, if there be no self-induction and an equal load in each circuit, that the number of amperes in one of the mains multiplied into the pressure between two mains into 1·732 gives the power in watts. If there be self-induction, the above quantity must be multiplied by the cosine of the angle of lag between the

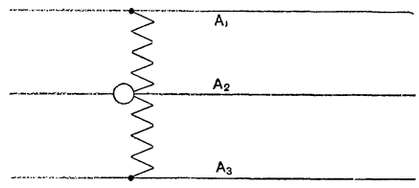

FIG. 9A

current and the pressure. The energy absorbed by a motor, therefore, will be expressed by E A 1·732 cos ϕ, where ϕ is the angle of lag. If the three circuits be equally loaded, the power can be measured by one wattmeter (*see* Fig. 9A). Put the current coil in one of the mains, say A_2, and take two readings, one with the pressure coil coupled between A_1 and A_2, and one with it coupled between A_2 and A_3. The power will be equal to the sum of the two readings. And if the load be unequally distributed, two wattmeters are required (*see* Fig. 9B). Place the current coils in two of the

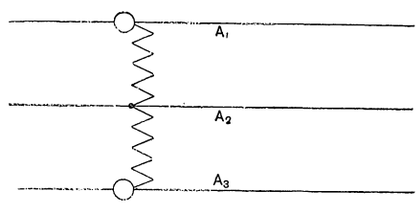

FIG. 9B.

mains, say A_1 and A_3, and couple one pressure coil between A_1 and A_2, and the other between A_2 and A_3. The power is then the sum of the two wattmeter readings.

The author is indebted to Dr. Sumpner for the above methods of measuring the power in multiphase circuits by wattmeters. They are also applicable for reading power with direct currents.

In part (a) of this section it was shown that with combined three-phase currents, even when neglecting the self-induction of the coils, there is a constant phase difference between the current and the line pressure. This, although not in itself a direct loss, is the cause of great difficulty in measuring, regulating, and controlling the currents, and also reduces the output for a given weight of material. Hence it has been found expedient to work the dynamo circuits unconnected and to use six or more separate coils. The currents from these are combined by a suitable transformer so as to convert the secondary currents into a combined high-tension rotary current with phase differences of 120deg. This high-pressure current is reduced at the motor end of the line by another suitable transformer and subdivided as required. In the transformers, says Mr. Dobrowolski, there is not the same constant difference of phase of 30deg. (between the current and the pressure) ; but, owing to the connections of the secondary coils, the transformation ratio is not equal to that between the primary and secondary turns ; so the latter must be increased to the extent of this difference. The ratio is 2 : 1·732, or a difference of 14 per cent., neglecting all losses from other causes than the connections. The efficiency of Drehstrom transformers is probably not quite so high as that of single-phase ones, but it is not much less ; and when the advantages of low-pressure dynamos and motors with high-pressure transformers is fully appreciated, the slight difference in efficiency appears insignificant.

The next point for consideration is the pulsation of the magnetism in the rotary field. This is not a simple matter to represent in a graphic manner, for the magnetic field is not merely the result of the *inducing* currents in the Drehstrom coils, but it is also largely affected by the frequency and magnitude of the *induced* currents in the closed coils of the armature, which vary from instant to instant with every fluctuation of load. The frequency of the induced currents will always be less than that of the exciting current—attaining its highest value at full load when the slip of the armature is greatest. It is expressed by $(N-n)/60$, where N $=$the number of revolutions of the magnetic field per minute, and $n=$that of the armature. (If $N=2{,}400$ and $n=1{,}920$, then the frequency will be 8 per second.) The average pressure acting in the closed coils will be given by the expression K C F $a\,10^{-8}$, where K $=$a constant, C $=$the number of turns counted all round the

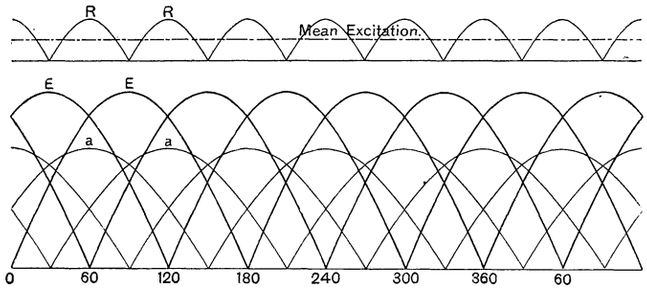

FIG. 10.—Diagram of the Excitation Fluctuations in a combined Closed-type Drehstrom Circuit.

periphery of armature, F $=$the average number of lines of force from one pair of poles, and $a=$the number of alternations per second of the armature induced currents. In determining the excitation for multiphase motors and dynamos, it is therefore necessary to make two calculations, one for full and one for light load, just as with direct-current machines.

It is clear that it is not possible to represent the changes of the rotary field magnetism by a general diagram. Fig. 10 shows diagrammatically the relative position of the current and pressure curves in a combined Drehstrom circuit, with the resultant excitation, assuming the armature reactions to have no effect—*i.e.*, the field and armature are supposed to rotate at nearly the same speed. An arbitrary angle of lag of 30deg. between the pressure and the current in the exciting coils has been assumed, and the curves have been drawn to suit the sine law. The pressure is shown in E_1, E_2 E_3, and the current in a_1, a_2, a_3. The resultant excitation is indicated in curves R, R, R, the limits of which are 2 a and 1·732 a, a mean difference of about 7 per cent. If the magnetism varied as the excitation, then the same fluctuation would occur in the rotary field, but, owing to hysteresis and eddy-currents, the mean variation is probably not much more than half as great, say from 4 to 5 per cent.

Now the torque will vary with the ampere turns, the frequency of the current, and the number of lines of force in the armature; or, the torque $=$C i_a F a/K_1, where i_a $=$ the armature current, and $K_1=$a constant, and the other symbols have the same signification as above. The magnetism is determined by the field excitation, and the number of turns of wire is of course fixed for a given armature ; hence, to increase the torque, it is necessary that the armature rotate more slowly.

This "slip" increases both the frequency and the magnitude of the armature current, thereby weakening the resultant field and lowering the counter E.M.F. of the field-magnet coils, and allowing more current to flow in the exciting circuit. But since the total magnetism decreases as the armature current increases, there is a point at which the torque is a maximum.

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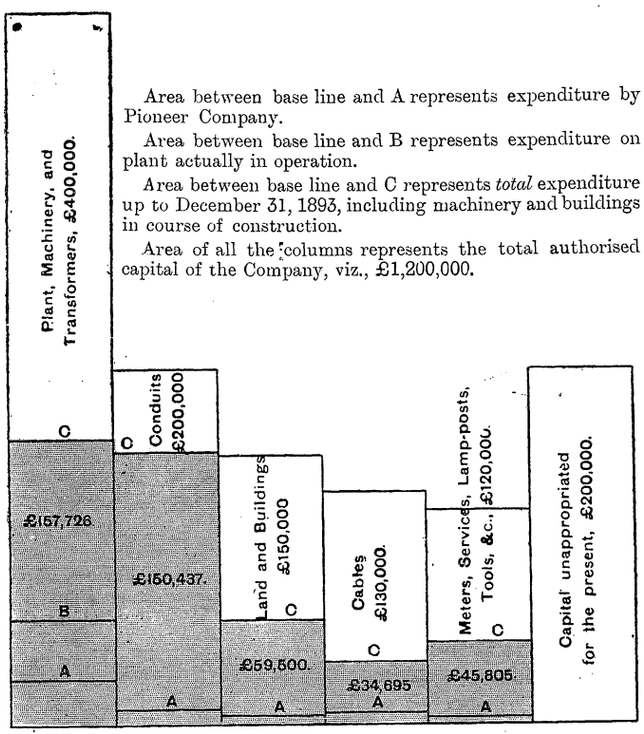
This corresponds to a definite current,* which is not the starting or maximum current, and hence these motors do not exert their greatest effort at starting. In order to avoid large rushes of current when closing the exciting circuit, it is advisable to insert variable resistances in series with the armature windings. This is specially necessary with large machines, and it appears probable from this reason, as well as from other considerations, that large Drehstrom motors will always be designed with stationary armatures and revolving field magnets.

(To be continued.)

THE CITY OF LONDON ELECTRIC LIGHTING COMPANY.

The City of London Company has continued this year the excellent custom of bringing home leading facts to its shareholders by the aid of curves, and we publish this week the most interesting of a set of three diagrams presented to the shareholders at the annual meeting last week.



Sir David Salomons remarked that such graphic representations told more than "the most elaborate and eloquent speech, or the most carefully audited accounts." We sincerely hope that they do; for we have known many an elaborate discourse to assembled shareholders which told nothing, and have not infrequently seen rigidly-audited balance-sheets which, owing to the omission of a negative sign in front of certain items, told something less than nothing.

The main fact, brought out (in vivid pink, or shall we say "*couleur de rose*") on the original diagram, is that the City of London Company has been wise in time, and by a lavish, but thoroughly judicious, expenditure on conduits, has carried out its underground work economically—by having done it all at once—and minimised, as far as is humanly possible, the bitter cry of the city man by administering one large dose of discomfort in lieu of several small ones.

* It is clear that the particular current for maximum torque is dependent mainly on the magnitude of the armature reactions, and if the latter were sufficiently small, the greatest torque might be obtained at starting, as is the case with a series-wound direct-current machine. With commutatorless Drehstrom motors it is probable, in the author's judgment, that the maximum effort will be obtained with a current little greater than that required for the greatest output.

BOARD OF TRADE REGULATIONS WITH REGARD TO SAFETY DEVICES FOR ALTERNATE-CURRENT SUPPLY.

We have received the following document from the Board of Trade for publication :—

Whereas in certain regulations made by the Board of Trade under the Electric Lighting Acts and certain Provisional Orders and licences granted under those Acts, it is provided that where the supply of energy is transformed at a converting station, some means or apparatus approved by the Board of Trade shall be provided which shall render it impossible that the low-pressure distributing mains shall be at any time charged to a dangerous difference of potential from the earth, owing to any accidental contact with, or leakage from, the high-pressure system either within or without the converting station ;

And whereas under such regulations it is also provided that where any transforming apparatus is installed on a consumer's premises some means or apparatus approved by the Board of Trade shall be provided which shall render it impossible that the low-pressure service lines and consumer's wires shall be at any time charged to a dangerous difference of potential from the earth owing to any accidental contact with, or leakage from, the high-pressure system either within or without the transformer ;

Now, therefore, the Board of Trade approve of the following arrangement for use in any case where a high-pressure supply of energy is converted to a low-pressure supply by alternating-current transforming apparatus, as a means of preventing contact between the high and low-pressure conductors within such transforming apparatus, viz. :—An arrangement such that by the construction and winding of the apparatus any wire or other conductor forming part of the low-pressure supply circuit within the transforming apparatus is separated from any wire or other conductor forming part of the high-pressure supply circuit within the transforming apparatus in every part by a wire or other conductor possessing sufficient sectional area, which is efficiently connected to earth, but is not in metallic connection with either the high-pressure or low-pressure supply circuits.

Signed by Order of the Board of Trade this 22nd day of March, 1893.

(Signed) COURTENAY BOYLE,
Acting Secretary, Board of Trade.

EARTH-CURRENTS IN INDIA.*

BY E. O. WALKER.

Papers on this subject were published in the *Journal* for the years 1883, 1884, 1888, and 1891. More recent observations, in connection with those previously taken, have led to an identity being revealed between the variations of these currents and those of atmospheric pressure. It is thought to be of interest, as the comparison is novel, to give a brief account of the facts which seem to establish this identity. In doing so references must necessarily be made to the former Papers. In the study of this subject much assistance has been afforded by the records kindly placed at my disposal by Mr. C. Chambers, F.R.S., Superintendent, Colaba Observatory ; Mr. Michie Smith, F.R.S., Government Astronomer, Madras ; and Mr. E. Kitto, F.R.Met.S., Superintendent, Falmouth Observatory ; and by information furnished by Mr. W. Ellis, F.R.A.S., Greenwich Observatory ; reference has also been made to the Bombay Meteorological Observations of 1845, and to the *Encyclopædia Britannica* (9th Edition, Vol. XVI. — "Meteorology").

The observations in India were not as a rule taken with a sensitive galvanometer, for the currents were of sufficient magnitude in the localities in which observed not to require it. The use of a sensitive galvanometer involves complications from weak electro-chemical and thermal currents produced at junctions, and the magnetic system is subject to displacement from terrestrial magnetism, the effects of which are difficult to screen. In all delicately-suspended magnets with long indicators, or with reflectors and distant scales, these effects are considerable.

It is necessary to remark that the long periods of settled weather in India are favourable to the regular recurrence of the same variations in meteorological phenomena from day to day during those periods ; and this has been found to be the case with the earth-currents. For fully 30deg. north and south of the equator the lines of maxima and minima run north and south, but in higher latitudes these directions are changed. Again, the amplitude of the oscillations of atmospheric pressure is greater in equatorial than in higher regions, and so far as can be ascertained, the earth-currents have higher electromotive forces in the former than in the latter. On the whole, therefore, India offers a better field for observation than the British Isles, where the weather is subject to such large and frequent disturbances from often unknown and unforeseen causes.

* Paper read before the Institution of Electrical Engineers, March 23rd.

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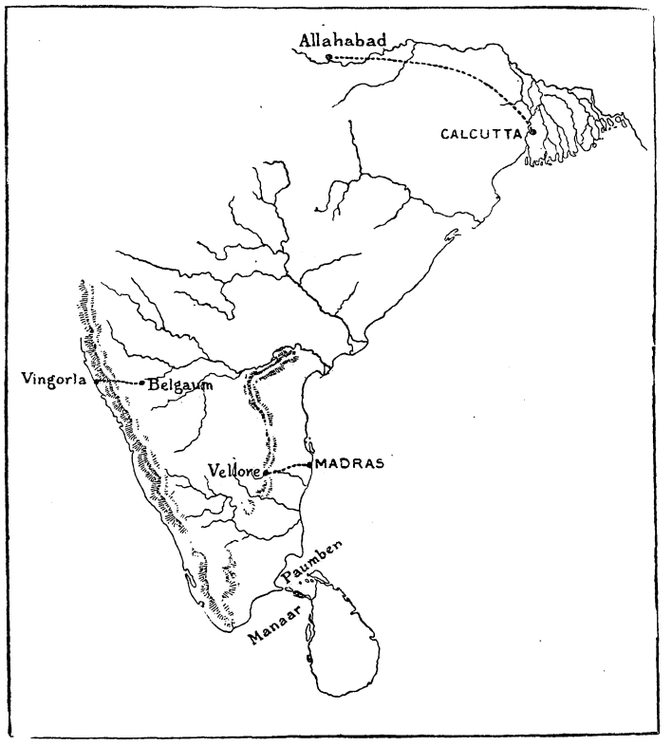
In my Papers of 1884 and 1888 reference has been made to difference in elevation between two places being favourable to the production of an earth-current, and to the probability that at any time difference in atmospheric density is also effectual in this way. Condensation and dispersion of aqueous vapour at high elevations have by other observers been shown to affect the direction of the current. On the coast of India the disturbances to telephonic communication, when earth has been used, have been very great on long circuits during that part of the day when solar heat was most active and when the sea-breeze prevailed, the cause apparently being, that electrically-charged films and particles of vapour were driven across the wires and discharged into them. The effect was to produce a hissing or grating noise on the telephone which often drowned the voice of the operator. It is thought, then, that these considerations, coupled with the results of fresh observations which follow, may lend colour to the supposition that the movements of aqueous vapour, as evinced by the daily barometric oscillations, are active in the production of earth-currents.

Observations of earth-currents have been taken on some days in March and April, 1891, between Belgaum and Vingorla; in February and July, 1892, between Madras and Vellore; in June and July between Paumben and Manaar; those of September and October, 1887, between Calcutta and Allahabad, also illustrate the same features of the daily recurrent phenomena. It is found that almost always the current flows in the morning from the inland places of observation to those on the sea-coast. A sketch map is



appended to show the geographical positions of the places indicated, In the afternoon the direction of the current is reversed. On the sections of lines from Belgaum to Vingorla and Madras to Vellore, currents of high electromotive force are observed from a halfo five volts they are remarkably steady, and cannot be producedby electr-o chemical or thermal influences at the earth-plates. Some observations kindly taken on one of the Madras-Penang cables in July, 1892, by Mr. Wolfe, acting-superintendent at Madras of the Eastern Extension Telegraph Company, also showed that electromotive forces of from 0·1 to 14·4 volts were operating from 6:37 a m. to 9:11 a.m. (between which hours observations only were made), and go to strengthen the conclusion that comparatively high forces do prevail about the time of the morning maximum of atmospheric pressure. The curve which shows the changes from early morning to evening was given in Plate I. of my Paper of September, 1884, and this is reproduced here (Diagram II.). These diurnal phenomena are occasionally reversed in times of cyclonic storms. The cables from Madras to Penang give evidence of similar effects.

The observations taken at Paumben on the line to Manaar are very instructive; they comprised seven days, the current was very weak, and exhibited no regularity in ebb and flow. The line is about 50 miles in length with a cable in circuit, and runs east and west. The difference between the phenomena exhibited here and those of Vellore and Belgaum I attribute to the fact that there can be but little difference in the meteorological conditions of Paumben and Manaar, and barometrical oscillations of the same sign and amplitude occur synchronously at the two places. It is to be regretted that this supposition cannot be confirmed by records. It should not be omitted, however, to note that Paumben is only thirteen miles south of the magnetic equator, and it is possible that magnetic forces there are variable to a greater extent than at the other places noted above. The photographic records of the earth-current at Greenwich Observatory in the line running east and west, prior to the disturbance which is caused by the City and South London Railway currents, show a rise and fall in the earth-current similar to that exhibited in Diagram II. herewith, although in a circuit only three miles in length the electromotive force is very small.

The barometric curves in Europe and in India as regards the diurnal oscillations are similar in respect of the morning maximum and afternoon minimum. Opportunity has been taken to verify

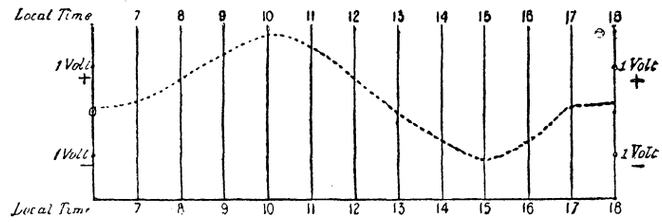
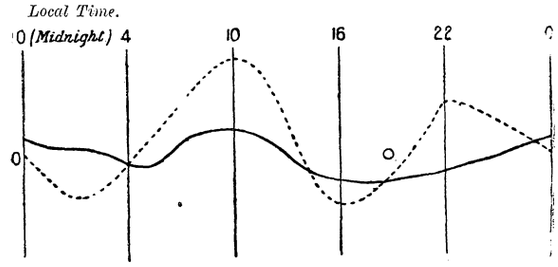


Diagram I.

this assertion by comparison of the Bombay curve with that of Falmouth. The general characteristic of the latter is naturally much obscured by the fitful weather to which this locality is subject. But on still days this similarity is undoubted. The morning maximum occurs from 9 a.m. to 10 a.m., occasionally as late as 11 a.m., and the afternoon minimum from 3 p.m. to 5 p.m. In Bombay, on three days in July taken at random, maxima occurred at 10 a.m., at 8 a.m., and at 11 a m., and the minima on the same days at 5 p.m., 4 p.m., and 3 p.m. This variability in times of maxima and minima also characterises the earth-currents. The curve for Vienna, as given in the *Encyclopædia Britannica*, is shown with that for Bombay in Diagram II., the two being typical to a large extent of the diurnal barometric oscillations in temperate and in tropical regions. Could comparisons be instituted between the electromotive forces of the earth-currents in those two regions, it is not unlikely that the typical curves would be similar to these. In India, at least, a large number of observations warrant the belief that the barometric curve is also



Curve at Bombay ·····
" " *Vienna* ——

Diagram II.

correspondent to that of the earth-current in its rises and falls and change of direction. Experience at present only permits me to speak of the morning and afternoon changes. It has not been possible in most localities here treated of to secure observations during the night.

Diagram III. shows the mean daily variation in declination in Madras for the month of July, 1855. Tables for later years are not available. But independent observations recently made show that the variation at present is very similar. It is preferable to give the curve constructed from the Madras Observatory tables, which contain the indications of exact instruments. The declination curve for the 6th July last, furnished to me from the Colaba Observatory, Bombay, bears the same character. It would seem, on the whole, that the earth-current tends to maxima when the diurnal variations in declination are at their minima. If this be a fact it is one of great interest, but it cannot be accepted without more prolonged observations in different localities.

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The earth-current curve is by no means a smooth one, and the rate of oscillation is a factor which is of great importance in forming a correct conclusion as to the origin of the current. The time of change of the needle of the galvanometer through several degrees, while on the move on quiet days, has therefore been observed. The motion on such days is slow, and shows on the occasions in question rates of change of force in four observations of 5·7, 9·0, 13·5, and 17·1 feet per hour only. In some similar observations made in Calcutta in 1887, a mean rate of only 0·5 foot per hour was ascertained. Be the cause of the current what it may, it may safely be asserted that it operates slowly on quiet days. This feature of the phenomenon is well worthy of further study.

It will not be going too far it is thought, in the light of the above facts, to surmise that the alteration in inductive capacity of the atmosphere by the action of solar heat occasions a slow redistribution of static charge upon the earth's surface, the aqueous vapour being the agent in this gradually progressive change. The uprisal of vapour under the influence of the sun in the early hours of the morning, and the condensation and fall in the afternoon, are in the East, and often in Europe, the phenomena of each day, and influence the barometric curves. If, as observation seems to show, high potentials are met with in the upper regions, these ascending and descending columns of vapour must be very potent in bringing successive portions of the earth's surface within their influence. So far as can be seen in India, the tendency in the morning is apparently to an inflow of negative electricity from sea-coasts to places inland where the barometric oscillations are large, and in the afternoon to an outflow. Thus, if there be induction from high regions, the gradual ascent of vapour in the air through heat promotes it, but the re-condensation later in the day of vapour operates to reduce it.

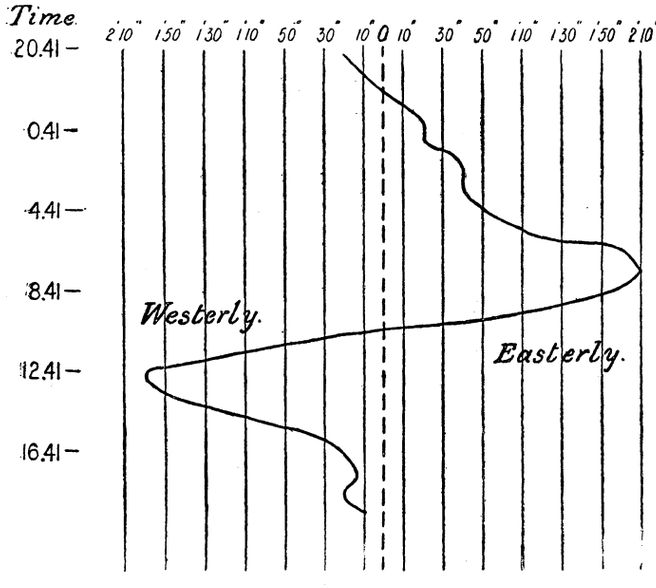

Diagram III.

It is felt that, in venturing upon this hypothesis, the cause of perturbations cannot be entirely satisfactorily dealt with. These are often so rapid in their changes that they fail to be registered in our observatories by photography, and are often far stronger than any forces measured on quiet days. During such disturbances the barometric trace scarcely varies from an even line, though in some cases minute oscillations of the mercury can be detected. It will be probably necessary to look for the cause of these violent changes to increased solar activity, evidences of which are, in fact, often seen at such times. If electrification in hige regions be due directly to the sun, the surface of the earth must partake of modifications of that condition.

DISCUSSION.

*Mr. ADAMS said he should like to have had a copy of the Paper earlier in order that he might have studied its various points. It really seemed to him that the author, if his ideas with regard to the effect of vapour were correct, had been dealing with local disturbances. There was, however, this fact which he thought would be admitted by all who had studied the question, that variations of the earth current, like variations of the magnetic elements in any one place, found their counterpart in degree, and in proportion to the local time, lunar and solar, in every other part of the earth. If the variations that were mentioned in the Paper were the ordinary variations, then they partook of a variation which occurred throughout the whole world. Now, if the Greenwich barometric results were studied, it would be found very largely that the weight of the atmosphere did appear to vary, and to coincide with the diurnal inequality, although there were many other variations underlying it. But in dealing with earth currents, as with magnetic variations, they must remember, and he thought it had been proved over and over again by different people, that they were dealing with parts of a grand whole, and not with local variations or variations due to local causes. He had never yet found anything in the shape of clear proof that an earth current or a magnetic variation had been due to any local cause. He knew it had been said that a snowstorm had come on and produced this, and that a change of wind had brought about that variation, but he could find no proof for anything of the kind. Now although he could not discuss the Paper as he would wish to do for want of the figures, he would nevertheless remark that, as in 1883 he pointed out that the earth-current variation took a tidal form, so now, after many more years of investigation, he would repeat that statement. With regard to the coincidence between the variation of the atmospheric weight and the earth-current variation pointed out in the Paper, it was to his mind a further evidence that the current variation and the magnetic variations were the results of variation in gravitation. Gravitation was without doubt varied by sun and moon, and, broadly, as a result we got corresponding changes in the earth's magnetic and electric conditions. Although he might be standing alone as to that view, he believed that a few years would show its truth. He was particularly interested in the results before the meeting, but he did not think they could be due to vapour change or to local effect of that kind, but must be looked at as part and parcel of great general variations which occurred in degree and proper sequence as to solar and lunar time at every other part of the earth.

Sir DAVID SALOMONS drew Mr. Walker's attention to Lord Kelvin's address to the Royal Society on the influence of the sun on magnetic currents on the earth.

*Mr. WALKER, in reply, said that a few years ago, on sending his earth-current curve to the Kolaba Observatory at Bombay for comparison with the magnetic curve of the day Mr. Chambers, who was in charge of the Observatory at Kolaba, noted a distinct similarity between the changes of the earth current, and that of the temperature of the surface soil in Bombay. It did not occur to him that there was anything more to be said on that subject just now; the observations in India were necessarily very limited, as they had few lines at their command which could be used for observation without detriment to traffic.

*The PRESIDENT (Mr. W. H. Preece) proposed a vote of thanks to Mr. Walker. The subject was one to which he had himself devoted a deal of attention, and on which he had written several Papers, and he had been intensely interested in the remarks Mr. Walker had made. But he would point out to that gentleman that he did not think he had in any way indicated that any direct distinction had been shown between currents due to atmospheric causes, and currents due to changes in the potential of the earth. Some thirty or forty years ago there was an extremely able Paper on this subject, giving the results of some observations made in America. In that particular paper it was shown unmistakably that it was necessary to draw a great distinction between earth currents and atmospheric currents, and by very ingenious contrivances it was shown that the currents due to atmospheric electricity were just as frequent as those due to changes in the potential of the earth. Mr. Walker did let out one thing which had great interest. It was a suggestion that the specific inductive capacity of the air might change. They were always taught and they were always accustomed to regard the specific inductive capacity of the air as one of Nature's constants. It had been given a particular value. It was generally supposed to have the value of 1, but they did not know what the value really was; indeed, they had not the least idea of what it ought to be, but at any rate, for purposes of calculation and for mathematical reasoning, it had been allotted the value of 1. Now, long experience in telegraphy had led him to believe that that was not true—that the specific capacity of air was not 1, and that the specific capacity of air was variable. He had tried innumerable experiments in endeavouring to prove that the presence of aqueous vapour in the air did change its specific capacity—but without success. There was this very striking fact, that in all instances in which he had compared the capacity of wires in England with the capacity of those in other countries, the capacity in England was invariably greater than in other countries. That might be due to the fact that our atmosphere was more charged with humidity than the atmosphere certainly was in America. It had been attributed, and he had attributed it himself, to the existence of earth wires on our poles, but although that might be some cause, the probability was that a change in the value of the specific inductive capacity would account for the difference. Another valuable feature in Mr. Walker's Paper was that he had given the value of these current in volts. He had tried often, through the columns of *The Electrician*, to call attention to the fact that observations made on earth currents in different parts of the world were absolutely valueless, because they did not give those very electrical measurements which enabled them to draw comparisons. They wanted to know the voltage, they wanted to know the direction of the lines observed, and they wanted to know their resistance. If they had the geographical position of the lines, if they had the measure of the voltage and the resistance of the circuits, they could from those facts deduce what electrical elements they desired. Mr. Walker had to some extent supplied that want, and he had given it in very clear language.

Royal Society.—The following Papers were down for reading yesterday before the Royal Society:—Dr. Hopkinson, F.R.S., E. Wilson, and F. Lydall, "Magnetic Viscosity;" F. W. Dyson, 'The Potential of an Anchor Ring."

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"ZENITH" PORTABLE ELECTRIC LAMPS AND BATTERIES.

In our issue of February 17th we described and illustrated the application of the Bristol lamps and batteries to the lighting of omnibuses and other vehicles. Further developments in omnibus, bicycle, and railway lighting have now taken place, and the near future will doubtless witness the introduction of electric lamps into all our public conveyances. We illustrate in Fig. 1 the "Zenith" pocket lamp and battery; in Fig. 2 the Inspector's button-hole lamp; in Fig. 3 the fireman's portable safety lamp; and in Fig. 4 the interior of an omnibus in which a triple set of

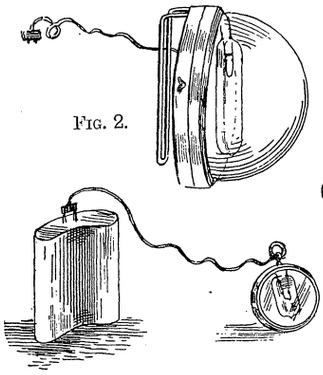

Fig. 2.

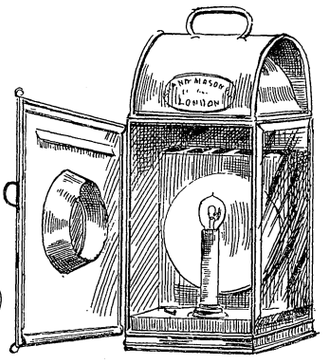

Fig. 1. Fig. 3.

"Zenith" accumulators and lamps, specially designed and constructed for omnibus lighting, are shown. The battery and lamp patents are owned by the "Zenith" Electric Light Company, of Kennington Park, S.E. The patentees claim that the "Zenith" battery plates, owing to their particular formation and the small amount of metal used in forming the frames, enables the use of a greater surface of active element than has hitherto been attained, and, consequently, a maximum of voltage with a minimum of cell capacity and weight.

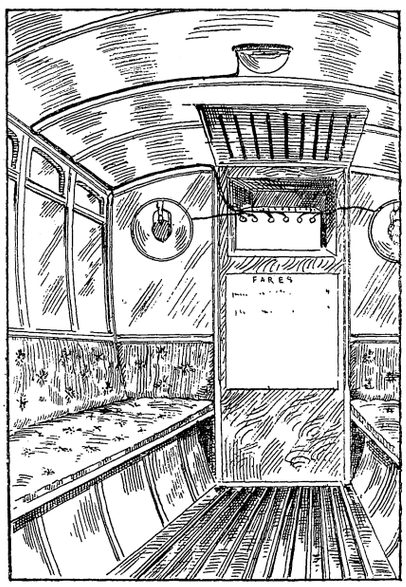

Fig. 4.

The positive plate frame is rectangular in plan, the internal edges being bevelled to form a key for holding the element, and upon the inner surface are two or more pointed projections pointing towards the centre, upon which are formed bevels corresponding to the bevel upon the frame, and for the same purpose. The negative plate frames are similarly formed, but without projections, in lieu of which are attached thin rods or wires of lead or lead alloy, preferably circular in cross section and occupying such a position that their ends impinge upon the bevel of the frame. These rods or wires may be either straight and extend from end to end, or crinkled, or both, or may be placed diagonally, or crossed. Suitable lugs are provided upon one of the smaller ends to facilitate coupling up. Both plates are filled in with paste composed of carbonate of ammonia and protoxide of lead or litharge, rendered plastic by the addition of dilute sulphuric acid, and this paste is smoothed off level with the frames and allowed to set, and then coated upon each side with a paste of peroxide of lead and water.

Fig. 1 is a portable pocket lamp and battery, the latter weighing, in the newest form, about 12oz., and the lamp is fitted in an imitation watch-case suitable for the waistcoat pocket. The patentees inform us they are arranging with W. H. Smith and Sons to have the battery and lamp on sale at their bookstalls throughout the country. The purchaser will buy the lamp and battery outright, and will afterwards be able to exchange an exhausted battery at any bookstall for a small sum. The battery is stated to last ten working hours, and the lamp gives a 1-c.p. light. These small lamps are also made with coloured glasses for photographic uses.

Fig. 2 is a button-hole lamp for use by omnibus, tramway, and railway ticket-inspectors. It is fitted with a small screw switch, simple in construction and effective. Fig. 3 is a fireman's lantern of the ordinary form, for use when the fireman is engaged in seeking for the gas meter to prevent an explosion. A 12-volt accumulator is fitted on a square block, and has a suitable switch and lamp attachment. The whole can be put inside the lantern and a safety-lamp be thus obtained, fitted with a reflector and showing a good light unaffected by wind or weather. Messrs. Shand and Mason are, we understand, supplying these lanterns.

Fig. 4 is an omnibus interior, showing the battery under the driver's seat. This is easily renewed from the inside. One box supplies the three lamps, and if a lesser number are required a third or two-thirds of the cells can be switched out. The triple set of cells weighs 30lb., or 23lb. for two lamps. The lamps are fixed in a case similar to an ordinary watch-case, and in the sketch three are shown, one on either side of the destination-board and one roof-light. The former have duplex reflectors and consequently act as signal lights.

In the Provinces many of the omnibuses and tramcars are being fitted with these lamps, and in London about 500 omnibuses are either completed or in course of being similarly equipped. Some of these are, we understand, to be supplied with a rearlight and a pedestal lamp on the outside, rising from the roof at the back of the driver to supply light for outside passengers to read by, also acting as a signal light. The lamps are 15in. diameter, with 12in. reflectors. The reflector is patented as an advertising device, the income from which enables the "Zenith" Company to supply their lights at a very small charge per omnibus. Instead of selling the apparatus outright, the Company provide the entire outfit, including accumulators, lamp frames, switches, and inspectors' lamps, for a small weekly rental, and meet the omnibuses at stated hours and given places each day, when a few moments suffice for changing the spent cells and replacing them by others freshly charged.

For bicycles, an 8-volt accumulator is fitted in a leather case with flexible cords, enabling the lamp to be placed at any part of the machine and at any angle.

CORRESPONDENCE.

CONCENTRIC WIRING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am glad to see in Mr. Sydney Walker's article in your issue of April 7th, a statement of the case against "Concentric Wiring," and beg you will afford me space to reply.

The only objections urged are briefly as follow:—

1st. There should be no metallic sheathing around the insulation of conductors.

2nd. There should be no contact with "earth."

3rd. Disturbances to ships' compasses.

4th. Alleged possibility of fire.

That it is necessary for the duration of a cable that there shall be "no metallic conductor outside the insulating material" I emphatically contravene. A sound, solid-drawn lead sheathing (as used over concentric cables) seems to me to be the most efficient means of securing the desired durability.

How it can have a positively contrary effect is not at all apparent. If Mr. Walker means that cable makers cannot make reliable sheathed cables, then I shall leave the cable makers to deal with him. Reliable cables of this type by several makers are on the market.

With regard to the second objection,—Mr. Walker is not alone in his objection to "earth" any system of conductors. But those who object most and fight hardest against earths—low-tension supply-station engineers—are finding the task too much for them. As the networks extend and larger numbers of

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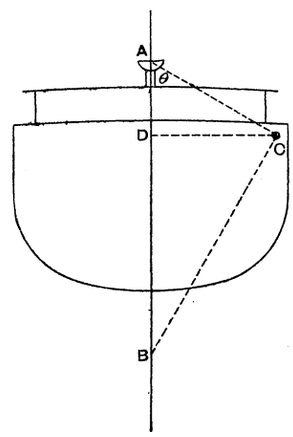
consumers are connected, the difficulties increase, as they have done in America, where to avoid incessant breakdowns the middle wires on their three-wire systems have been put permanently to earth. On this side of the Atlantic there are several authorities who are strongly in favour of the same practice. Where the attempt is made on a three-wire system to maintain the insulation of all three conductors, the maximum E.M.F. between any of the conductors and earth is, say, 220 volts, and if one outer wire becomes earth and a leak develops on the other, electrolysis may proceed with destructive results. If the middle wire be earthed then the maximum E.M.F. available to produce electrolytic action is halved. While if the middle wire be earthed and concentric wiring used on each side, the sheathings being connected to the middle wire, then the *maximum* E.M.F. available to produce electrolytic action is only that due to the loss of volts along the middle wire. The difference of potential along the middle wire may be kept down to a very low figure without additional expenditure of copper by increasing the section of the middle wire at the expense of the outer wires. The same method may be applied to the outer concentric conductor on a two-wire system. For example, a maximum drop of, say, 10 volts is to be allowed; then the inner wire may be so proportioned that there shall be eight volts drop in it, the copper saved from the inner wire being added to the outer wire, in order to keep the maximum difference of E.M.F. between any two points upon it—or between any point upon it and earth—within two volts.

The earthing of the middle wire is, however, so important and so complicated a question, that I much prefer not to involve concentric wiring in it at present. And while pointing out its bearing on the subject, I would distinctly discourage any attempt to force the solution of the problem by pressing the claims of concentric wiring in this relation.

Leaving this problem of the earthing of the middle wire to solve itself—as I believe it shortly will—I am content to hold in abeyance the discussion of the application of concentric wiring in this connection. It is for isolated installations of all kinds that I now urge the use of concentric wiring. During a large experience of it extending over seven years, I have never heard of a single instance of trouble—ever so slight—arising from the earthing of the outer conductor.

The third objection, relating to ships' compasses, is, when applied to concentric wiring, usually much exaggerated. Concentric wiring is often stated to result in the same disturbance to compasses as single wiring. This is not so in fact. But in arranging concentric conductors in relation to compasses on board ship it is well to assume that it is so.

The following is a formula (proved experimentally to be correct) which I believe is due to Dr. Bottomley, for calculating the disturbance of a compass needle by a current flowing in a single conductor.



$$\text{Deflection in degrees} = \frac{2\frac{1}{2}C}{D},$$

where C = current in amperes,
D = distance in feet from needle to conductor, if conductor is directly above or below needle.

If conductor is placed in such a position as shown in diagram

$$D = \frac{AC}{\cos\theta} = \text{distance A B.}$$

By a judicious arrangement of main conductors and the use of double-insulated concentric branch conductors in the neighbourhood of compasses the maximum possible disturbance of the compass may be kept within one-fifth of one point, while the greatest probable disturbance (due to any ordinary combination of lights) would not exceed one-twentieth of one point. He is a smart quartermaster who steers a vessel within these limits. A very large proportion of the ships lighted by electric light are single wired, and it is long since any disturbance of compasses has been reported. The position of the dynamos has often a much more important bearing on the compasses than the method of wiring.

Lastly, with regard to the fire risk. I do not wish to exaggerate the fire risk of electric lighting. That the risk is very small where the work is properly carried out, is proved by the fact that no fire due to electrical causes has occurred in any building where the ordinary precautions now well understood are observed. But I need not suggest the many ways in which a fire *might* occur, even in a well carried out system of double wiring. And I reassert that concentric wiring carried out with proper conductors and fittings entirely abolishes the fire risk. I have with much patience created artificial faults of many kinds in concentric conductors in the endeavour to communicate fire to inflammable material placed around the conductor, but always without success. I would ask Mr. Walker, with regard to the fire communicated by "a virtually concentric" cable, whether it is within his *certain knowledge* that the cable formed part of a system of concentric conductors with "earthed" return. It seems to me more probable that the conductor formed an armoured portion of a single or perhaps of a double-wire system. If this were the case a leak might take place from the inner conductor to the sheathing and from the sheathing to the ship's ironwork (an occurrence impossible with concentric conductors). The spark would thus be external to the sheathing. It is quite a common and most reprehensible practice to use in the holds and machinery space of single-wired ships, armoured cables or conductors drawn into iron pipes. The danger of such a practice is obvious. Single wiring cannot be too sharply condemned.

Mr. Walker's last sentence—"Never hide your connections in damp places; make them as large as you possibly can, and *repair the work the damp has accomplished as frequently as possible.*"—(the italics are mine), is surely a strangely ingenuous admission of the weakness of the methods which he advocates.

Why not protect your insulation and connections against damp by a hermetically-sealed metallic sheathing and abolish the absurd necessity of "frequent repairs"?—Yours, etc.,

56, George-square, Glasgow. SAM MAVOR.

CONDENSING FOR ELECTRIC LIGHT STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I must entirely disclaim any intention of making comparisons of coal consumption in the two cases given. It is quite obvious that the form of the load curve, and the relation of rate of output to boiler power in use at any time throughout the day have great effect on the proportions of coal used for engines to total coal burnt. The two cases were given one to confirm the other; and considering that one figure was for the winter and the other for the summer, and that exchange of dates might be followed by exchange of figures, and that the difference is only one forty-second, either may be taken as typical.

The table will be more easily interpreted if for "ratio condensing to non-condensing plant" be read "proportion of total non-condensing plant replaced by condensing." As the engine hours vary from year to year independently of the variation of the number of units, an approximate idea of the saving is all that is possible and all that is required. The statement has a limited application in that it assumes the straight line curves for condensing and non-condensing to be parallel. This is only true for a given non-condensing in the case of a particular condensing, *i.e.*, when the expansion is the same in both cases. The saving would be greater if the expansion were carried further in the condensing engine.

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The table shows that if two-fifths of the non-condensing plant be replaced by condensing, the saving is about 12·8 per cent., and the saving only reaches 16·9 per cent. if the whole of the plant be replaced; but in the former case the total boiler power could be decreased by 8 per cent., while in the latter it could be diminished 20 per cent.

I was not endeavouring to settle the question. You agree with me that this is only possible when local conditions are known. But I thought, and think, the table useful in a discussion as to the relative importance of partial and complete condensing plant, and that it might suitably follow your admirable leader.—Yours, etc., REGINALD WOOD.

THE PROTECTION OF THE ELECTRICAL INDUSTRY IN FRANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with pleasure in the last issue of your esteemed journal, your allusions to the article of M. Haubtmann, in *l'Electricien* of 8th April.

Long before my colleague, I raised this very question in the same journal in its issue of January 21st last, p. 56, in a short article entitled "Outlets to be sought for in the Argentine Republic." The contribution was signed "D," the initial letter of my name.

You will see, if you will kindly revise the article and take note of my opinions, that I protest with great energy against prohibitory protective tariffs, after having shown by examples from the annals of commerce that such tariffs are always disastrous. For a long time I have sounded the alarm in the columns of the economic press, and my conviction becomes more deeply rooted every day, and it is in the name of these principles that I take the liberty of addressing you this letter which you may publish if you judge it useful.—Yours, etc.,

April 17, 1893, Paris. EM. DIEUDONNÉ.

Extract from Article.

[We are not partisans of the outrageous protection which at present reigns in France. It is without a doubt profitable to a few electrical firms, at least it must be thought so judging by the efforts of the Chambre Syndicale des Industries Électriques to obtain a rise in the customs duties, but it is injurious to the industry at large and to the consumer. . . . Certain French firms fear foreign competition. Why? This implicit admission of commercial impotence is pitiful! But it is understandable. People want to live quietly upon an ancient reputation, without being harassed by the constant necessity of keeping on the crest of the wave of progress. There is the danger. This short-sightedness is a peril bearing in its train baneful consequences. The producer is attached to this "compensatory" system, seeing in it as he does a means of selling an often inferior article at a high price. But what becomes of the consumer's interests in this struggle? . . .].

"A NECESSARY MODIFICATION OF OHM'S LAW."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find in *The Electrician* of January 13th a reference to my paper on "A Necessary Modification of Ohm's Law," in which the discrepancies in the resistance of a copper wire observed by me and attributed to a change in the dielectric surrounding the wire are attributed to a change in the heat emissivity in the different media. Permit me to give the reasons why I regard such explanation as insufficient.

When I first observed the phenomenon, it at once occurred to me that it might be due to the heating effect of the current and the different rate of cooling of the wire in the dielectrics used, especially as the resistance in petroleum was less than in air. To satisfy myself upon this point, the current strength was varied through a wide range by interposing resistances up to 200 ohms between the battery and the bridge, and in every case the measurements made fell upon the same curve. If the observed difference in resistance were due to a change in the temperature of the wire, this difference should not be the same for different current strengths.

Again, in the article referred to, I mentioned the fact that while a trace of ether vapor in the tube noticeably increased the resistance of the copper wire, it caused a corresponding decrease in the resistance of a silver wire. The same can be said of petroleum, though not to the same extent. The resistance of a copper wire 1 mm. in diameter was less by about 0·8 of one per cent. in petroleum than in air, while the resistance of a silver wire of the same diameter was greater by about 0·04 of one per cent. in petroleum. If the variation in resistance were due to the more rapid cooling of the wire in one medium than in the other, it would seem that both wires should cool faster in the same medium It seemed to me, also, that any wire should cool faster in a liquid like alcohol than in air, and that the heating effect of the current should be in general less marked in a liquid than in air. On the contrary, however, the resistance of the copper wire was greater in every liquid used except petroleum than it was in air.

It is true that the temperature of the the thermometer bulb was not necessarily the same as the temperature of the wire, but that it could have been but little different is shown by the great regularity of the measurements made in the same medium. These measurements were made at all hours of the day, and some of them late at night, and the temperature of the room was probably increasing as often as it was decreasing, so that any difference in the temperature of the thermometer and wire would not always affect the results in the same direction. In the measurements for the curve given in Fig. 1 of the article in the *Phil. Mag.* the measurements were extended over a period of a month's time, while those given in Fig. 2 were made at different times for a period of five days. The very consistent results obtained in this way also answer what seems to me to be a more serious objection, namely, that the temperature of the comparison coils might be different from that of the wire.

It accordingly seems to me that I may be pardoned for useing the expression "necessary modification of Ohm's Law." I am not unaware that Ohm's law is supposed to apply to a conductor only when its physical state has been kept unchanged. In these experiments, however, I have been unable to see how any change in the physical state of the wire, except a change in temperature, could be brought about by changing the dielectric around it, especially when the dielectric is not known to exert any chemical action upon the wire, and when its pressure remains unchanged. That the differences in resistance which I have observed are not due to temperature changes seems to me to be also well established. If this be true, the strength of a current is not necessarily inversely as the resistance of the conductors in its circuit, if by that resistance is meant a quantity depending only upon the nature and physical condition of the conductor itself.

That the phenomenon has not been observed before is not remarkable when the extreme smallness of the quantities observed is taken into consideration. True it is that many of the best measurements made differ among themselves by quantities quite as large as the differences observed in these experiments, but it has been the custom to attribute these differences to temperature changes. So far as I know, no one else has ever looked for a change in resistance due to a change in dielectrics.—Yours &c.,

Palo Alto, Cal., April 4, 1893. FERNANDO SANFORD.

[We still think that the method used for measuring the temperature of the wire was a very crude one. The common method is to deduce the temperature from the observed resistance of the wire, and until our esteemed correspondent can devise an independent sensitive method of measuring the temperature *of the wire*, we fear he will be unable to establish his point.—Ed., *E.*]

BOOKS, &c., RECEIVED.

"*Journal* of the Institution of Electrical Engineers." Edited by F. H. Webb. Vol. XXII. No. 104. (London: E. and F. N. Spon.)

"Index to Vol. XXI. of the *Journal* of the Institution of Electrical Engineers." (London: E. and F. N. Spon.)

"Telephone Lines and their Properties." By W. J. Hopkins. Illustrated. (London: Longmans, Green and Co.) 260 pp., 8vo. Price 6s.

"Abstracts of Papers in Foreign Transactions and Periodicals." Edited by Jas. Forrest. (London: Institution of Civil Engineers.)

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This useful book contains over 1,000 pages, and several new and handy features have been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

TENDERS INVITED.—The Town Council of Winchester are prepared to receive specifications, plans, and estimates for lighting the streets and public buildings of the City, and also for private lighting. A premium of £30 is to be paid for the scheme which is considered the most suitable. Some further particulars are given in our advertisement columns, and printed conditions can be had of Mr. Walter Bailey, Town Clerk, The Guildhall, Winchester. The specifications have to be in by the 20th instant.

——— Our advertisement columns contain a notification that the Burgomaster and Aldermen of Liège, Belgium, invite tenders for the installation in that city of a system of electrical distribution. Copies of the conditions of tendering and all other information may be obtained, and plans may be seen, at the Bureau des Travaux Publics, Annexe de l'Hôtel de Ville, Liège. Tenders will be opened on June 15th.

——— Our readers are reminded that tenders have to be in not later than 10 a.m. on Friday next, for the various work required under their Electric Lighting Order for the Town Council of Aberdeen.

——— May 13th is the latest date for applications from companies or firms willing to undertake and carry out the Provisional Order of the Bedford Urban Sanitary Authority. Applications must be sent in to Mr. T. S. Porter, Clerk to the Authority.

——— The Ministerio de Ultramar, Madrid, will up to May 6th receive tenders for the installation and working of a telephone exchange at Santiago de Cuba.

TENDERS ACCEPTED.—The Gas Committee of the Aberdeen Town Council have agreed to accept the tender of Messrs. Stiff and Co., London, for porcelain insulators, the amount of the tender being £200, on condition that the time limit penalty clause in the contract is agreed to by Messrs. Stiff and Co., otherwise the contract will be given to the Glasgow house of Messrs. Doulton and Co.

TENDERS RECEIVED.—The Works and Lighting Committees of the Brighton Town Council issued special reports on Tuesday. The Works Committee recommend that the tender of Mr. J. T. Chappell, for the extension of the engine house, the erection of testing rooms, coal store, &c., and other works in connection therewith at the Corporation electricity generating station, North-road, for the sum of £2,839, be accepted. Five tenders were received, ranging from £5,595. 2s. 1d. to £2,839. The Lighting Committee recommend the acceptance of the following out of forty-six tenders sent in :—

	£	s.	d.
Mr. E. Danks, for supplying and setting three Lancashire boilers	1,475	0	0
Messrs. Yates and Thom, for supplying and fixing steam and water system and piping with feed pump	1,295	0	0
Messrs. Latimer, Clark, Muirhead and Co. (Limited), for supplying and fixing steam dynamos and motor dynamos...	4,894	4	0
Messrs. Crompton and Co. (Limited), for supplying and fixing lamp canopies with switches, &c., for lighting the King's-road	545	0	0
Messrs. Crompton and Co. (Limited), for supplying 45 Crompton and Pochin arc lamps, for lighting the King's-road	766	13	0
Messrs. Latimer Clark, Muirhead and Co. (Limited), for rewinding the armatures of the dynamos now in use at the generating station	450	0	0
Total	9,425	17	0

PERSONAL.—The officials of the Indo-European Telegraph Company and other friends of Mr. Frederick Moll, the secretary and accountant of the Company, entertained him at dinner at Bargens' Restaurant, Coleman-street, London, E.C., on the 8th inst., to celebrate his quarter of a century's service with the Company. Mr. Moll was presented with a silver epergne, suitably inscribed, and a pair of claret jugs, subscribed for by the whole of the staff.

APPOINTMENT VACANT.—The Lighting Committee of the Wolverhampton County Council require a resident electrical engineer. Further particulars appear in our advertisement columns, and applications must be sent to the Town Clerk by May 6th next.

BANKRUPTCIES.—An equalising and second dividend in the estate of Mr. Rankin Kennedy, electrical engineer, late of the Carntyne Electric Works, Glasgow, will be paid at Messrs. Dunlop and Murray's, 82, West Regent-street, Glasgow, on and after May 27th. ——John Herbert Gale, of the Old Vicarage, Stanton Drew, and 25, St. Stephen-street, Bristol, india-rubber merchant and electrician, has been adjudicated a bankrupt.

RE BARNES AND LOW.—Messrs. Bewley, Crump and Deeks, of 6, Lombard-court, Gracechurch-street, E.C., invite the creditors of Albert Moor Barnes, trading as Barnes and Low, at Exhibition-road, South Kensington, to send in their claims promptly. The meeting of creditors, which was to have been held this day, has been postponed till Friday next, the 28th, at Winchester House, Old Broad-street, at 2:30 p.m.

ELECTRICAL ACCESSORIES COMPANY (LIMITED).—This Company remove into their larger premises, at 110, Charing Cross-road, W.C., this week, and will have on show a large and varied assortment of their manufactures. The move is one in the right direction, and will doubtless result in increased business.

ELECTRIC SIGNALLING.—A system of signalling by means of electricity has been specially designed by Messrs. King, Mendham and Co., of Bristol, for the Clifton Rocks Railway, where water-power is used for hauling up the cars, which convey any number of passengers up to eighteen. If the number of passengers in both upper and lower cars is unequal, it is necessary to admit water into a tank on the upper car till it overbalances the lower one, but if the number of passengers in the upper car is equal to that of the lower one, this will establish a balance enabling the hauling system to be worked. In order to convey to the engineer at the top the number of passengers travelling by the lower car, an ingenious arrangement of contact, by which the conductor of the lower car is able to signal up to the top conductor the extra number of passengers to be provided for to establish a balance, has been devised and is at work. The signals are received in succession upon a signal board, and an electric bell rings at each fresh indication, and the engineer is thus able to provide for sufficient water being admitted into the tank to take the car down, and when it is ready a signal is sent down intimating that the car is starting. A local buzzer is then inserted in the circuit, by the sound of which it is known that a distant bell is ringing, and the indicators are arrested by the act of transmitting the "starting" signal, so that the apparatus is in perfect readiness for the next journey. Separate electrical contact and indicator boards are provided for each set of cars, and a double set of batteries ensures proper working of the whole system. When a car reaches the lower end of the tunnel the water in its tank is automatically discharged and is pumped up to the top, the height of water being shown at the bottom by means of an electric water level.

CONCENTRIC WIRING.—Messrs. J. D. F. Andrews and Co. inform us that Messrs Sharp and Kent are introducing concentric wiring into St. Botolph's Church, and that this system is being employed in several other places in the City.

MESSRS. HODGES AND TODD.—Mr. Percy W. O. Hodges has joined this firm, who are adding civil and mechanical engineering departments to their business. Additional premises have been taken in Red Lion-street, W.C., the offices remaining at Turnmill-street, as hitherto.——The firm send us a price list of ammeters and voltmeters manufactured by them.

MESSRS. J. H. HOLMES AND CO.—This firm have just completed one of the largest size "Castle" dynamos, capable of supplying current for nearly 4,000 8-c.p. lamps. This machine is to be coupled direct to a Willans patent compound vertical central-valve engine of 200 I.H.P. The firm have also just completed the generating plant for lighting the North-Eastern Railway Company's Hotel at York, and have been busy with a large number of medium-sized plants for some time past, including a special system for lighting some of the fast trains on the Midland Railway.

"THE ENGINEERING MAGAZINE.—This magazine, which is so well known in America, and with which many of our readers in this country are acquainted, has now found a British habitation. The magazine can be obtained from *The Electrician* offices, Salisbury-court, London, E.C., price 1s., or 12s. per annum post free. The number for April commences Volume V., and contains fully-illustrated papers of considerable interest to English engineers. Included in the April number are articles on "The Industrial Problem in Australia," "A Decade of Marvellous Progress," "English and American Railways," "The Dearness of 'Cheap' Labour," "Refrigeration from Central Stations," "The Past and Future of Engineering," &c., &c., and included in each monthly number is a fairly complete index of current technical literature. The magazine will be on sale at Messrs. Smith and Sons' bookstalls throughout the country on the 28th inst. The April number consists of 136 large 8vo. pages in addition to the Technical Index, which is detachable.

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AYR.—The Chairman of the Town Council recently inspected the electric lighting installation of Southampton, and has presented his report to the Board. The Burgh Provisional Order expires in August next, and the Clerk has been requested to make inquiries on the subject of electric lighting generally. A special Committee has also been appointed to deal with the matter.

BEDFORD.—At a meeting held last week it was decided to hold a large public meeting to discuss the question of the electric light in the borough, to which an expert was to be invited to put the citizens in possession of facts and figures on the subject.

BOWDON (CHESHIRE).—The Local Board has given instructions for the official seal to be affixed to the form of agreement prepared by the Manchester Edison-Swan Company, and to the modifications in the Provisional Order, which have been suggested by the Board of Trade.

BURNLEY.—The extensive building, known as the Oddfellows' Club, at Keighley Green, Burnley, is to be lighted by electricity. It is the largest institution of the kind in the town, and has thousands of members.

BURTON.—The Town Council having decided to apply for powers to borrow £69,000 for sewage and electric lighting purposes, a Local Government Board inquiry has been held on the subject. It will be remembered that Messrs. Hammond and Co. and John Fowler and Co., Leeds, have secured the contracts for the supply of plant and apparatus. Mr. Ramsden explained the scheme to the Commissioners, and intimated that only a slight deviation from the original compulsory scheme was contemplated.

CANTERBURY.—The transfer of the Provisional Order obtained by the Town Council to the Brush Electrical Engineering Company (Limited) is officially notified.

CHESTERFIELD.—The Water and Lighting Committee have received an intimation from the Gas Company, that in contracts about to be entered into for lighting the borough by gas a considerable increase is to be made in the charge for lighting, cleaning and extinguishing, Alderman Wood, who presented the report, stating that the Gas Company have adopted this means of squeezing the Corporation, as they had no power under their contract to charge more for the gas per thousand than was already charged. The Committee had received a number of letters from electrical engineers offering to advise the Council in the matter of the electric lighting of the borough, and it had been resolved to accept the services of Mr. Shoolbred, of Bradford, and he has been asked to attend an early meeting of the Committee. A circular will afterwards be distributed to a number of the consumers of light in the town, asking them the amount of support they are prepared to give to a scheme of electric lighting. Alderman Wood stated this had been found the most effective manner of ascertaining the amount of support likely to be given to such a scheme, and he instanced a case in Lancashire where a similar canvas had taken place, resulting in the putting down of a much larger plant than had originally been anticipated, owing to the very large number of favourable replies to the circular received.

CRIEFF.—The Local Authority have received a report from a Manchester electrician upon the subject of the introduction of the electric light to the district, for which it is proposed to use water power. We understand that the report states that for an outlay of about £3,000, and an additional outlay of £2,000 for accumulators, an almost complete installation can be secured. The situation is especially suitable for water-power work, and the electric lighting scheme is very favourably received by the ratepayers.

DUNDALK.—As the contract with the local gas company for lighting this district expires in July, Mr. Maxwell, a member of the Town Commissioners, considered it a fitting opportunity for endeavouring to obtain tenders for lighting the town by electricity, but after considerable discussion it was decided to advertise in the local journals for gas lighting, as hitherto.

DUNDEE.—The electric light is so keenly appreciated in Dundee that quite a storm arose at the last meeting of the Police Commission as to the position of the arc lamps in the principal streets, more than one member apparently feeling aggrieved that his establishment had not been selected as a point for the erection of one of the posts. There can be no doubt that an arc lamp forms an exceptionally good advertisement, to say nothing of the actual value of the light radiated through the upper windows.

FALMOUTH.—Notwithstanding considerable opposition, it has been decided to invite an expert to advise the Urban Sanitary Authority on the subject of the introduction of the electric light.

HENLEY.—At the last meeting of the Corporation a letter was read from the local Gas Company notifying them that they were unable to entertain a proposal for a reduction in the charges made for gas for public lighting. An attempt was made to bring forward the subject of the electric light for the town, but without avail.

HOOLE.—Dissatisfaction is expressed by members of the Local Board at the peremptory refusal of the Chester Gas Company to entertain any suggestion for a reduction in the price of gas supplied for public and private lighting, and the Chairman of the Board stated at the last meeting that if the Board can get sufficient support from the inhabitants steps will be taken for obtaining the electric light.

IPSWICH.—The Paving and Lighting Committee of the Town Council last week were engaged in a discussion on the subject of the electric light. Mr. Pratt, a member of the Lamp Committee, stated that he held an application for a large number of lights from many of the principal shopkeepers in the town. It was generally agreed that the light was becoming very popular, and that the matter would have to be dealt with promptly. After some discussion it was decided to refer the matter to the Sub-Committee already appointed, to which additional members were added.

JAMAICA.—The Kingston City Council have decided "that before fixing the signature of the Mayor and Council to the contract with the Electric Lighting Company, a committee of three members be appointed to report upon the correctness of the terms." A movement is on foot to considerably extend the installation.

LECTURES.—To meet the widespread demand for information on electrical subjects, lectures are still being delivered in various parts of the country. Among the most recent, we note one by Mr. Robert Hammond, at Blackpool, by Mr. Jerritt, at Plymouth, by Mr. J. Anderson, at Thurso, and by Mr. Flood, at Jarrow.

LEICESTER.—With reference to the contracts received for supplying the necessary plant, &c., for the electric scheme, these contracts were referred to an expert, with a view of settling some points in dispute. It is stated that he has given a decision confirming the recommendations of the Gas Committee, and there is, therefore, little doubt that the contract will be entered into with the Brush Electrical Engineering Company.

LIMEHOUSE.—Prof. H. Robinson has been instructed by the Limehouse District Board of Works to prepare a report on the subject of the electric lighting of the district. At the last meeting of the Board it was suggested that co-operation with the Poplar district would be advisable, and it was pointed out that the latter district had obtained its own Provisional Order.

MIDDLESBOROUGH.—A sub-committee has been appointed by the Town Council to obtain information of the cost of lighting the municipal buildings by electricity.

MILL LIGHTING.—The extensive sawmills and offices of Messrs. Moss and Co., of Hoxton-street, London, N., have been fitted throughout with the electric light. Arc lamps are used for the yards and mill, and incandescents for the offices.

NEWCASTLE.—The installation of the electric light at the extensive premises of the Co-operative Wholesale Society, in Thornton-street, is now complete, and the contractors, Messrs. Ernest Scott and Mountain, have handed the plant over to the representatives of the Society. The work has been completed under the superintendence of Mr. J. Thompson, of Newcastle. Between 1,100 and 1,200 lamps are fitted.

NOTTINGHAM.—Progress is reported regarding the building operations for the large central station to be erected on the site acquired by the Corporation between Talbot-street and Wollaton-street, and it is expected that a contract will shortly be let for the erection of the necessary buildings.

ROTHESAY.—As previously notified in these columns, it has been decided to defer any further consideration of the subject of electric lighting for the present. Messrs. Mavor and Coulson have reported on the subject, and a supplementary report has been prepared by Mr. Turnbull. It was agreed that the information the Committee had obtained would be available any time, but that for the present the cost was prohibitive.

SHERBORNE (DORSET).—An interesting exhibition of electrical appliances of domestic and commercial utility was held last week by the King's School Field Society. A large quantity of apparatus was on view, and the exhibition created much interest in the district.

SOUTHAMPTON.—The tender of Messrs. Donnison and Parmiter, of Manchester, for £167, has been accepted by the Free Library Committee for the electric light fittings required for their new building. There was a difference of £190 between the lowest and the highest tender—that of Messrs. J. Sugden and Co., of London, £375. The next lowest to that of the accepted tender was from Mr. F. M. Newton, of Taunton, £171. 5s. In all, nineteen tenders were received.

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TIVERTON.—At the next meeting of the Town Council a resolution will be brought forward by the Electric Lighting Committee on the subject of the report presented by Mr. Siddalls, together with a separate report on the advisability of utilising the water-powers of the rivers Exe and Lomann, prepared by Mr. Frank Christie, of Chelmsford. A digest of Mr. Siddall's report appeared in our last issue.

TUAM.—Communications have been received from engineers and others on the subject of electric lighting for the district, and the Board of Guardians are considering the subject.

WAKEFIELD.—For some time past a sub-committee of the Corporation have been collecting information regarding the electric light, and the subject is now likely to receive further attention. The Town Clerk will probably have instructions to apply for a Provisional Order.

WORCESTER.—The plans and estimates for the proposed buildings for the generating station at Powick were discussed at the last meeting of the Watch Committee, and it was decided to recommend the Council to apply to the Local Government Board for an additional sum of £9,000 to complete the scheme.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

March 16, 1893.

5,684. M. P. TUCKERMAN and A. W. MACKENZIE. London. Improvements in portable electric primary batteries and in their application to miners' and like portable lamps.

5,694. J. C. RICHARDSON. London. Improvements in apparatus for the electrolytic decomposition of solutions of chloride of sodium and potassium.

5,701. S. O. COWPER COLES. London. Improvements relating to the coating of articles with metallic alloys by electro-deposition.

5,709. H. F. IVEL. London. Improvements in the cores of armatures for dynamos, magneto machines, motors, and other purposes.*

March 17, 1893.

5,715. O. FERGUSSON. Woolwich. A new and improved depolariser for galvanic batteries.

6,720. G. MOSELEY. Kingston-on-Thames. Moseley's simplex burglar and thief-proof electric alarm.

5,771. P. SCHARF. London. Improvements in apparatus for electrica lighting.*

5,778. A. J. BOULT. London. An improved process of manufacturing bleaching solutions by electrolysis. (O. Knœfler and Fr. Gebauer, Germany).*

5,782. T. G. MARSH. London. Improvements in telegraph poles.

March 18, 1893.

5,844. W. P. THOMPSON. Liverpool. Improvements in storage batteries. (Max Hartung, Germany).

March 20, 1893.

5,911. J. R. MANN. London. An electric contact maker for ringing bells and other analogous purposes.*

5,935. W. S. WALKER and A. L. BEDFORD. London. Combined electric and compressed air motor.*

5,944. A. E. PARNACOTT. Penge. Electricity meter.

March 21, 1893.

5,937. G. E. FLETCHER. Stockport. An improved method of reducing electrical induction on telephone and other circuits.

6,000. B. H. THWAITES. Liverpool. Improved methods for effecting the electro-fusion of steel and its alloys.

6,004. F. E. SUDDARD. Germany. Automatic platen applicable to divers systems of typewriters and electric-printing telegraphs.

6,031. B. J. B. MILLS. London. An improved system for transmitting electric currents. (William Courtenay, United States).*

6,032. B. J. B. MILLS. London Improvements in switches for electric light fixtures. (Joseph Hutchinson, United States).*

6,036. G. J. W. JACKSON. London. Improvements in insulated conductors.*

6,050. O. T. BLÁTHY and M. DÉRI. London. Improvements in alternate current motors.

6,073. J. E. A. GWYNNE and R. KENNEDY. London. Improvements in electric lamps.*

March 22, 1893.

6,100. J. BAIER. London. Barrel springs or covered wire for use on telephonic, or as piano wire or any other kind of musical instruments in any thickness of half-round, square, or oval shape.

6,139. A. BARRETT. London. Improvements in coating the interior of hollow vessels by electro-deposition.

6,163. A. TRAUN. London. Improvements in tanks or cells for electrolytical and other chemical purposes.

March 23, 1893.

6,170. J. MEIR. Manchester. Improvements in apparatus for forming earthenware electric switches and the like.

6,200. W. AITKEN. Glasgow. A new or improved protector for electric insulators, also applicable as a wire guard.

6,205. R. WOOD. London. Improvements in method of and apparatus for distributing and regulating the distribution of electricity for lighting and motive power and other purposes.

6,225. SIEMENS BROS. and R VON FISCHER-TREUENFELD. London. Improvements in ground sockets for tubular posts for telegraphic and other purposes.

6,233. E. DU BOIS. Improvements in electric clocks.

6,241. T. DUNCAN. London. Improvements in electricity meters or motive devices for measuring single and multiphase electric currents.*

6,254. A. L. SHEPARD. London. Improvements in electric arc lamps.

March 24, 1893.

6,282. J. PHILLIPS, junr., and T. C. LEWIS. Sheffield. Electrical fire or temperature alarm.

6,295. T. STOBER. Manchester. Improvements in and relating to electric incandescent lamps.

6,306. S. E. NIELSEN. London. Improved electric current meter.

March 27, 1893.

6,439. T. E. MARSH and T. G. POOLE. London. Improvements in electric switches.

6,446. J. SWIFT. London. An apparatus for showing the phenomena of the expansion of crystals and other substances by heat produced by electric force.

6,468. SIEMENS BROTHERS and Co. (LIMITED) and J. NEBEL. London. Improvements in electric arc lamps.

6,470. B. J. B. MILLS. London. Improvements in electrical measuring instruments. (A. E. Kennelly, United States.)

6,475. J. J. RICKARDS. London. Improvements in means and apparatus for varying the speed of electro-motors or the electromotive force of electro-dynamos.

6,477. S. O. COWPER-COLES. London. Improvements relating to electro-plating and apparatus therefor.

6,478. E. THOMSON. London. Improvements in and relating to dynamo-electric machines and motors, and to circuits for use in connection therewith.*

March 28, 1893.

6,517. S. B. JENKINS. Birmingham. Induction system of electric heating and for other uses.*

6,532. G. KAPP. London. Apparatus for recording excess currents in the working of electro-motors for traction and other purposes.

6,551. T. G. HALL. London. A pyro-electric generator, an apparatus whereof such generator is an element, a process carried out by the aid of such apparatus, and a new compound gas made by such process.*

SPECIFICATIONS PUBLISHED.

All Specifications price 8d.

1892.

1,041. ROLLASON. Generating electricity for buildings.

5,579. SWINBURNE. Incandescent electric lamps.

5,712. ANDERS and KÖTTGEN. Telephones.

5,931. SPENCE. Dynamo electric machines.

5,988. RAWORTH and GEIPEL. Distribution of electricity.

6,015. HARPER. Incandescent electric lamps.

6,095. BELFIELD. Conductors for electric railways.

7,004. WALLACE. Electrical cooking apparatus.

7,016. MCFARLANE and EDGAR. Incandescent electric lamps.

7,142. KRÜGER. Incandescent electric lamps.

7,569. EVERITT. Electric lamp switches.

8,108. DAVIS and EVANS. Making metallic articles by electro-deposition.

8,258. SMITH and WILSON. Electric collectors.

8,452. CHAPMAN. Driving machines by electromotive power.

8,556. PATIN. Alternating-current electric machinery.

8,638. TOMLINSON. Electric mains.

8,663. JOEL. Electro-magnets for motors, &c.

8,854. SMALLWOOD. Electric light fittings.

8,956. KNOP. Electro-medical belts, &c.

8,986. RYLANDS. Electric cables.

9,132. HOWARD. Heating and welding by electricity.

9,147. EBBUTT and VERITY. Electric fittings.

9,486. DICKINSON. Overhead system of electric traction.

10,602. MYALL (Harrison). Telephonic apparatus.

14,096. CHURCH. Electric arc lamps.

21,794. ANDREOLI. Electrodes for ozonisers.

22,914. WISE (Buckingham). Printing telegraphs.

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22,950. HADDAN (Gabarro). Galvanic battery.
23,361. HEIL. Teaching telegraphy, &c.
23,501. LAKE (Vose). Electrically playing stringed instruments.

1893.

724. POPE. Electric incandescent lamps.
1,057. LAKE (Harris). Electric railways.
1,077. THOMPSON (Lesenberg). Electric telephone apparatus.
2,059. HEIL. Telegraphy.
2,145. LAKE. (LUNDELL and another). Dynamo-electric machines.
2,361. SZYMANSKI. Depolarising galvanic elements.
2,455. JERG: .. Electric arc lamps.
2,494. WHALLEY. Telephone annunciators.
3,572. WRIGHT. Printing telegraph receiving instruments.
3,747. Electrolytic copper.

COMPANIES' MEETINGS & REPORTS.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

The thirty-ninth ordinary general meeting of this Company was held on Wednesday at Winchester House, Old Broad-street, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting and the minutes of the thirty-eighth ordinary general meeting, and the report of the Directors was taken as read.

The CHAIRMAN: Before asking you to approve of the report, I shall as usual go over some of the details, and give you such information as I think it is well that you should possess. The gross receipts for the half-year under review have amounted to £247,766, against £243,658 for the corresponding period of 1891, showing an increase of £4,108, notwithstanding the heavy loss on exchange (£11,692) shown on the credit side of the revenue account. For the whole of the year the loss has amounted to £20,000, but since the close of the half-year steps have been taken, as explained in the report, to avert, as far as possible, any loss in the future from this cause. The working expenses have amounted to £91,768, against £74,314 for the corresponding period of 1891, showing an increase of £17,454, of which £16,000 is caused by the "expenses attending maintenance of cables" having amounted to over £38,000 in the past half-year, against £22,000 in the corresponding half-year of 1891. Of this large increase, however, £15,796, or nearly the whole of it, is due to cable expenditure, as shown in Abstract C of the accounts, by which is meant not only the various lengths of cable actually used on cable repairs and maintenance but also the "writing down" of cable in stock to a reasonable figure. Another exceptional item is the large payment of £6,030 shown on the debit side of the revenue account for income tax, which not only embraces the tax for the particular period but includes £2,071 for the arrears which accumulated pending the decision of the Special Commissioners on the Company's appeal against the surcharges made by the surveyor of taxes, together with adjustments of the account. Comparing the figures for the whole year, the results are as follows:—Gross receipts for 1892, £494,754, against £508,536 in 1891, or a decrease of £13,782. The working expenses for 1892 have been £171,049, against £145,790 in 1891, or an increase of £25,259. The net revenue for 1892 was £250,843, against £286,986 in 1891, or a net decrease for the year of £36,143, which is accounted for by the explanations already given. The usual interim dividends have been distributed during the past year, making, with the dividend proposed to be paid to-morrow, a total payment of 5 per cent. for 1892. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the past year. (Cheers.) The balance of £75,843 has been carried to the general reserve fund, which now stands at £509,732, made up as follows:—Amount of reserve at end of 1891, £428,842; interest during the year, £14,004; value of cable recovered from Rangoon-Penang section, after crediting capital expenditure with £20,000, £22,324; and balance from revenue during 1892, £75,843—making a total of £541,013, less cost of Singapore-Penang triplicate cable, £25,974, and partial renewal of the Shanghai-Foochow cable, £5,307, leaving the fund, as already stated, at £509,732, after having expended £1,162,000 out of revenue on cable renewals, duplications, and triplications since the formation of the Company, and thus greatly strengthened and improved the value of your property. A further drawing of 353 of the Company's Five per Cent. Australian Subsidy Debentures took place on the 6th inst. for payment at par on July 1st next, when the debenture debt, which originally stood at £640,000, will be reduced to £285,000. The Company's repairing ships have, as usual, been busily employed during the past half-year; but owing to most of our system being duplicated, the traffic has not been materially affected, except with China and Manila, which by our route are practically dependent upon a single line of cable between Singapore and Hong Kong. The weakness of this section has long been recognised, and much negotiation has from time to time taken place with the Governments of Hong Kong and Singapore and the Home Government with a view to strengthening it, but hitherto the necessary monetary assistance to enable the Company to lay a second cable has not been forthcoming, and no practical action has therefore resulted. Lately, however, negotiations have been revived on a new basis, namely, for the Company to receive special privileges in lieu of subsidies, and as soon as the negotiations are completed we shall at once proceed to have manufactured and laid an alternative cable between Singapore and China, connecting the valuable coal fields and harbour of Labuan *en route*. This will also practically provide telegraphic communication with British North Borneo, and lead to the development of new traffic, besides greatly strengthening the Company's position in the East. (Applause.) All the various sections of the Company's system are now in good working order. With reference to the Australian tariffs, which I have frequently alluded to on previous occasions, I am glad to say that the increased rates to Australia, referred to in the last report, came into operation on January 1st last, with the result that the additional 9d. has not caused any appreciable falling off in the number of words transmitted, consequently the increased rate is practically all profit, and will diminish the loss for the current year under the Government guarantee arrangement to a comparatively small amount. At the Postal and Telegraph Conference, recently held at Brisbane, the delegates of the guaranteeing colonies expressed themselves perfectly satisfied with the arrangement, and a motion was carried in favour of continuing it. The reductions of tariff to New Zealand and between Australia and New Zealand, which were also referred to in the last Report, took effect from the same date, and up to the end of last month have resulted in an increase of the international traffic of 88 per cent. out of 300 per cent. required to recoup the loss arising from the reduction, and of 51 per cent. out of 188 per cent. required in the inter-Colonial traffic. In other words, the Company's one-fourth risk of loss, based on the first three months' experience of the reduced tariffs, is at the rate of £3,188 per annum, and the New Zealand Government's three-fourths risk of loss is £9,563, but as the traffic shows signs of considerable vitality, and the commercial depression in New Zealand appears to be now passing away, it is not anticipated that the actual losses at the end of the year will be anything like so serious as these figures would represent. Since the close of the half-year under review, the Chinese and Russian telegraph systems have been connected and opened for traffic, with the result that the land lines are now competing with the cables for traffic to the cable ports as well as to the interior of China. As, however, the rates fixed by the Russo-Chinese Convention for the land lines are exactly the same as by the cables, although for the present a slightly higher sum is collected, owing to the depreciated exchange, for messages transmitted by the cables from the cable ports, and as, moreover, the working of the land lines is found to be somewhat irregular and unsatisfactory, the competition, as far as we can see, is not likely to prove serious. We trust, however, that a satisfactory working arrangement will eventually be arrived at with the Chinese administration. I have now given you a very careful statement of what has occurred during the last six months, thinking it is always right that, as far as lies in our power, we should furnish you with every information in order that you may see what we have been doing, and understand what we are going to do in the future. We have always felt that the more confidence that exists between the Directors and the shareholders the more successful the Company will be. I think that policy has been fully appreciated by you all, and I believe that there are very few Boards of Directors who can come before their shareholders as we do to-day, and show you a more satisfactory result of the year's working than we have done in the statement I have just made to you. Nevertheless, I may tell you that there is still a great deal yet to be done. It requires very close attention, and also a good deal of knowledge to work out satisfactorily all those problems that come up from time to time between the Australian colonies and the Mother Country. As you know, the Australasian colonies are becoming great powers in themselves, and I may here record the first instance of a thoroughly united action on the part of all the colonies in favour of our telegraph system. Hitherto, at least one has always stood aloof, and the one that has looked on probably more than any of the other colonies has been Queensland, whose sympathy with our action we have done everything possible to enlist. We expect a great deal more from that colony than it has yet given us. Having given them practically all the advantages which every other country derives from our great system, which now permeates the world, they have never yet said a thankful word to us, but have wished, above all things, to get some other Company to come forward, lay an alternative cable to that which exists, and give them half rates without their paying anything in return for it. That is the policy Queensland has been pursuing in the past. Possibly they have now begun to see things from a more reasonable point of view, and recognise that the Company has been doing everything it could to meet public requirements. Only the other day we showed our sympathy for them in their recent misfortunes. I hope sincerely that the little cloud that has hung between us for so many years will disappear now that unanimity has been established, as I have just mentioned. With all the other colonies we have the most happy relations, and I may add something which is almost unusual—that there is nothing existing at the present moment that is in the least objectionable between us. (Hear, hear.) Not even a complaint from these colonies. As you are aware, they have been labouring for the past two years under very severe commercial depression. We see from day to day indications of that in the banks which are having to close their doors; but the land does not run away, the spirit of the people remains, and while I believe that they have been somewhat speculative, the country will, I feel sure, eventually resume the same career of prosperity which it enjoyed for so many years. That will greatly benefit the Company, our system being an accurate indicator of the trade of the country. Notwithstanding all the depression which is abroad at the present moment, we have done rather better than worse this half-year. I referred in my earlier remarks to the proposed alternative China cable, which is the only section we have at the present moment not duplicated. The China and Manila traffic represents a considerable portion of our revenue, and if anything were to occur to the existing cable a very large amount of traffic would pass from us. For many years past we have been in negotiation with the local and home Governments with a view to enabling us to put down another cable, but commercial affairs have not been very prosperous, and we have found every succeeding Govern-

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ment rather more difficult to get money from than its predecessor We do not propose spending any money out of capital in connection with this cable; and if we can carry our negotiations to a successful issue with the Government, the result will give us such security as will add largely to the value and strength of our property. (Cheers.) Those of you who read the papers attentively will have seen the references to the laying of a cable from New Caledonia to connect with Queensland. This has been very much encouraged by the latter colony, which I believe has promised to contribute £2,000 towards it, New South Wales promising a similar amount. It is, however, like a drop in the ocean; and while we should be very glad to see the New Caledonia cable laid, the principle upon which it is being established is not likely ever to make it a successful cable. Still, under any circumstances, it will always be a feeder to us, to a certain extent. The cable, I believe, is to be laid by the French; it must be managed by the French; it must be engineered by the French; and it must be worked in detail by the French. There is to be no English blood or element connected with it, so I do not see any very great future for it. (Cheers and laughter.) I wish I saw a large future, because we are always disposed to encourage feeders such as this, which, if it does us no good, will certainly do us no harm. That cable is supposed to be the first link in a chain across the Pacific. I can tell you without any hesitation that to carry a cable across the Pacific would require a subsidy of about £100,000 a year. That being so, you may depend upon it that it will never be done by French capital, and it is not likely to be done by English just yet. If, however, it is ever done for strategical purposes, I think that we are the people who are likely to carry it out. I daresay you have read in the papers lately a suggestion from a gentleman—who takes a great deal of interest in these things—to the effect that the Government should buy up the cables. In fact, the matter is now on the paper of the House of Commons, and it will come up some day. What I would say about the subject generally is this, that it is a question which will involve something like 35 to 40 millions sterling, and I should like to know where that money is to come from. (Voice: Not from the present Government.) If the money is found you may depend upon it that the shareholders of this Company will participate in the benefit accruing from it, as we shall be able to show what we have done for this Company in improving the value of our cables and our position generally; and if the Government should desire to acquire our undertaking, I am sure you will not object to our selling it to them at the price we shall ask. At all events, when the time comes, your property will not be less but more valuable. (Applause.) I think I have now told you all that is good for you to carry away, as you now know almost as much about our affairs as your Directors do. I think we can congratulate you on the report, and on the thoroughly satisfactory working of the whole of our system, and I am only expressing the opinion of my colleagues when I say that we are very proud of the position we hold to-day in the City of London as a great and influential Company. I beg now to move the following resolution:—

"That the report and accounts of the Directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 4s. per share, both free of income-tax, payable on the 20th instant, making, with the previous distributions, a total payment of 7 per cent. for the year 1892."

The Marquis of TWEEDDALE: I beg to second the motion.

The CHAIRMAN: If any gentleman wishes to put any question to me I shall be glad to answer it to the best of my ability. After a pause, and no shareholder rising to address the meeting, he continued: Then, gentlemen, I will ask those of you who are in favour of the motion which I have just read to signify the same in the usual manner. To the contrary. Carried unanimously.

The Marquis of TWEEDDALE: Gentlemen, I think that the motion which I have now to make is one that will be most acceptable to you all, for it is the re-election of our Chairman as a Director of the Company. You know him nearly as well as I do, and, therefore, I do not think it is necessary for me to say a single word in support of the motion. As you are aware, Sir John Pender has proved himself one of the most able, active, and prosperous Chairmen in the City of London. I think I may take advantage of the opportunity which the moving of this resolution affords me to express the hope—which I am sure you will agree with—that he may long be spared to occupy this position. (Cheers, and hear, hear.)

Mr. FRANCIS A. BEVAN: I have very much pleasure in seconding the motion.

The resolution was then put to the meeting and carried unanimously.

The CHAIRMAN: Gentlemen, I beg to thank you for the honour you have done me in again re-electing me. Next year, I think, we shall attain our majority—we shall be 21 years old. I think we have grown very fairly, and that we have got a good physique, and, moreover, that we have all the spirit and "go" to make a new departure from our 21st year if necessary. I hope that there are many here who will see this concern continuing to prosper when I have left it, but as long as I have strength I am going to remain at work with it. The next resolution which I have to propose is:—

"That Sir James Anderson, who now retires by rotation, be and is hereby re-elected a Director of this Company."

I deeply regret the absence of Sir James Anderson, who is ill, and in a state of health which entirely precludes him from being among us; but I know from the warm and hearty interest he has always taken in the whole of the telegraph system that while he is at home to-day on a sick bed his heart is in the midst of us. I beg to propose this resolution, and I shall have very great pleasure in conveying to him the news of his re-election.

Mr. GEORGE G. NICOL: I second the resolution.

The motion was put to the meeting and carried unanimously.

The CHAIRMAN: The next resolution relates to the auditors, and must come from the body of the meeting.

Mr. JOHN NEWTON: I have much pleasure in proposing—

"That Mr. Henry Dever and Messrs. Welton, Jones, and Co. be and are hereby re-elected auditors for the ensuing year at a remuneration of £100 each."

Mr. KENNETH ANDERSON: I beg to second the resolution.

The CHAIRMAN put the motion, and, having declared it carried unanimously, said, "That concludes the business of this meeting."

Mr. BURGESS: I think we should be wanting in gratitude if we did not propose that the very best thanks of the meeting be given to our worthy Chairman and the Directors. I think if you were to go through the whole of London you would not get a more devoted Chairman or a better set of Directors than we have.

Mr. JOHN NEWTON: I second the resolution with much pleasure.

The motion was carried by acclamation.

The CHAIRMAN: I am very much obliged to you for the resolution you have just passed, and for the kind words which were said by the gentleman who proposed it. On behalf of my colleagues and myself I can only say that we warmly appreciate and value all the kind words that come from your side of the table, and I hope that we shall always continue to merit your confidence and support.

Phonopore Company (Limited).

The fourth annual meeting of this Company was held on Wednesday at Winchester House, under the presidency of the Right Hon. Sir Mountstuart E. Grant Duff (Chairman).

The SECRETARY (Mr. Charles Isaac) having read the notice calling the meeting,

The CHAIRMAN said he felt some diffidence in coming before the shareholders on that occasion, because there must be a great many of them who knew very much more about the earlier history of the Company than he did. Many of them had been connected with it since its existence, whereas he knew nothing about it before August 31st last. As they were aware, when the Company had been started for some time, it was found that they were approaching the end of their resources, and a considerable amount of additional capital was raised upon preference shares, some of those who advanced the money joining the Directorate He confessed, looking over the past, that if he had known that the amount of their liabilities was so large as it turned out to be, he would not have joined the Board. He should have stipulated that before he took part in the Direction they should have entirely settled with the inventor. If that had been done before they raised the additional capital, he should not have had to announce that there would shortly be a call of half-a-crown upon the preference shares. Referring to the accounts for the past fifteen months, ended December 31st last, he said they represented hardly anything except preliminary expenses in getting their ship out of harbour. There were items, amounting to £4,500, which would not appear again. One of the principal events that had occurred since the reconstitution of the Company in August last was the acquisition of Mr. C. E. Spagnoletti as Managing Director, whose fame was widely spread amongst those people, in this and other countries, to whom the application of electricity to the purposes of life was of great interest. When he (the Chairman) came behind the scenes he was a great deal disappointed to find that they could not work over as large an extent of wire as he had hoped. He found they could work perfectly well from London to Bristol, but not from London through to Plymouth. In foreign countries there were a great many places they wished to assist to communicate with each other, and which were further apart than London and Bristol. Mr. Spagnoletti had done all he could to perfect the instrument so as to be able to work unfailingly over long distances. He wished he was able to say that Mr. Spagnoletti had quite succeeded, but all he could venture to say was that he believed himself to be thoroughly on the way to success. When they could work unfailingly over long distances he was quite sure they would have a very large market for the phonopore instruments in a great many countries, to say nothing of the very considerable advantages to be obtained by the application of them to submarine telegraphy. Passing to what they could do and were doing, he said they were working with perfect success from London to Bristol, and from London to Birmingham on the Great Western; from London to Cambridge on the Great Eastern, and to places on other railways, including the Great Northern. After stating that the phonopore block connector—an instrument affording additional advantages for establishing telephonic communication upon the block wires from station to station while the wires were being simultaneously used for the transmission of telegraphic signals—was a thorough success, the Chairman said that now they had got free from their important liabilities he hoped that when they met again he should be able to give a much more cheering account of the prospects of the Company. In conclusion, he moved the adoption of the report.

Mr. E. F. WEBSTER seconded the motion.

Mr. LANGDON DAVIES said shareholders had heard at previous meetings over and over again everything the Chairman had stated on that occasion. He moved as an amendment that the meeting be adjourned till that day three weeks to enable the Board, after conferring with a group of shareholders, to report the result.

Mr. FELLOWES seconded the amendment.

Mr. POLLARD deprecated any such amendment as that proposed, now that that they had obtained the services of such an able practical electrician as Mr. Spagnoletti.

Mr. SPAGNOLETTI, in response to the meeting, offered a few remarks as to the prospects of the Company. He said a prejudice existed on the

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part of some of the railway companies against the phonopore instrume nts owing to the unsatisfactory manner in which they had worked in the p ast He was able, now, however, to obtain letters of recommendation from some of the companies which would be of great assistance to them. In his opinion, the great future for the phonopore lay in the foreign business, which at present they could not take in hand. They were now in communication with several Governments and foreign companies, and if they could only work the distances they required there would be a profitable business in that direction. Everything now was beginning to bid fair for making good business progress.

The amendment was negatived and the report adopted.

The retiring Directors, Mr. A. B. Isaac and Major-General J. Shaw Stewart, were re-elected

Indo-European Telegraph Company (Limited).

The following is the Directors' report for 1892, which is to be presented to the members at the meeting to be held at Winchester House on Friday, the 28th inst., at 1 p.m. :—

The Company's revenue from all sources for 1892 amounted to £117,479 13s. 10d., as compared with £116,699. 3s. 1d. for 1891, showing an increase of £780. 10s. 9d. The expenses were : on commercial and general account, £31,960. 8s. ; on maintenance account, £30,188. 8s. 3d. ; total, £62,148 16s. 3d., as against £61,108. 12s. 10d. for 1891, an increase of £1,040 3s. 5d. Deducting the above expenses, taking credit for £5,983. 15s. 4d. brought over from 1891, and debiting income tax, there remains the sum of £60,057. 16s. 11d. From this amount £10,000 has been placed to reserve, and that sum, together with £10,625 amount of interim dividend, have to be deducted, leaving a balance of £39,432. 16s. 11d.

The Directors now propose the declaration of a dividend for the six months ending December 31st of 17s. 6d. per share, making, with the dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent., carrying forward £7,557. 16s. 11d. to the credit of 1893.

The reduced tariff with the Australian Colonies, introduced on May 1, 1891, under agreement with the Colonial Governments, has undergone a slight augmentation with the object of diminishing somewhat the rather considerable losses occasioned. The Directors trust that the still largely reduced tariff at present in force may be enabled to be permanently established.

The Directors, on a careful review of the whole of the circumstances, do not think it necessary in the case of such a small undertaking to apply the machinery of the Forged Transfer Acts.

The former Director-General of Telegraphs for Germany, Herr Hake, having retired, has been succeeded by Herr Schffler, the present Director-General. The following Directors retire by rotation and offer themselves for re-election :—C. W. Earle, Esq., and C. Holland, Esq. The auditors, Messrs. C. F. Ford and Co., accountantr, retire, and offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

ARCAS PLATING COMPANY (LIMITED).—The statutory return of this Company, made up to April 3rd, has been filed. Out of a nominal capital of £80,000, in £1 shares, 17,908 shares have been taken up, of which 2,407 have been issued as fully paid. Upon the remaining 15,501 shares 10s. per share have been called, resulting in the payment of £2,593. 10s., leaving £5,157 in arrear.

AKESTER ELECTRIC SYNDICATE (LIMITED).—The statutory return of this Company, made up to February 17, 1893, has been filed. Out of a nominal capital of £15,000, divided into 300 shares of £50 each, only the seven signatories' shares have been taken up, and no calls have been mad on these shares.

CHLORIDE ELECTRICAL STORAGE SYNDICATE (LIMITED).—This Company has filed new Articles of Association, in which the Directors are given as follows :—William Mather, M.P., of Salford Iron Works, Manchester ; Edward Hopkinson, Salford Iron Works, &c. ; and Hardman A. Earle, of Victoria-street, Westminster, S.W. (Managing Directors) ; G. Annesley Grindle, of Great Winchester-street, London, E.C. ; the Hon. James J. Fellows, of Saxon Hall, Palace Court, Bayswater, London, S.W. ; Edward Tuck, of Paris, France ; and William W. Gibbs, of Philadelphia, U.S.A. The registered office has been removed from Abchurch-lane, E.C., to 8, King-street, Manchester.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to March 16th, has been filed. The nominal capital is £350,000, divided into 57,900 ordinary, 100 founders', and 12,000 preference shares of £5 each. 8,322 ordinary shares, 100 founders', and 4,291 preference shares have been taken up, and the founders' and 1,000 of the ordinary shares have been issued as fully paid. Upon the remaining 7,322 ordinary and 4,291 preference shares the full amounts have been called, resulting in the payment of £57,915. £150 is still owing on account of 50 of the preference shares.

LIVERPOOL ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to March 10th, has been filed. The nominal capital is £300,000 in £5 shares, of which 40,000 have been taken up. Upon 10,000 of these shares the full amounts have been called, and upon the remainder a call of £3. 10s. has been made. The calls paid amount to £175 130.

ROGER DAWSON (LIMITED).—An agreement, made March 10, 1893, between Alfred Roger Dawson, of St. Margaret's, Portmore Park, Weybridge, Surrey, electrical engineer (the vendor), Arthur R. Cobbett, Charles E. Tomlin, John H. Jenks, and the above-named Company, states that till recently the vendor carried on, in partnership with Mr. A. Rashleigh Phipps, the business of an electric light engineer and contractor, in London, and that the partnership had been dissolved, Mr. A. Rashleigh Phipps being released from all liabilities. The vendor owes Mr. Tomlin £11,664. 16s. 2d., Mr. Cobbett £6,526. 14s. 3d., and Mr. Jenks £115 12s. 10d., and as these creditors are willing to accept certain shares and debentures in the Company in payment of these sums, it is agreed that the vendor shall sell his business to the Company for £10,000, payable £7 in cash and £9,993 in fully-paid shares ; that the vendor shall be Managing Director for seven years, with a salary of £5 per week, in addition to his remuneration as an ordinary Director ; that Mr. Cobbett shall accept 4,900 fully-paid £1 shares and £1,626. 14s. 3d., and 2,499 vendor's shares ; that Mr. Jenks shall accept 100 fully-paid shares ; and that Mr. Tomlin shall accept 100 Six per Cent. Debentures of £100 each and £1,664. 16s. 2d. in cash, and 2,999 vendor's fully-paid shares.

PHOSPHOR BRONZE COMPANY (LIMITED).—The annual return of this Company, made up to March 10th, has been filed. Out of a nominal capital of £150,000, divided into 15,000 preference and 15,000 ordinary shares of £5 each, 8,375 preference and 7,335 ordinary shares have been taken up. Upon these shares the full amounts have been called, and all calls (£78,550) paid, and £11,560 has been paid on forfeited shares.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The numbers are announced of a drawing of 177 Five per Cent. Debentures of £100 each of the 1884 issue. These debentures will be paid off at par on July 31st next at Parr's Banking Company and the Alliance Bank, Bartholomew-lane, E.C., and interest will cease after that date.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended April 16th were £861, as against £734 for the corresponding period of last year, being an increase of £127. The total receipts for half-year amount to £13,717 against £12,495 in the corresponding period of 1892, being an increase of £1,222.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company give notice that payment by warrant will be made on May 1st of interest for the half-year ended April 30th, on the Four per Cent. Mortgage Debenture Stock. The transfer books will be closed from April 27th to May 1st, both days inclusive.

GREAT NORTHERN TELEGRAPH COMPANY (LIMITED).—The working account of this Company for the year 1892 is published, and the Directors recommend a final dividend of 7s. 2d. per share, making in all 8 per cent. for the year 1892, the amount actually paid for dividend during the year being £129,166. 13s. 4d. ; £83,333. 6s. 8d. is added to reserve and renewal fund (which now amounts to £806,327. 10s. 5d.), £2,777. 15s. 7d. is contributed to the pension fund of the staff, and a balance is carried forward to the current account of £45,666. 18s. 9d. The general meeting takes place on Saturday, April 29th.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have decided, after placing £1,182 to the reserve fund, to recommend at the forthcoming general meeting a dividend of 4s. per share, free of income-tax, being at the rate of £2 per cent. for the year 1892.

METROPOLITAN ELECTRIC SUPPLY COMPANY (LIMITED).—The annual meeting of this Company takes place at Winchester House this day (Friday) at 12 o'clock.

NEW SHANGHAI ELECTRIC COMPANY (LIMITED).—The report of the Directors of this Company has been presented to the shareholders at the meeting held at Shanghai on the 28th ult. The Directors report a satisfactory working during the twelve months ended December 31st last; the balance of income over expenditure allowing a distribution of 7 per cent., and a liberal allowance for depreciation of plant and apparatus. Only a small addition had been made to the arc lighting of the districts supplied by the Company, the demand for incandescent lighting had necessitated a large extension of the Company's plant, upon which no less than 15,000 tls. had been expended in 1892, which had been met by a loan guaranteed by the Directors. The plant would, doubtless, be working to its full capacity in a short time. Many of the public buildings and the principal hongs in Shanghai are now lighted electrically, and private house lighting is extending in a most satisfactory manner. The total number of incandescents run by the Company up to the end of the year 1892 was 1,269, and when the total number of lights on order were installed, the number would be 2,895. The Company were supplying plant and material for private installations, and to many steamers calling at the port. The operations of the Company were seriously hampered by insufficient capital, and it is probable that an addition will be made to the capital of the Company in the near future. The Directors have no objection to offer to the proposed purchase of the plant, property, and business of the Company by the Municipal Council, and await the action of that body without anxiety.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The Directors of the Company have decided, after placing £15,000 to the reserve fund and £6,674 to the debenture redemption fund, to recommend at the forthcoming general meeting a dividend of 4s. 6d. per share, free of income tax, making, with the interim dividend paid November last, a distribution of £2. 10s. per cent. for the year 1892, carrying forward £2,829. The traffic receipts for the week ended April 14, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegrap Company (Limited), were £3,137.

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WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have decided to recommend the undermentioned dividends for the six months ended December 31, 1892, viz., 6s. per share on the first and second preference shares, and 6s. per share on the ordinary shares, placing £1,600 to reserve, and carrying forward £1,430. The receipts for the two weeks ended April 15th were £2,789 as compared with £2,656 for the corresponding period of last year. The December receipts, estimated at £5,219, realised £5,275.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	La Divi. dend.	Name.	Previous Week's Price, Apr. 12.	Price Wednesday, Apr. 19.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 19. Highest	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American x‡	53 54	52 53	5 3 9	Jan., Apr., July, Oct.	52¼	52¼
£2,876,140	Stock	25/0	Do. Preferred xd	92 93	93 94	5 18 3	" "	92⅝	92
£2,876,140	Stock	5/0	Do. Deferred	12¾ 13¼	12½ 13	..	" "	13⅛	12⅝
£250,000	100	4%	African Direct, Telegraph 4% Debentures	101 104	101 104	3 16 11	January and July ..	102	..
130,000	£10	3/0	Brazilian Submarine	11½ 12	11¾ 12¼	5 6 1	Mar., June, Oct., Dec.	12⅛	11¾
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July ..	100¾	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1903)	105 109	105 109	4 11 9	June and December	..	..
$7,716,000	$100	$1¾	Commercial Cable Capital Stock	165 170	165 170	4 2 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½ 12½	11½ 12½	6 8 0	February and August	12½	12¼
6,000	10	10%	Do. Preference 10%	18 19	18½ 19½	5 2 7		..	..
12,931	5	1/7⅛	Direct Spanish (£4 paid)	2½ 3½	2½ 3½	4 11 5	April and October...	2⅞	2¾
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" " "	..	..
60,710	20	3/6	Direct United States	11⅝ 11⅞	11¾ 12	5 16 8	Jan., Apr., July, Oct.	11⅝	11⅜
400,000	10	2/6	Eastern xd	15 15¼	15 15¼	4 5 3	" "	15¼	15
70,000	10	6%	Do. 6 per Cent. Preference xd	16¼ 16¾	16¼ 16¾	3 11 8	" "	16⅜	16⅜
£1,294,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114 117	114 117	3 8 5	May and November	115½	115¼
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15½ 15¾	15½ 15¾	4 8 11	Jan., Apr., July, Oct.	15⅝	15⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112 115	112 115	3 9 7	February & August	..	..
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103 106	103 106	4 14 4	January and July ..	..	..
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102 105	102 105	4 15 3	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101 104	101 104	3 16 11	February & August	..	..
180,227	10	2/3	Globe Telegraph and Trust xd	9⅝ 10⅛	9¾ 10	4 12 6	Jan., Apr., July, Oct.	10	9¾
180,042	10	6%	Do. 6 per Cent. Preference xd	15⅝ 15⅞	15⅝ 15⅝	3 16 10	" "	15⅝	15⅝
150,000	10	5/0	Great Northern	19½ 19⅝	19½ 19¾	4 6 1	Jan., April, and July	9¾	9⅝
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	105 108	4 12 7	March & September	107	..
17,000	25	12/6	Iado-European	43 46	43 46	5 8 8	May and November	44⅝	44
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	106 109	106 109	5 10 1	March & September	..	..
10,802	8	4/0	Reuter's	7 8	7 8	..	April and October...	7⅜	..
3,381	£100 Cert.	30/0*	Submarine Cables Trust 6%	120 125	120 125	4 16 0	" "	..	..
15,609	10	5/0	West African Telegraph	5½ 6½	5½ 6½	7 13 10	January and July ..	5¼	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	101½	100¼
30,000	10	2/0	West Coast of America	2 3	2 3	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	105 109	105 109	7 6 10	June and December	..	..
88,321	10	6d.	West India and Panama	1⅝ 1⅞	1⅝ 1⅞	..	" "	1¾	1⅝
34,563	10	6%	Do. 6 per Cent. 1st Preference	11½ 12	11⅓ 12	5 0 0	May and November	12	11¾
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9½ 10⅛	9½ 10⅛	5 14 3	" "	10	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	108 111	108 111	4 10 1	June and December	110	..
64,242	15	3/0	Western and Brazilian	7⅞ 8⅛	7⅞ 8⅛	5 9 1	May and November	8	7⅞
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5⅝ 6¼	5⅝ 6¼	6 0 1	" "	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1⅝ 2¼	1⅝ 2¼	..	" "	2	..
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105 108	106 109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105 108	106 109	5 10 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	101 104	101 104	5 15 5	March & September	103½	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone (fully paid) xd and rights	3 4	3 4	..	..	..	..
224,850	14/0	1½d.	Consolidated Telephone Const. & Maintenance	¼ ⅜	¼ ⅜	1 13 4	May and November	..	..
220,000	£1	4⅜d.	Oriental (11s. paid)	⅛ ¼	⅛ ¼	7 18 2	Yearly	..	..
454,747	5	2/6	National	5¼ 5⅜	5¼ 5⅜	5 9 1	June and December	5⅞	5⅝
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15 15½	15 15½	3 17 6	" "	15⅛	15⅜
15,000	10	6%	Do 6% Cumulative 2nd Pref.	14½ 14⅝	14½ 15	4 0 0	" "	14⅝	14⅜
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	5⅜ 5⅝	5⅜ 5⅝	..	..	5⅝	5⅜
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	113 116	113 116	3 17 7	January and July ..	115	114¾
43,000	£10	..	New Telephone, Limited (£4 paid)	.. ..	.. ..	..	..	..	..
58,000	5	1/0	United River Plate	2½ 3	2 3	..	January and July ..	..	..
146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	11⅝ 12¼	12¼ 12⅝	..	—	12⅝	12¼
20,000	£10	..	Do. 6 per Cent. Preference	10¼ 10¾	10½ 11	..	..	10½	10⅜
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	—	—	—
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	—	—	—
8,332	£5	..	House to House Electric	.. ..	.. ..	..	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully pd.) xd	.. ..	.. ..	..	—	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid) xd	.. ..	.. ..	..	January and July ..	..	..
90,000	£5	3/4 92	Liverpool Electric Supply (£3 10s. paid)	4⅛ 4⅜	4¼ 4⅜	..	March	—	—
10,000	£5	5/0 '92	Do. (fully paid)	5⅝ 6⅛	6 6¼	..	March	..	..
111,000	5	..	London Electric Supply	1 1⅛	1 1⅛	..	—	—	—
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	7¼ 7⅜	7¼ 7⅜	..	—	7⅜	7¼
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	..	..
16,318	10	..	Notting Hill Electric Lighting (fully paid)	5½ 6⅛	5¾ 6⅛	..	—	..	..
18,680	£5	9½%	St. James' and Pall Mall	8 8⅛	7⅞ 8¼	..	—	8	7¾
7,900	£5	7%	Do. 7% Preference	8 8¼	8 8⅜	4 2 4	—	8¼	8⅛
£2,853	5	2/0	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 18 4	—	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/6	Brush Electrical Engineering	3 3¼	3⅛ 3⅜	..	—	3⅛	3⅛
69,996	2	6%	Do. 6 per Cent. Preference	2⅛ 2⅜	2¼ 2⅜	4 6 0	—	2⅞	2¼
£125,000	ock	4½%	Do. 4½ per Cent. Debentures	103 105	106 108	4 3 4	..	107⅜	106⅜
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼ 5¾	5¼ 5¾	6 1 9	January and July —	5⅝	5⅜
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	.. ..	.. ..	..	—	..	..
45,000	10	12/0	Electric Construction	2⅞ 3	2⅞ 3	..	—	..	..
70,000	2	10/0	Elmore's Patent Copper Depositing	⅝ ¾	⅝ ¾	..	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1 2	1 2	..	—	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	22 23	22 23	5 8 8	February & August	22½	22¼
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0 6/0	5/0 6/0	..	..	..	..
78,949	5	4/2⅝	Swan United (£3. 10s. paid)	3 3½	3 3½	10 0 0	May and November	3⅛	..
37,350	12	24/0	Telegraph Construction and Maintenance	32 35	31 34	5 5 10	March and July....	34	32
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July —	104	..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	..	—	—	—
..	£5	..	Do. Preference (fully paid)	.. ..	.. ..	—	—	..	..
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	.. ..	.. ..	..	—	..	..
600,000	Stock	5⅝	Do. Stock	37 39	37 39	2 17 8	May and November	..	..

* 30s. on account Coupon April 15, 1893.

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NOTES.

We regret to announce that the illness from which Sir James Anderson has been suffering for some months past has assumed a serious aspect; and at the moment of our going to press we learn that his condition is critical.

There was little that was new, but much that was too true, in Prof. Kennedy's lecture before the Royal Institution last Friday. In discussing the "Possible and Impossible Economies in the Utilisation of Energy," Prof. Kennedy exemplified, as many others have done before in the same place, that a thorough popular treatment of an important subject is far more interesting and useful than the serving up of brand new discoveries in a sauce of half-cooked theories. Figures and technical matters struggled hard to get in front, then seemed shy of the audience, and retired. The chief points of the lecture were directed against unscrupulous persons, such as "those who will tell you that they can get twice as much energy out of a pound of coal as anyone else can," and all the available missiles—Carnot's function, for example, and the doctrine of the conservation of energy—were hurled at their heads. A source of energy, we were told, might be likened unto a metalliferous ore, in which, there being only a certain percentage of useful stuff, it was foolish to attempt to get more than that percentage out. It was not the fault of the blast furnace—it was Nature's "fault"—that we did not get beyond a certain yield of metal.

Prof. Kennedy showed that was not the fault of the steam-engine, for example, that its efficiency could not be raised to anything like 100 per cent. This argument which ran through the discourse and served to hold together many a hard idea, must not, however, be pressed too closely. It has only a relative application, for in no source of energy is there an absolute limit of available percentage (under 100 per cent.) as there is of metal in an ore. Coal, relatively to a steam-engine, may not be able to yield more than 30 per cent. at the best; but, if the coal is turned into producer gas, its theoretical limit in a gas-engine becomes two and a-half times higher; and there is no denying that a process may be discovered whereby the availability may be approximated closely to 100 per cent. This need not—in fact, would not—be a heat engine. Considered thermodynamically, the human body is an engine which has an everyday efficiency far higher than the highest limit fixed by Carnot's function. That is because the human body is not a heat engine, pure and simple. The *impossible* economies relate only to the special processes of utilising energy, and do not depend upon rigidly exclusive general principles.

The relation of prime to working costs is an important point in this connection, which was not hinted at in the lecture. The highest limit of efficiency which may be fixed for the steam-engine is only the highest when we avoid all reckless expenditure in designing the engine and follow economic laws in the use of materials. Even for any special process of utilising energy, the impossible economies are less physical impossibilities than commercial ones. Perhaps this was what Prof. Kennedy had in his mind when he said that "as an engineer he did not believe in any impossibilities except perpetual motion and the transmutation of metals!" Lord Kelvin and Prof. Crookes, by-the-bye, might enlighten him as to his second *non credo*.

But the sin of wasting the energy of nature was laid, not so heavily at the door of Nature herself, as at that of the bad engineer. Woe unto you, ye bad engineers, who build engines so much worse than the best, for the world's annual balance-sheet of energy consumption would show only one-third of its present figure for the same amount of work done if every engine were brought up to the standard of the present working best. "The difference in economy between the worst and the best engineering is greater—far greater—than that between the actual best and the theoretically possible best." Considerably half our possibilities consist in improving up to the level of the actual best, in bringing the laggard majority up to the forefront of the fight. Improving the best is a far more difficult, and far less hopeful, matter.

In *The Electrician* for December 9, 1892, we described some experiments by M. Janet on the discharge curves of condensers, which showed very clearly the time oscillations in the potential and charge. In a recent number of the *Comptes Rendus*, M. Janet continues his investigation, and shows how from these curves the relation connecting the potential with the charge may be obtained. If the condenser for these rapid oscillations behaved simply as if it had a capacity, the relation in question would be a straight line, the ratio between the two quantities being constant. The curve obtained, however, encloses an

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area, and is analogous with, though not the same shape as, the hysteresis curve connecting magnetism with magnetising force. The writer appears to infer that this curve proves the existence of true electric hysteresis between the electric charge and the electric force. All it really proves, however, is that a loss of energy occurs in the dielectric. Similarly in the magnetic case, when the curve connecting magnetism with current is deduced from two curves, one connecting magnetism with time and the second connecting current with time, it is found that the hysteresis curve obtained differs considerably from the ordinary Ewing curve. It encloses a larger area, and, instead of being pointed at its extremities, it is always rounded. The difference in the two areas is due to eddy currents, and there would be no proof of the existence of true hysteresis if the only evidence in favour of it was the rounded curve obtainable in this manner. Static experiments alone can prove the existence of true hysteresis.

THE theorem of Professor POYNTING, concerning the path of the energy movements in the electromagnetic field, has recently been applied in an interesting manner by M. BIRKELAND, to explain some hitherto obscure phenomena presented by Hertz oscillations. Some of the more recent advances in this subject have depended upon the consideration of the mode in which the electrical disturbances die away. By applying POYNTING'S theorem to the case of a Hertz oscillator, M. BIRKELAND has shown that the rate of subsidence of the electromagnetic energy in a given space depends upon the shape and position of the conductors in the neighbourhood, and that it consequently varies with the place considered. This serves to explain the difference found between the values of the logarithmic decrement obtained experimentally, and by calculation from the general configuration of the oscillator; since the latter quantity is only an approximate value, in obtaining which the losses of energy in local circuits due to the resistances of the various parts of the apparatus are neglected. M. BIRKELAND has also offered a likely explanation of some reflection phenomena observed by MM. SARASIN and DE LA RIVE. According to these investigators, when electromagnetic waves are reflected at the end of a wire the stationary waves formed have the nodes differently situated for the electric and magnetic waves. This is explained by showing that the path along which the electric energy travels is quite distinct from that along which the magnetic energy moves. M. BIRKELAND'S note is printed in the *Comptes Rendus* for April 17th.

M. DESIRÉ KORDA has rediscovered the fact, announced some years ago by Professor TROUTON, that it is possible to increase the frequency of an alternating current by exciting the fields of an alternator with one alternating current, and using a suitably wound armature to produce a second. In Tesla and in three-phase motors the same effect occurs, for the frequency of the current in the short-circuited armature depends on the relative speed of the armature and field, as well as on the frequency of the current in the latter. M. KORDA'S armature is very similar to one devised by MM. HUTIN and LEBLANC, since it is doubly wound, with its two parts displaced so as to be in quarter-phase relation to one another; and it is shown mathematically that the result of this is to produce a current of three times the frequency of that which is used to excite the magnets. But the unsatisfactory feature of the article, which seems characteristic of all mathematical essays on the theory of multiphase machines, is the total neglect of the effect of armature reactions on the field. Moreover, we cannot share the optimism of the writer in urging the advantages of high-frequency currents for practical purposes. According to M. KORDA'S article, which appears in a recent number of the *Comptes Rendus*, the great advantages of avoiding the use of iron, and hence the losses due to hysteresis, in transformers, and also of rendering condensers of small capacity capable of passing large currents, are too well known to need repetition. On the contrary, the tendency of commerce is to reduce the frequency of alternating currents. Condensers are not likely to be much used in future, and transformers without iron are purely visionary.

WHERE simple fractions occur in the course of running text we have frequently used the /, called a solidus or shilling-mark, to avoid unsightly alteration in the "whites" between the lines. Since the discussion on the printing of mathematical symbols which appeared in our columns in October last, we have used it rather more frequently; but we can assure those who advocate such reforms that it has cost far more trouble than it is worth, by creeping into fractions having more than one term in the numerator or in the denominator. We hope that we have, as a rule, succeeded in detecting these in proof, and have not allowed them to appear in our columns. We regret, however, that last week, in an abstract of a Paper by Herr NERZ on the "Construction and Uses of Projectors," this symbol was ambiguously used more than once. It is hardly necessary to give the errata, as careful reading will show that by tan $a/2$, for example, is meant the tangent of half a, and not half the tangent of a.

WE notice this week the action of the Eastbourne Electric Light Company in offering to provide electromotors for ventilating the up-take columns of sewers. The offer has been accepted, and a motor is to be continuously supplied with the current for three months for £5, tests being taken in the meantime on the amount of foul air extracted from the sewer. The introduction of electromotors for this purpose is by no means the first occasion on which mechanical power has been employed for removing dangerous gases. Large blowers and fans have been successfully used for carrying a supply of fresh air through the workings at mines and collieries. As a rule, however, it has been found more economical to adopt a system of ventilation by hot-air currents, a furnace being kept up in the up-take for the purpose of heating the out-going air, and thus creating a draught. A proposal was made some time ago to place a resistance coil at the base of the column of sewer up-takes, and to keep this coil very hot by means of an electric current. Theoretically, this plan would be more efficient than mechanical ventilation, and would offer the further advantage of having no working parts requiring occasional oiling and repair. Practically, however, the mecha-

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nical method may prove to be the superior one, as in the alternative method the cast-iron column would offer a considerable cooling surface to the heated gases, and would thus lead to a dissipation of much of the energy supplied to the coil. Careful experiments extended over a lengthy period can alone determine the value of either of these systems. It is interesting to note, however, that in the mechanical method the energy which is not turned into mechanical motion by the motor is not altogether wasted; for the heat spent in overcoming the resistances of the armature and field coils, and in turning the spindle in the bearings, will warm the column of gas and assist its ascent. The mechanical device, therefore, offers a composite method, in which the gas is partly got rid of by a fan-thrust, and partly by becoming specifically lighter on account of a rise in temperature.

Municipal electric lighting committees are apparently inaugurating the somewhat hazardous, though we do not say disastrous, policy of disregarding expert advice. As a matter of general principle it would seem decidedly the better course for town councillors to take the advice of their experts on faith, like they do many other things that are beyond their mental jurisdiction, but two recent instances of municipal independence appear to show that perversity has its advantages. Last week the Islington Vestry adopted the high-pressure system in the face of a recommendation to do otherwise. This week the prevailing fashion for high-speed engines notwithstanding, the Leicester Town Council have decided to employ horizontal compound condensing slow-speed direct-coupled engines in their proposed central lighting station. The magnificent Sulzer engines seen at work in the Cologne and Dusseldorf central stations were at the bottom of this stiff-neckedness, but we hope their magnificence will not lead to the order being placed outside the United Kingdom. If horizontal, etc., engines *are* to be the order of the day at Leicester, we feel sure many an English firm could turn out sets quite as imposing in appearance and as economical in steam consumption as any made in Germany. However, whether the plant hail from this country or the Continent, we shall watch its performance with lively interest.

The Leicester Town Council seem to have rather more acquaintance with steam machinery than is usual with such bodies, but a little knowledge is, as usual, dangerous. So glibly did Councillor Billings talk of kilowatts that some inquirer demanded an explanation of the term, and was promptly told that it meant a thousand watts. But "What's a watt?" demanded this inquiring spirit. Alas! he had touched bottom; the united wisdom of Leicester's aldermen was not equal to an answer; the Council was, to put it vulgarly, "stumped." Alderman Priestman, of Bradford, and other municipal magnates, have, indeed, done good service to the electrical industry, but engineering had, on the whole, better be left to engineers, unless we are to have an engineering analogue of the mayor who addressed a meeting, on a recent occasion, on the civilising effects of the advancement of science, and suggested that the lines of latitude and longitude should be taken up and replaced by submarine cables.

It is not often that we have to chronicle in these days the rout of an entire dichotomous Legislature of the orthodox pattern by a group of company promoters. In the Isle of Man, however, both the Court of Tynwald and the House of Keys have had to give up a clause upon which they had set their Legislative hearts, making it compulsory upon the Douglas-Laxey Electric Railway Company to carry goods. The promoters of the Douglas-Laxey Electric Railway stated their willingness to do as much goods carrying as would pay, but the line being mainly a mere pleasure line, they would rather sacrifice their Bill than proceed with it harassed by such an obligation. On the principle that even a paying railway is better than none at all, the Manx Legislature gave way.

The Late M. Van Rysselberghe.—The Belgian Government has granted an annuity of £120 to the widow of the late M. Van Rysselberghe.

Taunton.—A Local Government Board Inquiry was held at Taunton on Wednesday last week, relative to the borrowing of £16,000 for electric lighting.

Blackpool.—The corner stone of the Corporation electric-lighting station, now in course of erection, will be laid by the Mayor of Blackpool to-morrow.

King's College Old Students.—The annual dinner of Old Students of King's College will be held at the Holborn Restaurant on Monday, May 15th, with Mr. W. H. Preece in the chair.

Royal Society.—Amongst the Papers down for reading before the Royal Society yesterday was one by Prof. J. C. Ewart on "The Electric Organ of the Skate: Note on an Electric Centre in the Spinal Cord."

Telephonic Communication in the United Kingdom.—At the weekly meeting of the Balloon Society, held at St. James's Hall on Friday evening last, Mr. A. H. Hastie delivered an address on "Telephonic Communication in the United Kingdom."

Telephone Rates.—The House of Representatives of Missouri has recently passed a Bill establishing maximum telephone rates at £10 per year in towns of over 100,000 inhabitants, £8 per year in towns of between 30,000 and 100,000 inhabitants, and £6 per year in all other towns of the State.

Arc Lighting in St. Pancras.—In spite of the Electricity Committee of the St. Pancras Vestry having twice recommended centre-lighting for Park-street, it has been decided to adopt side-lighting in view of the complaints made with regard to the obstruction to traffic occasioned by the Tottenham Court-road pillars.

Institution of Civil Engineers.—On Thursday, May 4th, at 8 p.m., being the forty-first anniversary of the election of the secretary as an associate, the first "James Forrest" lecture will be delivered by Dr. W. Anderson, F.R.S., M.Inst. C.E., the subject being "The Interdependence of Abstract Science and Engineering."

The General Electric Company.—According to the "condensed balance-sheet" of the General Electric Company (U.S.A.) covering the first eight months of its existence down to January 31st last, its stock and debenture capital now amounts to close on £9,000,000, its net profits for the eight months in question being stated at over £670,000.

Folkestone.—At a meeting of the Town Council last week there was a notice on the agenda "To consider the expediency of introducing the electric light into Folkestone, either generally or over a limited area of the town, and as to terms and arrangements, and generally in relation thereto." After some discussion the motion was carried.

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Electrical Bills in Parliament.—The Kensington and Knightsbridge Electric Lighting Company's Bill has passed the examiners in the House of Lords. The following Bills have been read a third time in the House of Commons :—Brighton and Rottingdean Seashore Electric Railway Bill, and the City and South London Railway Bill.

Morals of Corporations.—Amongst the Papers read at the last meeting of the National Electric Light Association at St. Louis was a somewhat lengthy dissertation on the "Morals of Corporations," presumably American. We should have thought it possible to have compressed the subject within the briefest limits :—The morals of Corporations ; they have none.

Worcester.—At a special meeting on Tuesday, the Council adopted the recommendation of the Watch Committee to apply for a further £9,000 to build a generating station for electric-lighting purposes. The building was originally estimated to cost £2,000, but a more substantial structure was rendered necessary owing to a change of site and the decision to use water as well as steam power.

Cable Interruptions and Repairs—

Cables.	Date of Interruption.	Date of Repair.
Accra-Grand Bassam	April 11th	April 21st
St. Thomé-Loanda	April 11th	April 25th
Para-Maranham	March 20th.....	—
Paramaribo-Cayenne	April 15th	—
Santiago de Cuba-Mole St. Nicholas	April 20th	—

Huddersfield.—At the meeting of the Town Council last week it was stated, in answer to a question, that applications for the electric current already received exceeded what their present machinery could supply during the coming winter. The Committee were, therefore, obliged, only the week previous, to increase their machinery by one-third. They believed now that their machinery would be ample for the coming winter. Gas at Huddersfield is 2s. 9d. per thousand, and the Board of Trade unit 6d.

The Frankfort Exhibition.—The first volume of "The Official Report on the Electrotechnical Exhibition at Frankfort-on-the-Main, 1891," has now left the press. It is a profusely illustrated volume of 632 pages, and deals not only with the exhibits but with the inception, opening, progress, and close of the Exhibition. The price of the first volume is 20 marks, and Messrs. J. D. Saverländer, of Frankfort, are the publishers. Vol. II., containing an account of the labours of the Committee of Tests, is now being printed.

Electric Transmission of Power in Sweden.—An application has been made to the Swedish Government for a concession to install an electric transmission from the Dal River waterfall at Mansbo to the Norberg mining district, a distance of some ten miles. The power transmitted will, to begin with, be about 200 H.P., and the potential will be about 10,000 volts. The town of Ostersund will also soon have have an electric transmission of power from the Strup waterfall on the Indal River, The distance is about eleven miles, and the pressure is also to be 10,000 volts.

American Transformer Design.—The only features of note in the latest type of transformer now being placed on the American market by the General Electric Company (U.S.A.) are the use of oil, the earthing of the core, and the relegation of fuses, switches, &c., to a separate case. The fuses are covered in with rubber tubing, with a view, it is said, of hindering sparking. The earthing of the core is done mainly with a view to prevent lightning getting into the secondary. The 1,000-watt 52-volt transformer has a quarter-load efficiency of 88·2 per cent., and the secondary drop on full load is 1·21 volts.

Fans for Ventilating Columns.—The Manager of the Eastbourne Electric Light Company has devised a fan which can be introduced into the base of the ventilating columns, and driven by a small electro-motor. The Company having offered to fit the apparatus in the column situated at the junction of Meads and Carlisle Roads, and supply the current to drive the motor for three months for the sum of £5, the Highway Committee have decided to accept the offer, and have instructed the Borough Surveyor to take daily tests of the amount of foul air extracted from the sewer, and report to the Committee as to the value of the apparatus.

Electric Lighting in Calcutta.—It was thought, says the *Indian Engineer*, a few years ago that Calcutta was within measurable distance of the time when it would be possible for the residents of this large city to obtain a supply of electricity for lighting or motive purposes from road mains, as is now the case with gas. And, in fact, as far as the spirit of enterprise was concerned, there was no hitch whatever ; but the obstacle proved to be the absence of State regulations. This want, strange to say, has not during these five or six years been met, and no department seems to concern itself with this very important question. It is surely time that Calcutta should be allowed to choose between gas and oil on the one hand and electricity on the other.

Electric Railroads and Electrolysis.—In a recent leading article our New York contemporary, the *Electrical Engineer*, remarks that, as it has been shown that in many instances the railway currents take to the water pipes and other conductors in the ground by preference, it must be obvious that if the currents can be made to return to the generating point *exclusively* by such conductors without utilising the earth, all difficulty will be obviated. A beginning of this kind will soon be made near Boston, where a special line of feeders will be run from the central power house to the different parts of the city, and will not be connected with the machines at all, but will be connected with the water pipes to the station and with the pipes in all sections of the city.

Telegraph Extension in India.—The Telegraph Department, says the *Indian Engineer*, is pushing forward with considerable energy the opening up of new offices. By April 1st 100 new departmental and combined offices will have been opened in India since the commencement of the year. A large proportion are in Lower Bengal and Madras, in both of which provinces the telegraphs pay better than in others, a result due not only to the fact that trade is brisker than elsewhere, but also that the people are, on the whole, better educated and seem to understand more readily the great advantages afforded by the telegraph wire. Satisfactory as the yearly reports of the department have been in the past, still better results may be looked for in the future. Burma should soon commence to assist in swelling the annual returns, and the Kashmir line, which has already been partially taken over, may also prove a paying concern.

Edinburgh.—After a discussion which lasted almost four hours, the Town Council on Tuesday adopted the recommendation of the Lord Provost's Committee—"that it be remitted to the Committee to carry out the necessary Electric Lighting Works and employ an engineer"—by 20 votes to 10, eleven members of the Council being absent. A local paper expresses itself as follows regarding this decision :—

> If yesterday's division in the Town Council of Edinburgh truly represents the feeling of that body on the electric lighting question, the majority will be assuming a tremendous responsibility in proceeding further on the course now nominally sanctioned. . . . . The Corporation is free to impose its own terms upon the companies, and if these terms are regarded by the companies as too onerous, then some justification might be offered for municipal management. . . . . And would it not also be advisable to obtain—as could easily be done by authority of the Council—an account of the financial condition of companies and corporations in England which have engaged in electric lighting? Such information would be worth the perambulations of scores of deputations, most of whose members do not know the difference between a volt and an ampere.

Leicester.—On Tuesday last the Town Council again considered the report of the Gas Committee (an abstract of this report appeared on page 472 of our issue of February 24th) upon the tenders for an electric-lighting plant, and which recommended that the scheme of the Brush Electrical Engineering Company should be adopted and their tender at the sum of £26,977 accepted, and that application should be made to the Local Government Board for permission to use the land adjoining the Aylestone-road Gas Works as the site for works, and for sanction to a loan of £50,000. Owing to allegations of unfairness in the matter of awarding the contract, Prof. A. B. W. Kennedy was called in to report. In this report Prof. Kennedy stated that the total prices of the Brush Company and Messrs. Ferranti came out as £26,517 and £23,225 respectively. The former firm, however, tendered for considerably larger plant than the latter. In the matter of price it appeared to

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him, that the costs compared with value were practically the same in the two cases. Each of the firms claimed that it had successfully solved the vexed question of supplying satisfactory alternating-current motors. The two tenders being so exceedingly alike, and the tender of the Brush Company, on the whole, the more advantageous, Prof. Kennedy recommended its acceptance. Prof. Kennedy concluded by saying that he had no hesitation in asserting that "from the engineering point of view the marine triple-expansion engines are preferable to the horizontal compound." After a lengthy discussion, the Brush Company's tender, exclusive of engines, was agreed to.

The Cleaning of Tramway Rails.—At a recent meeting of the Society of Engineers, a Paper was read by Mr. H. Conradi on "The Cleaning of Tramway and other Rails." The author made a few remarks on street-cleaning appliances in general, and the conclusion arrived at by him was, that they do not tend to keeping tramway rails clean, but rather the reverse. He then referred to the regulations enforced by some local authorities which compel the tramway companies to leave their lines in the muddy and dirty condition engendered by the general street traffic unless mud-collectors are used in combination with the apparatus for clearing the rails. He pointed out that, although the combination of a mud-collector with an ordinary street-sweeping machine had been condemned and abandoned, several local authorities still imposed this combination. He also showed how prejudicial to both animal and mechanical traction dirty tram rails were, and described several machines devised for effecting their clearance. The author then described a rail-cleaning machine devised by himself. The apparatus had been fixed to four tramcars at Reading, and had now been in operation for 18 months. He then described several experiments made during the running of the cars, by which it was shown that the tractional resistance met with by a car running on rails cleaned by the previous car was from 25lb. to 30lb. less than when running on dirty rails. He also compared the cost of various systems of cleaning, arriving at the following results :—By hand, once a day, 1s. per mile of single line in the fine season, and 2s. per mile in the severe season. Watering by cart twice a day, 2s. 6d. per mile. By the author's rail cleaner, as often as required, 6d. per day.

Bristol.—The electric lighting of a large part of Bristol will be inaugurated early in September. The engine-room and boiler-house extend the whole length of the central station, and at the rear are coal bunkers, in connection with which there is an elevator which conveys the coal into mechanical stokers fixed to each boiler. Two large 210-kilowatt alternators, and two small ones of 88 kilowatt, are to be used for private supply. These are designed to work at a pressure of 2,000 volts, the current being conveyed by steel-armoured cables to 11 sub-stations in different parts of the city. The arc-light dynamos will each supply a current of 80 amperes at 650 volts to the lamps, arranged 12 in series and 8 in parallel. These dynamos are coupled direct to Willans engines, so arranged that they may be worked condensing or otherwise. The steam pipes are arranged on the ring main system, so that, in the event of a mishap, any section may be cut out without interfering with the general working of the plant. The high-pressure cables are concentric, and the distributing mains triple concentric, the distribution being on the three-wire system. Ordinary single cables, provided with solid-drawn lead sheathing and steel armouring, are to be used for arc lighting. The street lighting will commence at the railway station and extend to part of Clifton, there being 96 arc lamps of 1,500 nominal candle-power placed at intervals of 50 yards on alternate sides of the thoroughfares. It was suggested that the lamps should be suspended over the centre of the streets, but, owing to difficulties with regard to fire escapes, this has been abandoned. In one unusually wide thoroughfare the lamps will be erected in the centre. Mains have been laid in most of the scheduled streets, and 3,800 applications have been received for the light.

Willans Memorial Fund.—It has been thought very desirable by some who knew the late Mr. Willans personally and knew the value of his work, that steps should be taken to aid in perpetuating his name in connection with the branch of engineering in which he so greatly distinguished himself, and in which his knowledge and experiments, always freely placed at the service of everyone, were and still are so useful. It has been considered, after discussion, that the most desirable way of doing this would be to establish a fund from which a premium might be awarded annually or biennially, or at such periods as might be thought fit, for a Paper on such a general subject as the utilisation or transformation of energy, treated especially from the point of view of efficiency or economy. It has been further thought that it would be advisable to ask the Councils of the Institutions of Mechanical and Electrical Engineers to become joint trustees for this fund, and to award the premium in alternate years to the best Paper bearing upon the subject mentioned presented to them in the interval, the premium not to be awarded in case of no paper of sufficient merit being presented. It is proposed that the fund necessary for this purpose should be called the Willans Memorial Fund, and should be collected by subscription, the subscriptions (unless anonymous), being limited to sums not exceeding two guineas. Mr. Alexander Siemens has consented to become treasurer of the Committee for the purpose of carrying out this scheme. Amongst the Committee are Lord Kelvin, Dr. William Anderson, Sir Frederick Bramwell, Messrs. Frank Bailey, Latimer Clark, R. E. Crompton, Sydney Dobson, Bryan Donkin, E. B. Ellington, W. T. Goolden, Druitt Halpin, Prof. George Forbes, Dr. John Hopkinson, Mr. Gisbert Kapp, Prof. A. B. W. Kennedy, Messrs. J. Macfarlane Gray, W. H. Massey, W. H. Mordey, J. F. Moulton, Q.C., Thomas Parker, Prof. John Perry, Messrs. W. H. Preece, J. H. Rosenthal, Prof. W. C. Unwin, and Major-General Webber.

Frequency in Transformers.—"Some years ago," says *Industries*, "there was a very unprofitable discussion as to the relation between the dimensions and output of a dynamo. Professors multiplied the linear dimensions of phantom dynamos by n, and found the output was various fractional powers of n times that of the original phantom before they had tampered with it. The discrepancies were numerous, but they were all due to electricians assuming different conditions. The dynamos might be compared if designed so as to give the same efficiency or the same final temperature. The copper might be run at the same current density, or the magnets at the same induction. If the same induction were employed, the armature of the larger machine, when enlarged to scale, had too many ampere-turns, and so on. Then, again, the larger machine could not reasonably be expected to run at the same speed, so it had to go either with the same factor of safety or the same peripheral speed. Hence, there were so many ways of comparing the machines that the results of the calculations did not agree. We are now threatened with a similar pseudo-scientific epidemic with regard to transformers and frequencies. Mr. Steinmetz calculates that the output of a transformer varies as the three-eighth power of the frequency. Obviously, if a transformer of a given size is to be re-designed with the same weights of iron and copper for, let us say, increase of frequency, it may be designed to give an increased load at the same efficiency, or with the same percentage drop, or with the same total rise of temperature, or with the same light load efficiency, and it will have a different output in each case. Again, there is no reason why in the comparison we should adhere to the same weights of copper and iron. We might vary them, keeping the total weight or total cost the same. We thus have at once pointed out twelve different laws of the relation between the output and frequency of a transformer. If other comparisons are made, such as the same bulk with different weights of copper and iron, and if allowance is made for the relatively smaller volume of insulation on a high-frequency transformer, we obtain still more laws. It is, therefore, sincerely to be hoped the unpractical electrician will not flood the technical Press with calculations as to the relations of output and frequency. He has so far spared us the discussion of the output of a phantom curve of sines transformer whose dimensions have been multiplied by n. Such calculations are quite useless."

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ELECTRICITY AS A MOTIVE POWER.*

BY ALBION T. SNELL.

(Continued from page 676.)

(*e*) *General Conclusions with reference to Field-Magnet Design.*—A point to be specially observed before discussing the proportions of iron and copper is that no one design of field is equally well adapted for every size of armature. If cost of production be the ruling factor the single-magnetic circuit type is preferable for armatures up to, say, 12 inches in diameter;

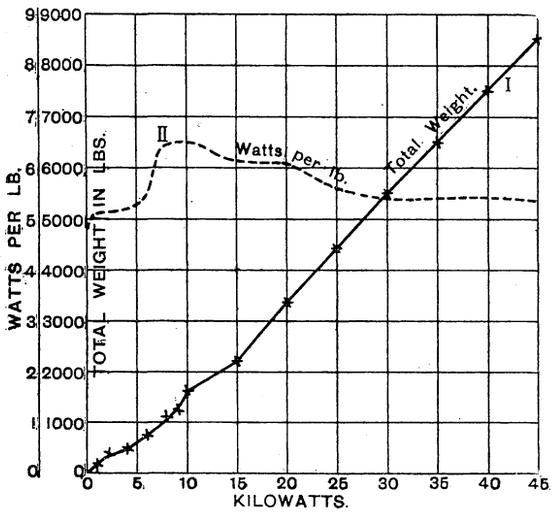

FIG. 11.

from this to 15 inches the double circuit may be used; but from 18 inches and upwards one of the multipolar forms should always be employed.

This feature of dynamo design has not been much discussed as yet; but the author has been led to investigate it when designing large machines. He discussed at length the relation of weight to cost, with varying types of machines, a short time ago. He finds that the curves connecting weight and output, and cost per kilowatt with output, follow

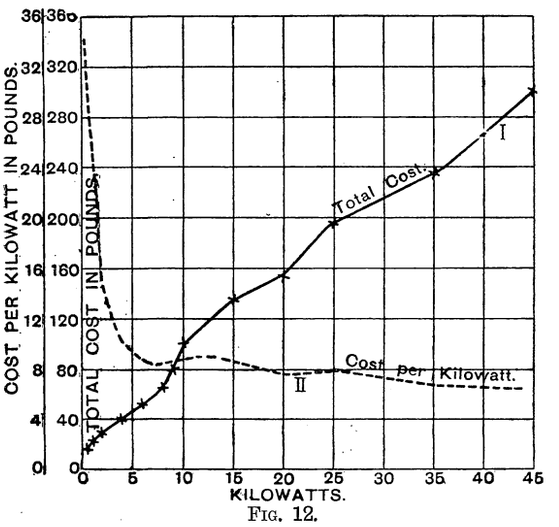

FIG. 12.

very different laws with distinct types of machines. The subject is interesting, but rather outside the scope of this book, and therefore only two diagrams will be given, which show the general shape and order of the curves. It will be seen that the weight and output curve follows practically a straight line law, and that the output of a dynamo or motor is proportional to the cube of the linear dimensions of the machine, practically of the armature diameter and length. (*See* Figs. 11 and 12.)

The question of material has not yet been mentioned, because this is rather a matter of cost and convenience. The necessary sections and corresponding inductions with wrought and cast iron are given in the following tables, and the student can estimate for himself the relative advantages. Practically, with bipolar machines at the inductions usually employed, viz., B''_f = from 77,000 to 97,000 in wrought iron and B''_f = from 45,000 to 50,000 in cast iron, the relative magnet cross-sections should be in the ratio of 3 : 1·6, the effective armature section being taken as unity. Of late, cast steel magnets have been used with some success. The induction curve for cast steel lies nearer to that of wrought than to that of cast iron, and so there seems a probability of its use becoming more frequent.

Table C.

Table giving area of wrought and cast iron to correspond to given inductions in air, assuming all the lines to pass through the iron and none to leak.

Wrought Iron.		Cast Iron.		Air.
Area.	B''_a.	Area.	B''_a.	B.
1	70,750	2·2	36,500	100
1	90,750	2·17	42,000	200
1	100,250	2·17	46,000	300
1	100,575	2·07	48,500	400
1	100,650	1·9	52,500	500
1	100,770	1·9	54,500	600
1	110,050	1·93	57,250	700
1	110,150	1·83	59,750	800
1	110,250	1·8	61,750	900
1	110,265	1·74	63,500	1,000
1	110,500	1·7	65,250	1,100
1	110,650	1·7	66,500	1,200
1	110,750	1·6	67,750	1,300
1	110,800	1·6	69,250	1,400
1	110,900	1·57	70,250	1,500
1	120,000	1·4	71,250	1,600

From George Halliday's "Notes on Designs of Small Dynamo," p. 33.

The shape of the magnet cores is of importance, because the length of the mean turn of the winding is affected thereby. The circle has the minimum perimeter for a maximum area enclosed, and therefore possesses the ideal section; and the square gives, from this point of view, better results than any other rectangular form. Structural considerations, however, carry great weight, and it is found in many designs that a rectangular core, with length equal to twice or three times the depth, most nearly meets all the conditions, in spite of the extra expense in copper.

§ 9. Calculation of the Magnet Details.

(*a*) *Winding Space.*—In the preceding section the relative areas of cross-section of armature and field-core were shown to be in the ratio of 1 : 1·6 for wrought-iron magnets, and 1 : 3 for cast-iron. These ratios are not absolutely the best in all circumstances, but in practice they give economical results. It may be assumed, then, that a type of field is chosen, and that the material has been decided on. The area of the field-magnet cores will also be known from its relation to the area of the armature iron. The open factor at present is the length of core to carry the exciting coils. This cannot be settled without calculation; but a few trial and error determinations will show the minimum length to carry the necessary turns of wire, allowing at the same time the proper area of surface for the watts spent. For bipolar single magnetic circuit machines 0·75 D, for double circuit 0·9 D, and for multipolar fields from 0·4 D to 0·5 D will be very nearly correct for all ordinary designs. And when the other quantities are properly balanced the number of square inches in the surface of the winding, not including the ends, will be equal to about twice the number of watts wasted in heat, or each watt of energy wasted in the magnet windings will be dissipated through a superficial area of two square inches. This is found to be sufficient in machines with windings not exceeding 2½in. in depth. But for large machines a greater margin is preferable if it can be obtained.

(*b*) *Poles and Polar Extensions.*—The next point to determine is the length of the polar cavity. This has already been referred to in § 8, division (*c*), and the practical limits have been given. It may be further noted here that since the magnetic resistance is lowered by increasing the width of the polar cavity, it appears advisable to make the arc embraced as large as possible. But this is limited by the strength of the cross field, which is directly proportional to the extent of the pole pieces. With

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drum windings the lead of the brushes is comparatively little, as the field disturbance is small, and so the polar angle may be somewhat larger than is permissible if a gramme ring be used. A safe rule is to make the angle 135deg. for drums, and 125deg. for grammes; but both of these figures may require to be slightly modified by the peculiar conditions of the design.* In a well-proportioned dynamo, when the armature is carrying the maximum circumflux for its diameter,† the brushes will require a lead just sufficient to bring them under the tips of the pole piece, so that the lead and the width of the polar cavity roughly depend on each other. The question of lead is, however, very complex, and is affected by so many other points in the design that the author deems it best simply to refer to the above relation. The ratio of area of polar cavity to the cross-section of the magnet core is determined mainly by the induction B''_g in the gap. It is not found economical to push the flux beyond $B''_g = 33{,}000$; and, therefore, neglecting leakage, the ratio of area of polar cavity to core-section will, be approximately, 1 : 2·75 if wrought iron be used, and 1 : 1·6 if cast iron. But there is always a certain loss of magnetism from leakage, and it is necessary to allow for this in estimating the total field core flux. Calling the leakage coefficient v, the relation between the field lines and the armature lines is expressed by

$$N_f = v\,N_a \text{ or } v\,N_g.$$

The assumption that the armature induction is equal to the induction in the gap will not introduce a large error for ordinary designs, and it simplifies matters. The stray field is not constant for every type of magnet, but varies with the armature induction, increasing in value as B''_a approaches its maximum. The practical values of v in the types of machines most in vogue are given in Table D.

Table D.

Table giving approximate values of v, the leakage coefficient, for various types of field magnets.

Type of Magnet.	Open Circuit.	Full Load.
Single magnetic circuit, upright type, Figs. 1 and 2	$v = 1{\cdot}3$	$v = 1{\cdot}32$
Single magnetic circuit, inverted form, Figs. 3 and 3A	$v = 1{\cdot}31$	$v = 1{\cdot}33$
Double magnetic circuit, Figs. 4, 5 and 6	$v = 1{\cdot}4$	$v = 1{\cdot}42$
Four-pole machines, Fig. 7	v = from 1·4 to 1·45	v = from 1·42 to 1·47
" " " 8	v = from 1·45 to 1·5	v = from 1·47 to 1·6
Armour-clad field, Fig. 9	$v = 1{\cdot}2$	$v = 1{\cdot}22$

(c) *The Yoke.*—The yoke is that part of the magnet which connects the cores. It is not usually covered with windings, and is made either in wrought or cast iron so as to suit the design. Generally cast-iron is preferred, since the bed and yoke can, in many cases, be combined in the same pattern. If this device be adopted, as in Fig. 1, care must be taken that the path through which the magnetic flux will principally pass is at least as wide as the area of cross-section of the cores, and usually it is found advisable to make it about 1·2 times larger, if the cores and yoke are of the same material. If the cores be made in wrought and the yoke in cast iron, the latter should be about 1·6 to 2·0 times as great as the former in the area of the cross-section at right angles to the lines of force.

Attention must be given to the joints between the cores and the yoke, that they be truly machined and be in close contact over the entire face.

In machines of the double-magnet circuit type there is no yoke, since the pole pieces are connected directly to the magnet cores; these joints must be carefully made.

In some designs the polar cavity can be bored from the solid iron (*see* Figs. 2, 3 and 6); but in others it is necessary to attach extension pieces, so as to increase the polar cavity (*see* Figs. 1, 4 and 5). But the dimensions of the pole-pieces will in all cases be governed by the rules previously given.

(To be continued.)

* *See* § 8, division (*e*). † *See* equations (9) and (10).

THE CONSTRUCTION AND USES OF PROJECTORS.*

(*Concluded from page 715.*)

Source of Illumination.

The arc light is of course generally used now, as it combines with great intensity the nearest approach to a point of light. The spherical form assumed in the above considerations is not a property of this light; the chief source of illumination is the incandescent crater of the positive carbon, the negative carbon emits relatively much less light, and least of all the arc itself; and the negative carbon itself gets in the way of an even distribution of the light emitted. Various methods have been suggested to avoid the losses due to this shadow effect. One of these is to incline the carbons 30° to the vertical, and displace the negative carbon parallel to the positive nearer the object to be illuminated, but this method can only be used with advantage on mirrors of small useful angle such as those of Mangin. For angles over a certain amount, the best arrangement is the arc placed in the axis of the mirror and its superiority is probably, almost certainly, due to the fact that part of the light emitted by the negative carbon falls on the edges of the mirror, and part is reflected

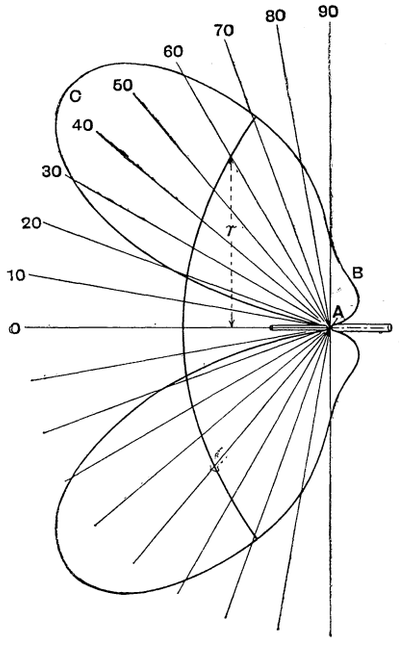

Fig. 5.

from the positive crater on to it. In Fig. 5, A B C shows the intensity curve of a horizontal lamp. If we consider an element of surface Δ of the mirror, it is illuminated by an intensity $f(J)$, which can be taken from the curve; and the zone of the mirror belonging to this element of surface reflects an amount of light

$$L_1 = \frac{f(J)\,2\pi r\Delta}{\rho^2},$$

and if we determine these values for particular points on the mirror, we find that they increase from the centre up to a maximum at an angle ϕ_x, which is larger than the angle ϕ_y corresponding to the greatest value of $f(J)$. Again, if the average amount of light reflected be calculated for increasing values of the useful-angle, it will be found to become a maximum for a certain angle ϕ_z; and this angle will again be larger than ϕ_y. Mirrors which have as nearly as possible this useful angle will have the greatest output. With parabolic mirrors it only remains to choose the proper focal length for a reflector of given diameter in order to secure the greatest possible output.

* Abstract from a Paper presented to the Verein Deutscher Ingenieure by F. Nerz.

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If the output of mirrors of different diameters is to be compared, all being constructed for the same "useful angle" ϕ, we can substitute for

$$4\pi r^2 \sin^2 \frac{\phi}{4} \cos^4 \frac{\delta}{4}$$

the expression

$$\pi C d^2/4$$

in the above formulæ. The intensity of illumination of a field at a distance e, is then

$$J_2 = \frac{\pi C J d^2}{4} \frac{D^2}{d^2 e^2}$$

whence we see that the diameter of the sphere of light—*i.e.*, the crater—drops out of the formula, which takes the simple form $J_2 = \pi C J D^2/4e^2$;

that is to say, that the intensity of illumination in the field due to the mirror is as great as if it were produced by a source of illumination which has increased from the size of the sphere of light to the size of the mirror without abating in specific intensity.

As the surface of the crater is approximately proportional to the power, but the specific intensity remains, within the limits under consideration, fairly constant, it follows that the brilliancy will not be increased by extra expenditure of power, but only the size of the illuminated field. It follows that as far

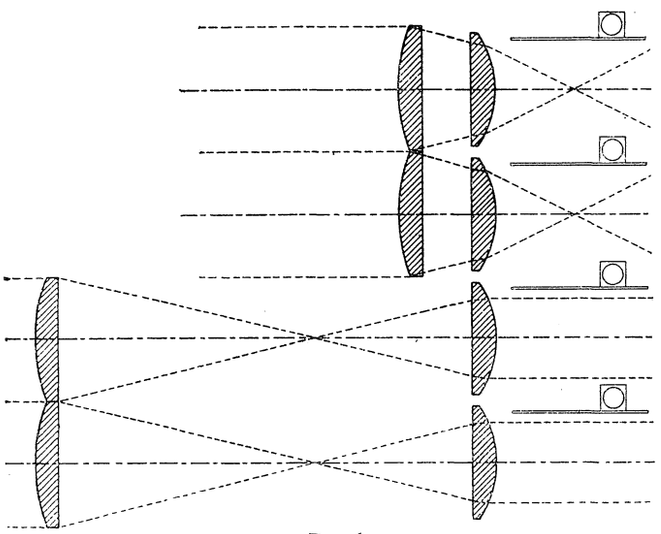

Fig. 6.

as brilliancy of illumination is concerned, so long as concentrated light is used, the efficiency of a projector cannot be increased by increase in current, and the current strength should be chosen for a certain diameter of reflector only by consideration of the "angle of illumination." Thus having determined for a certain projector the proper focal length, the second most important point is to choose the proper current strength in order to produce the maximum illuminating effect for the least expenditure of electrical energy.

Of course there are often points of construction which necessitate deviation from the best possible form of mirror. For use at sea it is not so important to see a ship as far off as possible, but to illuminate the water all round at such a distance that torpedo boats must pass the illuminated zone before coming near enough to do damage, and an instrument to light all round would serve this purpose best; but there is not room, generally speaking, on ship-board for such apparatus, and often in old ships there is not even place for one projector.

To increase the "output" of a projector, as we have seen, it is necessary to increase its dimensions, and practically mirrors may be about 3ft. in diameter; they cannot be larger, firstly, because the working of the guns would damage them and secondly, because they would become too clumsy for use on board. To facilitate the search for torpedo boats, the beam should be spread as much as possible horizontally, and special apparatus is used for this purpose. If the beam has a natural angle of m which is increased to $n°$, the intensity diminishes in the proportion $m:n$, whence we see that the angle of illumination, and hence the current strength, should be as large as possible. It will be seen that under these circumstances the intensity of illumination *can* be increased by increase of current strength, although of course not in proportion to the extra expenditure of energy, but in proportion to its square root.

There is another point to be noted in this connection, that when the current becomes relatively large, it is necessary to reduce the "useful angle" in order to prevent overheating of the mirror, and this is a point of the utmost importance in the design.

The author refers then to the marked contrast observed at the Frankfort Exhibition between the parabolic-mirror search light of Schuckert and Co., and the one with a Mangin reflector by Siemens and Halske. The former firm exhibited a projector having the mirror 166·0 centimetres in diameter—the largest on record. The lamp took 150

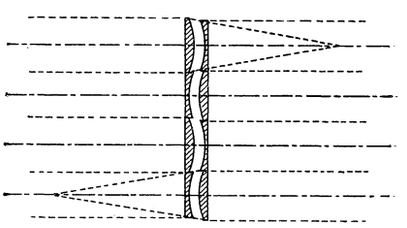

Fig. 7.

amperes and about 60 volts, corresponding to an output of about 12 H.P. in light. The light was seen 71 kilometres (about 40 miles) distant quite plainly, its "ratio of intensification," D^2/d^2, being nearly 4,000—that is to say, the effect was as if the projector were replaced by an arc lamp of 222,000,000 c.p., using a current of about 500,000 A! Another projector was for use on shipboard; its mirror was 91 centimetres in diameter, and the lamp (arranged like the other for 150 amperes) took 120 amperes; this apparatus was provided with a means of varying the horizontal dispersion of the beam between 6° and 45° by simply turning a wheel. The difficulty of changing glasses in front of a projector is naturally well-nigh insuperable, owing to their great weight and surface, and the new apparatus is, therefore, a very important improvement. There was also fitted a signalling apparatus of the "venetian blind" type, so arranged that it could be permanently fixed to the projector without interfering with its working.

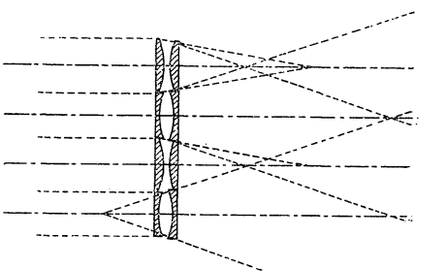

Fig. 8.

The dispersing apparatus consists of two frames behind one another, having an equal number of cylindrical lenses; the one behind has lenses of greater focal length than the front one. When the glasses are distant from one another by an amount equal to the sum of the focal lengths the light is concentrated, and by gradually approaching each other they disperse the light by increasing amounts up to 45°. In Fig. 6 the upper figure shows the greatest dispersion and the under one the parallel transmission; the shutters of the signalling apparatus are seen in the dark spaces between the lenses.

When the projector is so small that a single shutter can be used for signalling, another kind of dispersion apparatus may be used, illustrated in Figs. 7 and 8. The two frames carry alternate concave and convex lenses; and when they are so placed that the concave comes opposite the convex lens, the frames act like plain glass; but when the converse is the case and concave comes opposite concave by means of a sideways

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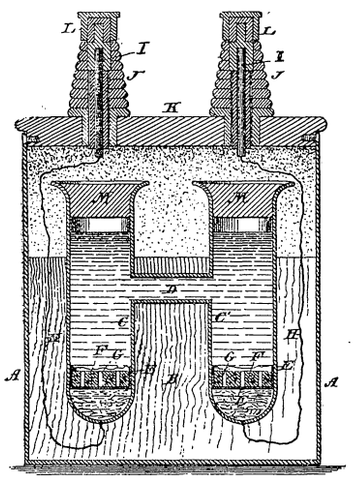
movement, then the dispersion caused by each frame is increased by the other.

A further improvement was added to these projectors by placing motors on their two axes in such a manner as to make them controllable from a distance, a device which is very useful on shipboard; and will continue to be of importance until the present single projectors are replaced by eight smaller ones arranged to illuminate the entire horizon, and this improvement can only be a question of time; only when this is accomplished will the projector have that importance in warfare which it is certainly destined to attain.

[Erratum.] On p. 713 of our last issue, the sentence beginning "the efficiency of a projector depends," should read on as follows:—(1.) On the size of the "useful angle"—that is, the angle contained by the rays which are *received* by the extreme edges of the *reflector or refractor*, this angle being a measure of the amount of the *light* which is *utilised* by the projector, etc., etc.

THE WESTON STANDARD CELL.*

Mr. Edward Weston's attention was early directed to the production of a primary standard of electromotive force. The standards of electromotive force available up to the present time did not come up to the ideal which Mr. Weston had set before him, even the best of these, the Clark cell, being subject to a variation of 0·077 per degree centigrade. In analysing the causes for this, Mr. Weston discerned that the density of the zinc sulphate solution



The Weston Standard Cell. Transverse Section.

is dependent upon the temperature of the solution, and with every change in density there is a corresponding change in electromotive force. Again, the local action which takes place in such cells affects the electromotive force to an appreciable extent.

Mr. Weston employs the cadmium salts. Their value for this purpose appears to be due to the fact that such salts are equally as soluble in hot as in cold water, the density of the solution remaining substantially the same, so that there is no disturbance of electromotive force due to changes in destiny. The chemical affinities in the cell are substantially the same, no matter what the temperature of the cell may be within reasonable limits. Any salt of cadmium may be used, the acid of which forms a practical insoluble compound with mercury when the salt is in the state of a saturated solution in water, or in a solution of the salt of cadmium employed. Such salts, for example, are the sulphate, the chloride, the bromide, and the iodide.

The cell may be made up in a number of ways, but one of the best arrangements for an absolute standard cell is to employ a saturated solution of cadmium salt in water, and as electrodes an amalgam of cadmium and mercury opposed to an electrode of pure mercury and proto-sulphate of mercury. The accompanying engraving shows the cell in transverse section. A is an outer shell of sheet brass and elliptical in form. In the bottom of this shell is inserted a wooden block B, containing cavities or recesses to receive the glass cells C C′. These cells consist of two cylindrical vessels connected by a transverse tube D. Within one vessel, C, there is placed an amalgam of cadmium and mercury, in the other vessel a mixture of pure mercury and proto-sulphate of mercury. There is then inserted in each vessel above the electrode a piece of muslin, E, the edges of which turn upward. In the cup-shaped piece of cloth thus introduced cork F, pierced with apertures G, is inserted. The arrangement of cork and muslin serves to hold the materials of the electrodes in place and prevent their becoming commingled with the solution when the cell is moved about. At the same time, the openings in the corks, F, allow of free contact of the solution with the electrodes. There is then placed in each cell, C C′, a saturated solution of cadmium sulphate. Lastly, the stoppers, M, are secured in place with cement. The connecting wires, H, pass through the bottom of the cells, C C′, and communicate electrically with the electrodes. They are connected to copper wires, I, which are received in binding posts, J. These binding posts, J, are carried by the cover, K, of the shell, which cover is made of rubber. The binding posts are provided with covering caps, L. After the cells are in place, the space in the shell above the block, B, is filled up with a composition composed of beeswax, resin, and linseed oil. The cover, K, is then adjusted and the cell permanently closed.

When the cell was submitted to temperature changes ranging over 200° F., Mr. Weston was unable to detect any greater variation of electromotive force than $\frac{1}{100}$th of 1 per cent. The electromotive force is 1·019 volt.

* Abstract from the *Electrical Engineer* of New York.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, April 28th.

PHYSICAL SOCIETY.

5 p.m. Paper to be discussed: (1) "Experiments on the Viscosity of Liquids," by Prof. J. Perry, J. Graham, and L. W. Heath. Paper to be read: (2) "On Luminous Discharges in Electrodeless Vacuum Tubes," by E. C. Rimington.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Fire-Risks of Electric Lighting," by H. W. Handcock, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Transmission of a Nervous Impulse," by Prof. F. Gotch, F.R.S.

SATURDAY, April 29th.

ROYAL INSTITUTION.

3 p.m. Tyndall Lecture (3): "Some Applications of Electricity to Chemistry," by James Swinburne, M.Inst.E.E.

MONDAY, May 1st.

ROYAL INSTITUTION.

5 p.m. Annual Meeting.

SOCIETY OF ENGINEERS.

7.30 p.m. Ordinary Meeting at the Town Hall, Westminster. Paper to be read: "Blake's Bridge, Reading," by Edmund Burrows.

TUESDAY, May 2nd.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion: "Mining and Ore-Treatment at Broken Hill, New South Wales," by M. B. Jamieson, Assoc.M.Inst.C.E., and John Howell. At this Meeting, the monthly ballot for members will be taken.

WEDNESDAY, May 3rd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Practical Electrical Problems at Chicago," by Prof. Silvanus P. Thompson, F.R.S.

THURSDAY, May 4th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "The Atmosphere," by Prof. Dewar, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Extra Meeting. First James Forrest Lecture: "The Inter-dependence of Abstract Science and Engineering," by Dr. William Anderson, F.R.S.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting.

FRIDAY, May 5th.

CHEMICAL SOCIETY.

8 p.m. Hofmann Memorial Meeting: Addresses by Lord Playfair, F.R.S., Sir F. A. Abel, F.R.S., and Dr. W. H. Perkin, F.R.S.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Fogs, Clouds, and Lightning," by Shelford Bidwell, F.R.S.

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THE PROPOSED NEW UNIVERSITY FOR LONDON.

The latest scheme for the solution of the London University problem is that issued by "The Association for Promoting a Professorial University for London," which appeared in *The Times* of the 3rd ult. The scheme is a comprehensive one, and the difficulties which beset the path of the reformer of the existing institutions for higher education in London have been boldly faced, but whether they have been overcome is quite another matter.

It will be remembered that the Charter of the Gresham University was withdrawn from the House of Commons and referred to another Royal Commission still sitting; that Charter provided for a Federal University pure and simple. The University had no power whatever over the internal management of the affiliated colleges (except in fixing duration and nature of courses of study for degrees); it had no power to appoint professors, teachers, or lecturers, and in fact was no more entitled to the name University, in the true meaning of that term, than the existing University of London. It was merely a very cumbrous plan for giving every teacher some control over the examination of his students. The University proposed by the Association is the very opposite. Under their scheme every institution of University rank in London will go into the melting pot, and by the Medæa spells of a statutory commission, out of that pot will arise a glorious University full at once of the elasticity of youth and the vigour of manhood.

We propose to examine rather closely some of the details, and to point out what we fear are rocks ahead. In regard to the Preamble we have nothing but praise; it seems so often ignored that it is necessary again to reiterate what

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ought to be self-evident—namely, that while the chief function, after all, of a University is to teach, it has an important responsibility in the advancement of science and learning by encouraging and endowing original workers and original research. That is to say, it should not confine itself to collegiate or other classes in which teaching should be the sole aim, but should afford opportunity for original investigations, and these should, in our opinion, be clearly distinguished from purely educational work. The proposed supreme governing body is to be the University Court, one half professors and the other half Crown nominees and elected members other than teachers. Since professors are likely to attend more regularly than the other members, this division seems likely to us to throw too much power into the hands of the professors—not a desirable thing. A very large share of the work of such a court is of a purely business character —financial, &c.—and will want very careful management, while it often enough happens that distinguished professors are far from being sound business men. Moreover, this preponderance of professors is a point of extreme importance in view of the fact that the appointment of all professors and teachers is to be vested in the Court, acting, however, on the recommendation of the Senate, a purely professorial body. The election, is therefore, likely to be entirely in the hands of the professors, which we do not consider an ideal state of things. The Court and the Senate will be such unwieldy bodies that the real power is likely to be in the hands of small executive Committees and Boards of Studies.

It is, however, in the change from the existing state of things that the main difficulty will occur; the proposal of a statutory Commission is an heroic measure, but we think it merely shifts the difficulty a step on and does not solve it. Is it the intention of the Association that existing institutions shall be forced into the scheme? If so, this is very drastic treatment and sure to raise a storm of opposition. Vested interests are usually very powerful, and have a way of asserting themselves in a way which often puts a stop to admirable paper reforms. Surely, too, some appeal from such a Commission should be granted. This was done with the Scotch University Commission dealing with far less knotty questions, whose ordinances all had to lie on the table of both Houses of Parliament before they became valid. Who are to be the members of the Commission? Are they to be entirely independent members, or drawn from the governing bodies of existing institutions. We fear there is great danger of such a Commission being overwhelmingly South Kensington in character, which would be a serious disaster. The names of the members of this Commission will have to appear before the proposed Charter becomes law, for on that Commission the whole future of the new University will hang. The labours of this Commission may make or mar the new University.

We must enter an emphatic protest against any idea to centralise the University, especially at South Kensington. It must not be forgotten that London is something more than a German University town, something more even than Berlin; it is a province in population, and almost in extent, and actually is if we include that Greater London which will be one of the main feeders of the University; it will not be residential, but students living all over London will attend in its lecture theatres and laboratories. It would most seriously cripple and injure the future of higher education in London were any idea of building a vast central block of buildings allowed to be carried out; the existing institutions and their buildings, on which hundreds of thousands have been spent, must be kept working as they are now, only with their appliances and staff strengthened. There is ample room for half-a-dozen professors or more in many subjects, and room for each to impress on his own students his own individuality. We have but little sympathy with so-called electrial *engineering* laboratories, and hold that the teaching of electrical and of mechanical *science* in lecture-rooms and laboratories should be separated from the training of an engineer in works and office. We pointed out on a former occasion that mechanics, mechanism, electricity and magnetism, and other subjects which form the foundation of engineering, fall under the well-established head of Physics. We should like to see these subjects treated scientifically, and not commercially, at the older Universities; but there appears to be a loud call for something called technical education, and on every side we find institutions at which the purely utilitarian parts are picked out and are taught to students who have no time for true science. We should like to see engineers receive their preliminary scientific education side by side with other men going in for other professions, and taking a more liberal view of the subjects than the mere commercial considerations demand. A little acquaintance with the spirit of true science would show the shallowness of the disparagement of "useless learning," and would prevent that wretched narrowness of mind which encourages men to think that there is nothing else worth thinking about in this world but their own profession. Applied science must be taught—at all events pure science having been studied, the proper method of applying it must be understood. It is this application which, being pushed too far, gives rise to laboratories side by side, the one for pure physics the other for men who, intending some day to join a profession in which a knowledge of physics is essential, are drafted off to learn a modified and "useful" edition of the subject. We credit a large number of professors at technical colleges with the best possible intentions, and our belief is confirmed by their repeated disclaimers of any desire to supersede future training in the workshop. We are, perhaps, fighting against the name electrical engineering laboratories rather than against the system; but we do so on the ground that parents send their sons to, and these sons pass through, such institutions, and naturally suppose that an electrical engineering laboratory is a place for learning electrical engineering. Having successfully passed through the course, they may be pardoned, then, if they fall into the error that they *have* learned electrical engineering. But granting, as we are very ready to do, the usefulness of such establishments to have, let us say, one electrical engineering laboratory for the whole of London would be harmful in the extreme; it would do much to arrest advance in higher technical education. It would lead to flooding the market with numbers of young engineers all cast in the one mould, and would tend to destroy individuality. We fear that to some extent there has been a failure on the part of the Association to recognise the just claims of applied science. It is too late in the day for any plan to be carried out which would be likely to drive the applied sciences outside the walls of the coming University of London. The engineering profession, in all its branches, is now-a-days deemed as worthy of University rank and recognition as any of the older learned professions, and while we cannot agree with this, for reasons which have been fully set forth in these columns in connection with engineering at Cambridge, it must, of course, under the circumstances be allowed to take its proper position in the Court and the Senate of the new University. May the Royal Commission show themselves worthy of the distinction assigned to them, and may we soon be able to welcome in the capital of the Empire a University worthy of the greatest city the world has ever seen!

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REVIEWS.

Absolute Measurements in Electricity and Magnetism. Vol II., Parts 1 and 2. By ANDREW GRAY. (Macmillan and Co., London.)

This work, in conjunction with the first volume, already published, forms a book of reference of very great value. It is the most complete treatise yet written dealing with the theory and practice of electrical measurements. The writer has made full reference to the classical methods of treating the subject, and has also endeavoured with much success to bring the matter up to date. The result, of course, is a very lengthy book. The second volume consists of nearly nine hundred pages, mostly printed in small type, and it has rightly been judged advisable to bind the volume in two separate portions. Of these the first part deals with the more theoretical portions of the subject, and the second with the experimental methods of measurement. Throughout the book there are numerous references to experimental researches, but the work as a whole is distinctly mathematical, and the greater portion of it can only be read with advantage by those who have had the benefit of a mathematical training. The amount of time spent in selecting the analytical matter from the original Papers must have been very great indeed, and the author has in many cases put himself to the trouble of developing the mathematical expressions into a more practical form. Occasionally also the proofs given are original. In general, however, the mathematical parts of the book appear to be needlessly long. Frequently a long piece of analysis is given where a reference to the original Paper, together with the resulting formulæ, would have been quite sufficient. The student gains little by wading through proofs which involve the same principles over and over again, and the trained reader would be quite satisfied with the bare outline of the proof, if accompanied with the final result. This defect is noticeable in several places, but is specially marked in Chapter VIII., on the Measurement of Inductances. This chapter consists of no less than seventy pages devoted to describing the different methods of measuring the coefficients of self and mutual induction. Many methods are described, good, bad, and very bad; and, in each case, the appropriate formula is worked out at length. The proofs are all highly classical, involving the dissipative function and the equations of Lagrange. There is, however, no need to resort to such powerful analytical methods, since the results arrived at can be obtained much more simply, and it is unnecessary to give all the proofs in full, since the same method of analysis is employed in each case. It would have been far better to merely give the formula, and leave the student to work out the proof as an exercise.

The second part of the book is of more interest to practical electricians, as it deals with such subjects as galvanometry, the measurement of currents, the graduation of instruments by electrolysis, the graduation of voltmeters, the measurement of inductances, dimensions, the measurement of resistance, the comparison of units, the measurement of power in direct and alternating-current circuits, the measurement of strong fields, magnetic induction, hysteresis, and electromagnetic radiation. The chapter on galvanometers is well written, and contains much practical information. The latest form of d'Arsonval galvanometer, that of Messrs. Ayrton and Mather, is illustrated and described; but the great advantages of galvanometers of the d'Arsonval type are not sufficiently dwelt upon. Voltametry is treated very fully, the researches of Lord Rayleigh and Prof. T. Gray on silver and copper electrolysis are given, and the subject-matter is much the same as in the author's smaller treatise on absolute measurements. The work of the Board of Trade Standardising Committee in connection with the Clark cell was not finished early enough to be incorporated in the book; but this should be added when a new edition is called for.

The book naturally contains a great deal of matter which hitherto has only been obtainable in the publications of learned societies. For instance, a full abstract is given of Prof. Poynting's celebrated Paper on "The Transfer of Energy in the Electromagnetic Field." More than 40 pages are devoted to a description of Hertz researches, and the mathematical theory of the oscillator, as given by Hertz, is reproduced, this being, we believe, the first time it has been published in English, with the exception of the original translation by Dr. Lodge, which appeared in *Nature* in 1888, and a short notice in Preston's optics. Later work on electric oscillations, done by Trouton, Poincaré, Bjerknes, and others, is referred to, although only briefly. Dr. Lodge's important work on lightning discharges is dismissed in a couple of paragraphs. The length already reached by the book is, perhaps, the chief reason for such a brief reference; nevertheless, it gives the reader a very unfair impression of the relative importance of the work of Lodge and Hertz. Dr. Lodge not only established the existence of electric surgings under novel circumstances, but showed that they could be detected very simply by means of sparks. Hertz, in addition, made experiments which proved that these waves took time to travel through space.

The matter is brought well up to date. Ewing's magnetic curve-tracer is described, and the recent work of Hopkinson on hysteresis and transformer testing. Alternate current measurements are discussed very fully, and the results of some of the most recent tests of transformer efficiencies are given. The book has been written in the short intervals of time available from other duties, and the arrangement of the matter has, to some extent, suffered, but there can be no question as to the great value of the work.

Telephone Lines and their Properties. By W. J. HOPKINS, Professor of Physics, Drexel Institute, Philadelphia. (Longmans, Green, & Co.)

This is a good book, and into its 258 pages there is gathered a large amount of information, in fact, the propagation of telephonic electrical currents is treated with a grasp and completeness which will be beneficial in helping telephone engineers to appreciate and grapple with the difficult problems which confront them.

The book is, be it obsesved, descriptive of American practice, both as regards the erection of poles and wires and the employment of cables and conduits. There are brief chapters also on wire, insulators, exchanges, and switchboards, but valuable rather to the student than to the practical man, who would want to begin where these short summaries leave off. They are, however, well and clearly written, and will be useful to English and Continental readers as a sufficient guide to American methods, and they lead up very well, as they are intended to do, to the theoretical consideration of the subject which begins with Chapter VIII.

Professor Hopkins does not pretend to enunciate original views of his own, but taking the theories of Lord Kelvin, Lodge, Hertz, Maxwell, and other writers on the propagation of energy, and coupling them chiefly with the experimental researches of Mr. J. J. Carty of the Metropolitan Telephone Company of New York, he is enabled to present the theory of telephone working, with much clearness and lucidity. Indeed it is only within the last two years or so that materials for such a work have been available, and Professor Hopkins is to be congratulated on having so well put them into shape. We do not mean to say by this that the book is exhaustive in its treatment, or that it is a complete guide to any of the subjects with which it deals, but it does for telephony what in a great measure Dr. Fleming's late Paper has done for alternating currents as employed for electric lighting, that is, it levels up all round, puts existing knowledge on a firmer and clearer basis, and furnishes indications and suggestions as to how present methods may be improved and progress looked for in the future. The book is intended partly for students and partly for practical men, but it will be of most use to the latter, because there are few things in which practical experience is more desirable, in order to comprehend them properly, than telephonic disturbances and effects. They are so entirely abstract and incomprehensible until the ear has learned to distinguish and analyse them.

The author brings prominently into view, using chiefly as illustrations the experiments of Mr. J. J. Carty, the great influence of static effects in causing disturbances in telephone circuits as distinguished from the absorption and partial obliteration of electrical pulsations by capacity, with which the much-talked of $K = C R$ law deals. The experiments show

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that where telephone lines run parallel, "cross talk" and some other disturbances are due to statical charge and discharge from neighbouring conductors, and to the tendency of charges so set up to dissipate themselves by forming currents along the conductor of the wire in which the induced effect is produced. They are not the result of simple dynamic action between wire and wire, as has been usually assumed to be the case, telephone currents being too small in themselves to produce this effect. The explanation, though not given in the book, seems to be that the transmitter induction coil in a set of telephone instruments sets up a current small in quantity but varying in potential, this potential reaching probably several volts. Owing to the great self-induction of the corresponding instruments at the other end of the line, the flow of the current is much retarded, and the whole line is brought nearly to the full potential which the first transmitting coil would produce on open circuit before much flow takes place, then the receiving set of instruments, that is to say, the phase of the current in the receiving instrument lags considerably behind the impressed E.M.F., and thus the line becomes charged to potentials which Ohm's law would never lead us to suspect. In this way much greater disturbance of surrounding dielectrics is produced than earlier writers suspected, and the extraordinary transference of articulate sounds from one circuit to another is satisfactorily accounted for.

Formulaire de l'Electricien. Par E. Hospitalier. Onzième année, 1893. (Paris: G. Masson.)

In external form and internal arrangement, this work retains the characteristics of the ten former editions. It is not a pocket-book—it is too large; it is not a textbook—its information is too didactic. Perhaps its most useful function is to be a work of reference on an office or a study table. There is much in the book that must be useful to anyone connected with electrical engineering, whether a professor or a practical man, and the material is well arranged. Perhaps it is a little hypercritical to express surprise at the information on page 362, that the current money of "Angleterre" includes a twopenny piece! The chapters on dynamos and motors have received some additions and have been brought up to date. We may particularly notice the data of the experiments on, and trials of, alternate-current motors at Frankfort and other places. The chapter on transformers and storage cells has also been extended. The old and very useful mathematical tables, especially that one which tabulates numbers and the two sets of logarithms on one page, still remain one of the best features of the book.

The Mining and General Telegraphic Code. By BEDFORD MCNEILL. (London: Whitehead, Morris & Co. 1893.)

In the compilation of this useful mining and general phrase code, the author claims to have endeavoured to include all the technical terms and sentences usually required by Mining, Metallurgical and Civil Engineers, and the Directors of Mining and Smelting Companies, with special regard for the needs of the financial departments. More than usual care has been taken in the selection of the code words, which, from a casual survey, appear less liable to telegraphic error than is frequently the case. In all, 44,572 phrases are included in the book, in addition to tables of numbers, moneys, measurements, weights and measures, &c. The code is frontispieced by a map showing the land and submarine cables of the world.

BOOKS, &c., RECEIVED.

"Premiers Princeps d'Electricité Industrielle." By Paul Janet. (Paris: Gauthier- Villars et Fils).

"Transactions of the North-East Coast of Engineers and Shipbuilders." Vol. IX., Part 3. (London: Andrew Reid, Sons, and Co.)

"Memoires de la Société des Ingénieurs Civils." (Paris: The Office of the Society.)

SOME APPLICATIONS OF ELECTRICITY TO CHEMISTRY.*—II.

BY JAMES SWINBURNE.

The electrolysis of fused salts has not been studied nearly so thoroughly, either from theoretical or practical points of view, as of the aqueous solutions of the same compounds. There are many reasons for this, the chief being the inconvenience of having to work at high temperatures. Though many of the salts appear to fuse easily, that is to say, at low temperatures, it will generally be found that they contain water of crystallisation in which they melt, and that the anhydrous salts need something approaching red heat. It is not easy to work with substances which are red or white hot. Again, many of the salts volatilise at temperatures close to their fusing points, and on the small scale necessary for laboratory work it is troublesome to regulate such temperatures with any accuracy. Nevertheless, the electrolysis of fused salts is of enormous importance. The production of caustic soda and bleaching powder by the electrolysis of a solution of salt has been discussed in the previous lecture; the electrolysis of fused salt is a much more tempting process. Chlorine is given off at one pole, and there is no trouble from formation of hypochlorites. At the other pole sodium comes off in vapour. Sodium, it need hardly be mentioned, is very much more valuable than caustic soda. It is largely employed for reducing aluminium from its chloride by substitution. In addition to that, however, it would provide a means of obtaining pure caustic, as all that has to be done is to allow water to act upon it. This would mean saving in packing and carriage. Many attempts have been made to produce sodium from fused common salt on a large scale, but, so far, the process does not seem to be satisfactory. Sodium is produced, but it is difficult to collect it well, as it comes off mixed with a great deal of vapour of salt. Then there is trouble with the anodes; any metal is attacked, as chlorine, of course, attacks a red-hot metal. Carbon also seems unable to stand. There is still another difficulty. Salt volatilises at a temperature not very much above its fusing point, and distils over with the sodium. In addition to this, hot sodium attacks silicates, so that it is difficult to collect it.

Common salt may be taken as typical, as its electrolysis shows most of the difficulties as well as most of the advantages of working with a fused electrolyte. In the first place, when a solution is used the electrolyte contains oxygen, and the result of this is that there is difficulty in reducing metals that have a strong affinity for oxygen—such, for instance, as sodium or aluminium. Water, of course, contains oxygen, and so does alcohol. Glycerine, which is a much more universal solvent than is generally known, also contains oxygen. Alcohol, which dissolves many metallic salts, such as nitrates, is unavailable for the same reason; and liquids like the hydro carbons, which contain no oxygen, do not dissolve salts, and are not conductors of electricity. If fused salts are employed, however, the difficulty is overcome. The various metallic chlorides are mostly easily fusible, and so are many fluorides and cyanides. By employing their fused chlorides, strontium, magnesium, calcium, aluminium and barium may be reduced electrically. Most chlorides can be prepared easily by dissolving the oxide in hydrochloric acid, and evaporating down. This process cannot be applied in the cases of barium, magnesium, or aluminium, as the metals have such an affinity for oxygen that hydrochloric acid is given off and the oxides, and not the chlorides, are left behind. There is an interesting point to be mentioned in connection with the electrolysis of fused sodium and potassium chloride; the yield of metal is said to be considerably below the theoretical value. It has been suggested that this is due to the formation of a sub-chloride. This suggestion is probably wrong; but it is worthy of careful investigation, as, if it is true, sodium and potassium cannot be monovalent metals. It has been suggested on quite other grounds that they are trivalent, which would, of course, make two more chlorides possible. Another curious phenomenon is that many fused salts appear as if they conducted without any decomposition—that is to say, they seem to act like metals. This also seems impossible. It would

* A course of three "Tyndall" lectures at the Royal Institution.

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mean that fused electrolytes were an exception to the rule that all transparent liquids which conduct do so electrolytically. All transparent solids are, of course, non-conductors of electricity. It must be remembered that the distinction between fused and ordinary electrolytes is purely arbitrary, depending on the temperature at which we happen to live. If we were beings living at a temperature a few hundred degrees higher than the world is at present, we would regard water as gas and salt as a liquid, and Prof. Dewar would be freezing salt into the form they now know it, and liquefying water under great pressure. It seems unlikely that any extraordinary action, such as non-electrolytic conduction should take place in the case of a fused iodide; it is more probable that these salts are good solvents, and that the products of electrolysis dissolve and are carried over to the opposite electrodes. Potassium, sodium, lithium, strontium, magnesium, barium, calcium and aluminium can be easily reduced from their fused anhydrous haloid salt. Tungsten can be obtained from fused sodium tungstate and boron from melted borax.

It is remarkable that pentachloride of antimony and tetrachloride of tin, which are decomposed by water, are non-conductors. The mixture is also a non-conductor. The fused trichloride of antimony conducts much better if not quite anhydrous.

The chief industrial application of the electrolysis of fused salts is in the production of aluminium. One of the forms in which aluminium occurs in nature is a double fluoride of aluminium and sodium, cryolite. This ore is fairly plentiful, and was for a long time employed in Germany as a source of sodium in soda manufacture. The cryolite is fused and electrolysed in an iron vessel. This is kept hot, and the cryolite is kept in a molten state by the heat produced by the passage of an enormous current against the resistance of the electrolyte. Oxide of aluminium, or alumina, is in many cases dissolved in the cryolite also. Salt is frequently added to reduce the melting point, so that a lower temperature will serve. The electrical power is taken from large dynamos driven by water power.

It is not impossible that great things will come from fused salts in the future. One of the greatest problems of the age is to obtain power more economically from coal. The boiler and steam engine is not an economical arrangement, and many workers have tried to use carbons as the burning plate in a primary battery. Carbon has little affinity for oxygen at ordinary temperatures, but when it is hot it is possible to get a current with carbon as the positive element.

When an electrolyte is subjected to an electric current a transference of the radicles takes place, or, as it is generally put, there is a migration of the ions. If a solution of chloride of copper were electrolysed, and if there were no movement of the chlorine and copper during electrolysis, all the chlorine in the immediate neighbourhood of the anode would be used up and the water would be called upon to give up oxygen. At the cathodes, on the other hand, a little copper would be produced, but as soon as the salt in contact with the electrode was exhausted hydrogen would be evolved. The result would be that with, say, a 20 per cent. solution of the salt only a fifth of the chlorine and copper corresponding to the quantity of electricity passed would be produced, the rest being spent on decomposing the water. The solution would, in fact, be decomposed just in the proportions in which it came in contact with the electrodes. It is because the radicles change places and move in opposite directions that a continuous supply of chlorine and copper is produced. It is as if the chloride of copper were made up of molecules, each consisting of an atom of chlorine and an atom of copper; the atoms of chlorine and copper keep changing partners in such a way that the chlorine moves towards the anode, and the copper in the opposite direction. To use a homely simile, it is like the "ladies' chain," in which the ladies go in one direction and the men in the other, but they are nearly always in pairs all the same. This transference is made available in electrical tanning. It takes a long time to tan a thick hide, because the tanning solution penetrates the skin very slowly, because the cells of which it is built are impervious. Mechanical agitation will force the liquid into the interstices of the hide, but no farther; it cannot force the liquor through the walls of the cells. The passage of electricity, however, causes the tannin to pass through the walls of the cells also. It thus comes about that mechanical agitation alone does not accelerate tanning much, and electricity alone is also of little use, for the movement of the radicles is exceedingly slow. The combination is most effective, however, as the agitation brings the liquor into contact with the cells, and the electrical action drives it through the walls. The action of electrical tanning has been investigated by Dr. Rideal and Mr. Trotter, and it was during a discussion on a Paper of theirs that the lecturer suggested the explanation here given. Mr. Falkenstein is doing further work on the same very obscure, but interesting and important, subject. It has been proposed to utilise electric osmosis in various other ways, but so far without any important results. Experiments were made showing the reduction of sodium, calcium, antimony, tin and lithium from their fused chlorides. Fused glass was shown to be a conductor, and the local heating at the electrodes was shown.

THE DISTRIBUTION OF POWER BY ALTERNATE-CURRENT MOTORS.*

BY ALBION T. SNELL, MEMBER.

(*Concluded from page 720.*)

So far, if the difficulty of measuring the power be disregarded, the main point calling for improvement appears to be the magnetic pulsation. The mean variation does not, theoretically, exceed 7 per cent., and, practically, probably not 5 per cent. In order to still further decrease this, Dobrowolski has devised a very pretty combination of the open and closed type windings, which reduces the mean variation of the excitation to 3·5 per cent., when the magnetic field should be practically constant. The winding is shown diagrammatically in Fig. 11, and is known as the double-

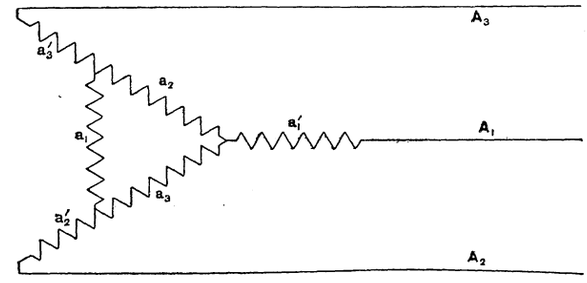

FIG. 11.—Combined *series* and *parallel* Drehstrom Couplings.

linked winding. The coils indicated by the symbols a_1^1, a_2^1, a_3^1, are severally wound in two parallels, 15deg. removed from the closed coils a_1, a_2, a_3. The complications involved are considerable, and the gain perhaps not commensurate with them; yet for large machines the device may prove useful.

There are some important points to be noticed between the *series* and *parallel* connections. It has been shown that with the *series* coupling $e = E/1{\cdot}732$ (*see* Fig. 8), and that the currents in the coils and mains are the same, and in the *parallel* device (*see* Fig. 5), that each coil carries a current equal to $A/1{\cdot}732$, and that the pressure at the coil terminals corresponds to the pressure between the mains. These differences are suggested by the terms *parallel* and *series*, which are in this respect more apt than those of *triangle* and *star*.

Now the magnetising effect exerted by a given number of turns of wire, and a definite effective current in the mains, will be different with the two kinds of windings. Consider Figs. 12 and 13, which severally represent the *parallel* and *series* couplings, and the direction of current at the instant when the Drehstrom is entering by one main and returning equally by the two others. Let n be the number of turns of wire in one coil. Then the total ampere-turns in the *parallel* device is n A, and in the *series* arrangement $3/2\ n$ A. Therefore, the magnetising effect and also the self-induction of the *series* device is greater than that of the *parallel* for a given current and a fixed number of turns. Now, the total power absorbed by the two circuits may be made the same by a proper adjustment of pressure and frequency; but since the lag is

* Paper read before the Institution of Electrical Engineers, April 13th.

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involved, a complete solution is not very simple. Probably, however, a few experiments made with different-sized machines will do more to assist the constructor than pages of mathematical theory.

It must be borne in mind that the triphase system has not been definitely proved to be superior to the diphase, and the leading authorities on the subject differ strongly. Herr Dobrowolski says that "the diphase current now belongs to the past," because in practice machines give curves departing so widely from sine functions. He admits, however, that if the phase differences of current and pressure be the same in each of the two circuits and *follow a sine law*, the work is the same in each at the same instant. Messrs. Brown, Kelly, Stanley, and Kapp all maintain that there is little to choose between the two systems from this point of view; and Mr. Brown further states that "his extensive experience with multiphase currents shows that two or three-phase motors of similar outputs are much the same machines with regard to their respective efficiency, starting torque, weight, and apparent watt consumption. This holds good for synchronous as well as non-syncronous machines." It is generally admitted that the Drehstrom presents many difficulties for lighting, and still more for a combination of lighting and power work; but Continental engineers have to a large extent successfully overcome these. Whereas, on the contrary, the diphase system admits of as simple a treatment as the single-phase one. It appears to be, therefore, probable that, if multiphase currents come into general use, the diphase may be employed chiefly for combined *light and power distribution*; and that the Drehstrom may find its field of usefulness in *transmission* and *distribution of power*. Experience alone can settle these points.

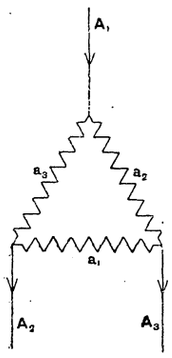

FIG. 12.

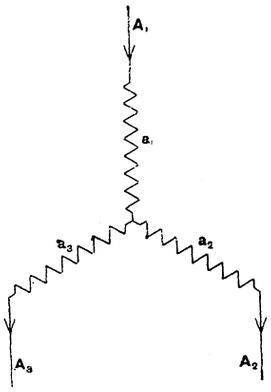

FIG. 13.

6.—*Practical Application of the Drehstrom.*

With a view of adding to the somewhat scanty practical information on the subject of multiphase working, the author proposes to lay before the Institution a few tests of two Drehstrom machines, designed and built by himself some eighteen months ago. These machines were adapted from material at hand, and were built under restrictions as to cost and time, and thus can only be regarded as rough experimental designs. The dynamo was a Gramme-wound 10-unit two-pole shunt machine, designed to give 160 volts and 60 amperes, at a speed of about 1,000 revolutions per minute. Three insulated copper rings, with suitable brushes, were fitted around the commutator and connected to the windings of the armature at points 120deg. apart. The ordinary commutator and brushes were left intact, so that both direct and triphase currents could be taken from the armature, and the field was separately excited. At a speed of 720 revolutions per minute, the frequency was 12 $\sim$ per second. This was afterwards increased to 33 $\sim$ by raising the speed of the armature.

The motor was specially built, and had a laminated ring magnet, with Gramme windings, and a closed-circuit armature. It was estimated to give 3 B.H.P. at about 1,200 revolutions per minute, and the gross weight was approximately 300lb. The armature plates had holes drilled parallel to the shaft and as near to the periphery as possible without breaking through. In these were placed lengths of No. 4 S.W.G. copper wire, insulated from the plates and soldered at either end to massive copper rings. The field winding consisted of six coils, each containing 68 turns of No. 6 S.W.G. copper wire, and having a resistance of 0·055 of an ohm. Opposite coils were joined in series with each other, so as to make three separate circuits, each of 136 turns and 0·11 of an ohm resistance, which could be connected in star or triangle fashion as desired. This motor proved to be a very effective machine, having considerable torque at starting, and a speed regulation quite as good as a direct-current machine of similar output. The only instruments available for taking electrical measurements were a Cardew voltmeter and a Siemens dynamometer; hence it was not possible to measure the angle of lag, or estimate the true watts. The experiments made with the dynamo and motor are shown in the following curves and tables, which at this stage may be instructive, since they show the order and direction of the difficulties met with in Drehstrom working.

(*a.*) *Preliminary Experiments with the Dynamo.*

The three copper rings were connected to points in the winding at 120deg. apart, the Gramme winding being otherwise untouched. The arrangement is diagrammatically represented by Fig. 14. The

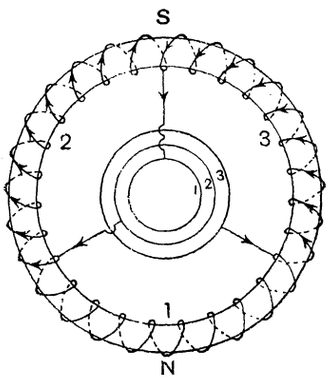

FIG. 14.—Connections of Drehstrom Dynamo, Coils in Series.

field was separately excited by 3·05 amperes, and the speed was kept at 710 revolutions per minute. The load was absorbed by iron spiral resistances with small self-induction. Readings were taken of the direct pressure; the alternating pressure at the ends of the three coils, a_1, a_2, a_3; and the current in each of the three mains, A_1, A_2, A_3 (*see* Fig. 15, curves 2 and 3). It was found that with the armature unloaded the pressure developed by each coil was practically the same; this was also the case when they were equally loaded (*see* Fig. 16). But it fell rapidly as the current increased, and

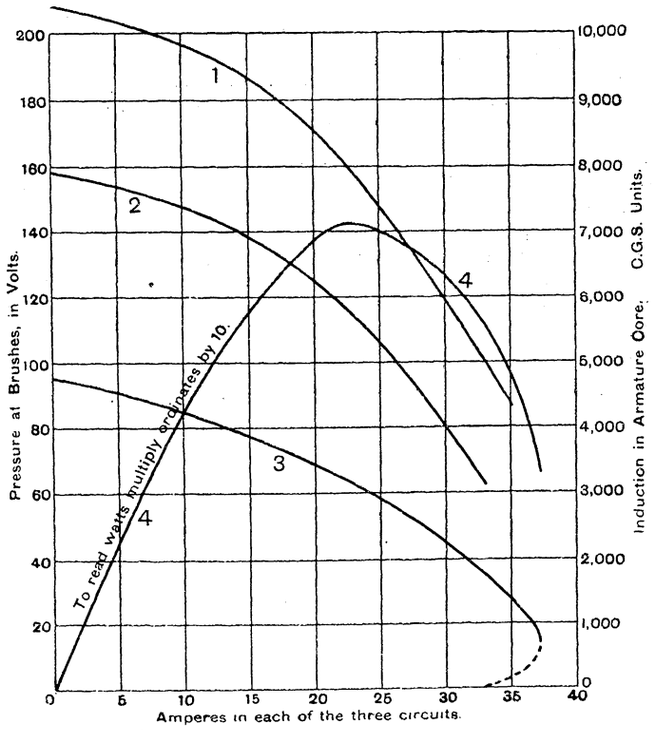

FIG. 15.—Curve 1. Induction in Armature Core. Curve 2. Direct Pressure. Curve 3. Alternating Pressure. Curve 4. Apparent Watts in each circuit. Speed 710 revolutions. Exciting current 3·05 amperes.

so a considerable difference could be made between the pressure of the three circuits by simply giving different loads to each of them. The magnetic induction of the armature core, curve 1, Fig. 15, was calculated from the usual formula, $E_a = N A n/10^8$, where E_a equals the total number of volts in the armature, A the number of turns counted all round the armature, N the total flux, and n the number of revolutions per second. It will be seen that the values of the induction measured were all small. The frequency was 12 per second. These conditions were not the most favourable, it is true,

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but they showed the detrimental effects of internal resistance and self-induction in not only restricting the output, but also in affecting the regulation of the pressure of distribution. It will also be seen that the direct pressure is higher than that of the alternating in the proportion of 158 to 94 on open circuit; and with 20 amperes in each branch (or a total of $1{\cdot}732 \times 20 = 34{\cdot}64$ from the combined circuit) in the proportion of 124 to 70. This difference is to be expected, since the alternating pressure is the average value of 120 deg. of the differential curve of potential; and, further, when

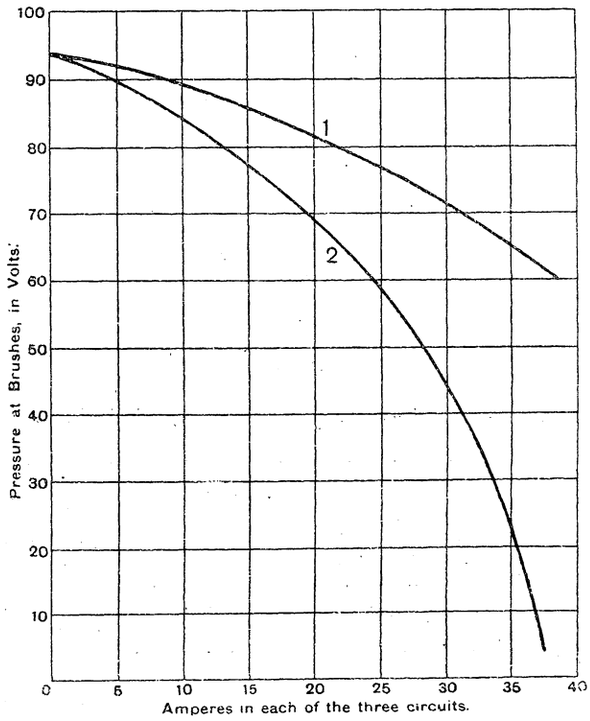

FIG. 16.—Shews Fall of Pressure at terminals of Drehstrom Dynamo with Armature Coils coupled as in Fig. 14. Curve 1. Only one circuit loaded. Curve 2. All three circuits equally loaded. Speed, 710 revolutions. Exciting current, 3·05 amperes.

the armature is loaded, the self-induction probably increases the difference between the two values. The apparent output, curve 4, Fig. 15, estimated by the product of effective amperes and volts is found to be a maximum with about 22·5 amperes in each circuit, or 39 in all. The current was next increased in each circuit so as to find the slope of the external characteristic curve. It was found to steadily fall at about the same slope until 37·5 amperes were reached, corresponding to a torque due to 65 amperes, this current being rather more than that designed for the armature. At this point the belt began to slip, and the experiment was stopped. It is clear that this class of dynamo can be safely overloaded for short periods.

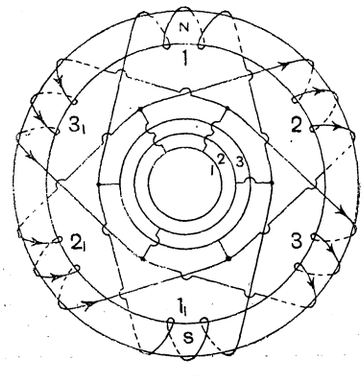

FIG. 17.—Connections of Drehstrom Dynamo, opposite Coils in Parallel.

The winding of the armature was next divided into six equal parts, and opposite sections were joined in parallel (*see* Fig. 17). The copper rings were then connected as before to points at 120deg. from each other. Each of the three circuits had now only half as many turns as with the coupling shown in Fig. 14, and one-fourth the resistance. The effect of this alteration was to lower the internal resistance of the armature and also, presumably, to reduce the self-induction. The excitation was maintained as before at 3·05 amperes, and the speed also at 710 revolutions. The results obtained from the two couplings are shown in Figs. 16 and 18 respectively. It is noticeable that the parallel winding has not materially affected the apparent output of the dynamo. The effective number of turns in each coil is only one-half that with the series winding; and, therefore, for the same heating effect the number of amperes is twice as great. To compare the two outputs, then, it is necessary with the series arrangement to take only half as many amperes as with the parallel one. Referring to Figs. 16 and 18, it is found that the apparent watts at 710 revolutions per minute are severally 69×20 and 34×40, or approximately the same. There was probably a smaller lag of current with the parallel than with the series connections. The smaller pressure and larger current were most suitable for testing the motor, and so

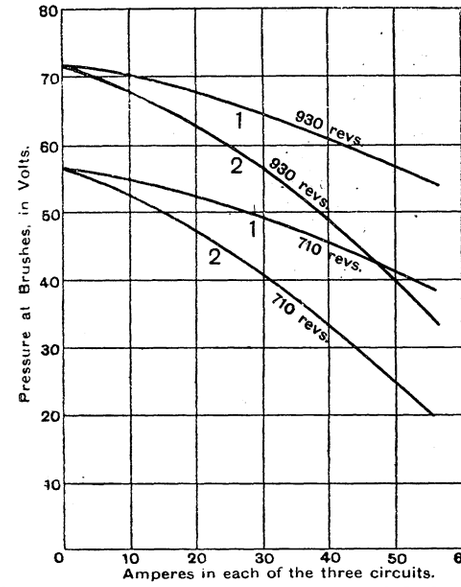

FIG. 18.—Shews Fall of Pressure at Terminals of Drehstrom Dynamo with Armature Coils coupled as in Fig. 17. Curves 1. Only one circuit loaded. Curves 2. All three circuits equally loaded. Exciting current, 3·05 amperes.

the parallel connections of the dynamo armature were used during the whole of the following experiments.

(*b.*) *Experiments with the Drehstrom Motor.*

(1.) *Star* or *open-coil* coupling. The motor was coupled to a dynamo by belting, and then supplied with current at frequencies ranging between 12 and 33·3 $\sim$ per second. With the lowest frequency the motor ran light at about 700 revolutions per minute, being nearly synchronous with the dynamo. As the load was applied the speed decreased, and since the output was inconveniently small, the dynamo speed was raised to about 900 revolutions per minute, when the following readings were taken :—

Groups A and B.

No. of test.	Speed of motor.	Pressure on Mains.	Amperes in each circuit.	Exciting current in dynamo field circuit.
1	848	58	21	2·5
2	746	55	21	2·8
3	880	77	38	4·5
4	800	77	27	Not taken.
1	888	80	28·7	4·3
2	866	80	27·6	4·3
3	824	75	27·6	4·3
4	890	77	28	3·9
5	790	70	27·6	3·9
6	866	75	27·6	3·9
7	Armature held stationary	70	34·7	3·9

The frequency was about 15 in the above experiments; but the dynamo speed varied from 932 to 833 revolutions per minute, owing to the engine governing badly.

The load on the engine was next adjusted so as to give a steady dynamo speed of 960 revolutions, and the tests included in Groups C, D, and E were made.

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In C a prony brake was applied to the pulley of the motor, and in D and E a dynamo was driven, as in the tests of Groups A and B, this being found to be more convenient.

Group C.

No. of test.	Motor Speed.	Pressure on mains.	Amperes in each circuit.	Weight on end of 24″ brake arm.
1	736	84	31	2lbs.
2	624	82	32	3lbs.
3	500	83	32·9	4lbs.
4	500	81	33	4lbs.
5	340	84	34·7	5lbs.

The frequency was 16.

Groups D and E.

No. of test.	Motor speed.	Pressure on mains.	Amperes in each circuit.	Dynamo speed.
1	0	79	37·8	960
2	340	79	34·8	960
3	512	78	32·5	960
4	740	77·5	30·6	960
5	820	77·5	28·15	960
6	864	76	28·1	960
1	922	91	31	952
2	914	90	32·9	956
3	0	85	39·8	970

In both D and E the frequency was approximately 16.

Next, the dynamo speed was increased to 1,960 revolutions in Group F, and to 2,000 revolutions in Group G; and the motor connections were altered to the *triangle* or *closed type*. This required 1·732 times the current and 1/1·732 times the pressure for the same output with the *star* or *open type* (*see* latter part of 5). The prony brake was used in Group F.

Group F.

No. of test.	Motor speed.	Pressure n mains.	Amperes in each circuis.	Weight on 24″ brake arm.	B.H.P. of motor.
1	1,820	41·5	26·5	1	0·68
2	1,480	41	29·8	3	1·67
3	1,200	40·5	31	4	1·8

The frequency was 32·6.

Group G.

No. of test.	Motor speed.	Pressure on mains.	Amperes in each circuit.
1	0	36·5	39·4
2	732	37	35
3	1,000	37·75	35
4	1,276	38·75	30·5
5	1,702	41·5	27
6	1,750	42·5	27 Motor running free.

The frequency was 33·3.

Groups A and B were made to see how far the excitation of the dynamo affected the experiments. The pressure on the mains varies, of course, with the excitation, but the speed of the motor, as far as can be seen from these rough measurements, is nearly independent of the pressure, and seems rather to vary with the frequency and perhaps the lag. The law connecting speed and current variation for constant frequency and pressure of supply is not very obvious, and evidently requires the lag to be taken into account. For example, *see* Group B: in test 6 the motor loaded with 27·6 amperes in each circuit and 75 volts, makes 866 revolutions; and test 7 shows zero speed for 70 volts and 34·7 amperes. Evidently the lag in 7 is far greater than that in 6. This is confirmed by test 1 in Group D, by test 3 in Group E, and test 1 in Group G. It is curious to notice how small are the variations of current between running light and full load, or even when the armature is held stationary. This large waste or idle current is most prejudicial, and if it cannot be lessened by some practical means (by condensers or otherwise), will militate seriously against multiphase motors without commutators. If the revolving part of the motor be supplied with the triphase current, these troubles will be much less; because the moving part will contain less iron, and hence the hysteresis and eddy-current losses and the induction disturbances will be of less importance. The frequency in the induced circuit is then so small as to give little trouble.

In Group C a prony brake with a lever 2ft. long was fitted around a 6in. pulley, and the motor was supplied with current of 16 ∽ per second. The pressure and current variations are seen to be insignificant, though the speed varies some 50 per cent. This low frequency (16) was found unsuitable for the design of the motor, since it gave too low a speed; but the tests in Groups D and E were taken so as to show the capabilities of the motor under these conditions. The power of the motor was utilised to drive a direct-current dynamo, the two machines being coupled by a belt. The figures in Group D again show large variations of speed for nearly constant pressure and small changes of current. In Group E the pressure was increased, but only a few readings were taken, as the increase in speed was insufficient to give results widely different from those obtained in the preceding tests.

In the next experiments the connections of the motor were altered to the *triangle* or *closed* arrangement, the end in view being the increase of motor speed and consequence output.

The tests in Group F are some of the most important in the series, for the output measured by the prony brake was sufficiently large to give practical data. It will be seen that the frequency was 32·6 per second and the pressure about 41 volts. The speed again shows large variations. When running light the speed of synchronism, 1,960 revolutions, was nearly attained.

In Group G the motor was coupled to a small dynamo by a belt, and the frequency was raised to 33·3 per second. In test 6 the motor was running free, but the speed was 250 revolutions below that of synchronism. The best results seem to have been obtained with a frequency of about 32 (test 3, Group F), and it appears probable that if the arrangements had been such as to admit of a larger current at this frequency, at least 3 B.H.P. might have been taken from the motor.

These rough experiments show the importance of reducing the magnetising current to a minimum. It can be accomplished by careful attention to the design and by making the air-gap as small as possible. The Drehstrom motor may be regarded as an open magnetic circuit transformer, and the only way to lessen the waste current is to make the magnetic resistance as low as possible. Mr. C. E. Brown has already suggested bedding the field as well as the armature turns in iron, the method being applicable to either ring or drum windings.

7.—*Drehstrom Motors with Stationary Armatures.*

Triphase motors are sometimes made with the rotary magnetic field in the revolving part of the machine. This necessitates brushes and rings, it is true, and consequently simplicity of design is departed from; but it must be recollected that there can be no sparking under ordinary conditions. The brushes would probably be made of flexible strands of copper, such as are commonly used for alternators. The chief point gained is that the most marked effects of hysteresis, eddy-currents and self-induction are limited to the relatively small moving part of the machine; whilst the massive stationary portions, which then form the armature, are magnetised by currents of frequency equal only to the difference between the speed of the armature and that of the rotary field. It is clear that the speed of the revolving part can never equal that of the rotary field; but at normal loads the period of the armature current will be small, and therefore the heating from hysteresis, &c., will be comparable with that of a direct-current machine, the period being probably of the order of from 8 to 10 per second. Herr Dobrowolski's 2-H.P. motor described in *The Electrician*, August 7, 1891, is of this type, and a brief comparison with the small motor built by the author may be interesting, because it will show the order of the results obtainable from the two types of machines. Herr Dobrowolski's motor weighed approximately 565lb., and the maximum output deemed advisable was 4 B.H.P. at about 1,700 revolutions per minute. On open circuit it made 2,100 revolutions, and at 2 B.H.P., the rated output, about 1,950. The frequency was 35, the supply pressure 70 volts, and the torque at starting considerable. The lag was stated to be 72 deg. when the motor was running light, 28 deg. at 2 H.P., and 22 deg. at 3 H.P. The efficiency at 1 H.P. was 75 per cent., at 2 H.P., the rated output, it had reached to about 80 per cent., and at 2·3 H.P. it attained its maximum of 81·4 per cent. The author's motor weighed about 300lb., and at 1,200 revolutions gave 1·8 H.P. on the brake; and it was evident from the slight heating that this output could have been safely doubled if the speed had been raised to about 1,800 revolutions. But it had a larger lag than the other machine, the waste currents at small loads were much greater, and the all-round efficiency was certainly less.

8. *Combined Rotary and Synchronous Motors.*

A multiphase dynamo requires the revolving field magnets to be separately excited by a direct current. It is reversible and will run as a motor if supplied with a multiphase current, but is

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not necessarily self-starting, and probably will not start against a large torque. If, however, the magnets be rotated so as to synchronise with the rotary magnetic field, the motor will work as satisfactorily as a single-phase machine. Attempts have been made to combine the advantages of a self-exciting rotary field and a synchronous motor. The plan proposed is some modification of the following idea:—The moving part, usually the armature, is wound with two circuits, the one closed on itself acting precisely as the closed circuits of the multiphase armature, the second supplied with a direct current, and, therefore, having fixed poles. When the field is excited by a rotary current the induced currents in the closed circuits will stert the armature (if the torque be not too great), and the permanent poles due to the direct current will have but little influence. But as the speed of synchronism is approached the induced currents in the armature will decrease, and the fixed poles will have more effect, until, finally, the armature rotation will be entirely due to them. Such a motor has many disadvantages, besides requiring an independent direct current. It necessarily has a low efficiency at starting and at all speeds below that of synchronism; but within wide limits of load, when once started, it will run at a constant speed with a high efficiency. The initial torque cannot be so great as that of a simple diphase or Drehstrom winding, since the closed circuits on which the starting depends are relatively smaller.

M. Schuckert has built a self-exciting diphase rotary-field synchronous motor on the above principles. But the method does not appear to offer any special advantages, and it is not likely that such motors will supersede ordinary single-phase alternators.

9.—*Single Phase Non-Synchronous Motors—Self-Exciting and Self-Starting.*

Messrs. Hutin and Leblanc, C. E. L. Brown, and others, have devised modified forms of Prof. Elihu Thomson's motor, all of which will run with single-phase currents, non-synchronously and with good efficiency. The principle seems to depend on the induction of currents in short-circuited coils, in unsymmetrical positions with reference to the main field, but this end is not necessarily attained by brushes and rings, as in Thomson's motor,* but by the rotation of the armature itself. In its simplest form this type of motor has no commutator, and is self-exciting, but will not start. If, however, the armature be spun in *either* direction, it will rapidly acquire the speed corresponding to the torque, and will then revolve at a uniform rate.

By the combination of an additional rotary magnetic field, the armature can be made to start against a considerable torque, and the auxiliary field can be stopped after the proper speed is attained. Various devices to secure such a field are suggested by Mr. C. E. L. Brown,† the most feasible being two parallel windings on the field magnets, one with small self-induction (or even capacity) and the other with larger self-induction. These two circuits when supplied with a single-phase current will produce a rotary field, and so cause the armature to revolve. (Other forms of this ingenious motor have been suggested by Mr. Brown, for which reference should be made to the technical journals of January and March of this year.) Most of the arrangements, however, necessitate rings and brushes, and the motor is, therefore, only preferable to a synchronous reversed dynamo inasmuch as it is self-exciting and self-starting. These two points are of great importance with small motors, and probably the invention will be of utility in many ways.

The general details of construction are, broadly, similar to those of a multiphase motor, but the number of poles in the field magnets and armature must not have a common factor, and the windings of both armature and field magnets are preferably laid in grooves or holes in the iron—an arrangement which permits the magnetic resistance to be reduced to a minimum and decreases losses from Foucault currents, while the weight output is increased. This is, perhaps, the best type of single-phase motor up to date, but it is undoubtedly susceptible of considerable improvement, and the problem of alternate-current motors suitable for running on ordinary supply circuits cannot yet be said to be satisfactorily solved.

The author has to thank several members, especially Prof. W. E. Ayrton and Dr. Sumpner, for kindly discussing with him some of the points raised in the Paper; but he alone is responsible for all inaccuracies and oversights.

DISCUSSION.

The PRESIDENT (Mr. W. H. Preece) said the subject of alternate-current motors was one of great interest at the present moment, and they were all looking forward to the introduction of an efficient one. He hoped the discussion on the Paper would lead to some novelty and some information.

Mr. KAPP, after referring to some things in the Paper which seemed to be printer's errors, proceeded to discuss the Paper. He must, he said, congratulate Mr. Snell for introducing it. English electrical engineers had been working with a cosine of lag that was really shocking. On the Continent and in America they had gone ahead at a great rate, but we had absolutely not a single multiphase current motor in practical work in this country. They might say that was because they were of no use; as a matter of fact that was not the case. There was quite a number of them doing excellent work abroad. There was no difficulty in a multiphase-current motor which would serve as an excuse for having neglected the subject so long. He would like to make a criticism which applied very much to most of the theories which had hitherto been put forth to explain multiphase-current working. Authors found it extremely convenient to neglect armature reaction. Now, if they wanted to investigate scientifically the theory of rotary field motors, at the same time leaving out armature reaction, it was very much like the proverbial case of playing *Hamlet* without the principal character. Armature reaction was extremely important, and it had not so small an effect as the author seemed to suppose. Mr. Snell had given them, though not quite endorsing it with his authority, the explanation of Dobrowolski as to why his three-phase currents were much better than the two phase currents, and why the complicated six-linked arrangement was better than the ordinary three-phase. Practical experience did not prove that at all. There was no disadvantage in the two-phase current. On paper, when they came to draw out those curves, it looked almost convincing; they saw those wavy lines going up and down, and they said, "It must be a very bad effect, having this pulsating field." But, as a matter of fact, they did not get that effect: it acted on an armature plentifully provided with good conductors, and the result of the presence of those conductors was that all the pulsations of the field were immediately wiped out. It was as though they had a transformer with a short-circuit secondary. When the secondary was short-circuited they could not get up any E.M.F., and that proved that they could not get up a pulsation of field; they could get up an E.M.F. which would burn out the transformer, but for a small pulsation they would not burn out the transformer. Any pulsation would immediately call forth opposite currents in the armature conductors which would balance the pulsations, and there was very little waste of power. That was, he believed, the only objection which the advocates of three-phase currents had been able to raise against the ordinary two-phase current. But, on the other hand, the ordinary two-phase current had the enormous advantage of being easily regulated. The three-phase current had been introduced in Heilbron, and it worked admirably there; but the superintendent had had a very heavy time of it before he was able to balance all his customers properly, so that all three branches were equally loaded. At last he succeeded, and everybody was satisfied, but none of those present would envy him his job. There was one more point he wished to draw attention to. The author said:—"Mr. C. E. Brown has already suggested bedding the field as well as the armature turns in iron, and the same end may be attained by perhaps a better way—*i.e.* by winding the field coils in drum fashion." He (Mr. Kapp) failed to see how the particular way of winding could affect the magnetic resistance between the surface of the field and that of the armature. He would ask the author whether that was not an oversight.

Mr. SNELL thought they were talking at cross purposes, chiefly on account of the definition of field and armature. He had stated in the beginning of his paper that he regarded as the armature that part of the machine which had the induced currents in it, and the field that which received the "Drehstrom" current. The case to which Mr. Kapp had referred was an oversight.

The PRESIDENT said that from the list he had before him it was evident a good many members wished to take part in the discussion, and no doubt they would be very glad to have the opportunity of clearing away a little of the fog that might have entered into their minds in consequence of the discrepancies in the paper. He knew that the motor that had been referred to was in London, and he was quite sure when he expressed the wish of the meeting to Mr. Sparks he would at the next occasion be kind enough to bring the novel motor of Mr. Brown to their meeting, and he was not sure that they would not be able to see it in action. He would therefore adjourn the discussion for a fortnight.

* See *The Electrician*, March 16, 1893.

† All of these have already been referred to in the first portion of this Paper.

CORRESPONDENCE.

CONCENTRIC WIRING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the statement in my letter of last week that the drop of volts in the outer conductor might be minimised by increasing the section of the outer conductor at the expense of the inner, I omitted to acknowledge that the originator of the idea is Mr. T. B. Murray, of Biggar, by whom it was suggested to me. I beg you will afford space to repair this omission. Thanking you in anticipation,—Yours, &c.,

56, George-square, Glasgow, April 26, 1893. SAM MAVOR.

[Owing to pressure on our space we have been compelled to hold over a very lengthy communication on this subject from Mr. Sydney F. Walker.—ED. *E.*]

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EXHIBITS AT THE INSTITUTION OF CIVIL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Kindly allow us to correct a small inaccuracy in your note upon this subject. The 60-I.H.P. engine exhibited, which had been running up to 1 p.m. on the same afternoon, was the *works* engine here—*i.e.*, the engine which drives the machine tools, not the lighting engine. An exact representation of it chances to be given on the advertisement page exactly opposite to the "Note" in question, with the base and pulley, the two latter being the only portions not shown at the Institution.—Yours, &c., WILLANS AND ROBINSON (LIMITED),

Thames Ditton, April 25, 1893. C. S. ESSEX, Secretary.

EFFICIENCY OF TRANSMISSION.

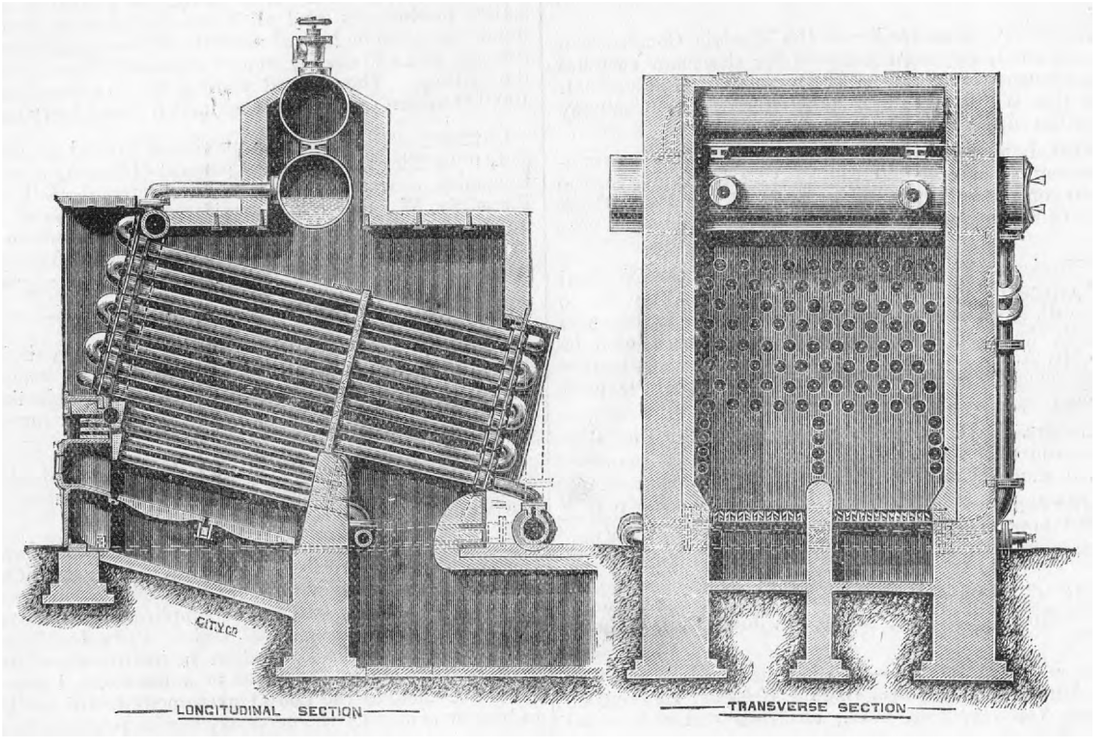
TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your summary—or note—on Mr. Preece's interesting lecture at Liverpool you say that his "expression of the efficiency of the transmission of energy by transport of coal is not only correct but original." Allow me, therefore, to point out that when the Planté cells or accumulator batteries were being puffed some years ago I ventured to criticise some statements by Sir W. Thomson concerning the transmission of energy by such storage cells, and to point out that an ordinary railway truck formed by far the more economical method of transmitting energy. My letter was, I think, published in *Engineering*. The efficiency of this method of transmitting energy depends, of course, upon the railway charges; but it is not fair to take the railway truck as the deciding example of such efficiency by coal transport, which varies greatly according to the means employed. For instance, coal is often carried many thousands of miles practically as ballast in the holds of sailing vessels. Again, its transport by canal is far less costly than by rail. In each of these cases the efficiency would be far less than any figures based on rail transport.—Yours, &c.,

J. T. BUCKNILL, Lieut.-Colonel.

ROOT'S PATENT WATER-TUBE STEAM BOILER.

Messrs. Conrad Knap and Co., makers of the improved Root boiler, recommend this tubular boiler for electric lighting purposes. the tube principle, whilst retaining the important feature of safety and facility for repairs, as well as ease of transport, which are



The accompanying illustrations show longitudinal and transverse sections of it. It will be noticed that the tubes are rather shorter than is usual in water-tube boilers, and it is claimed that a much higher rate of evaporation per square foot of heating surface is attained, together with greater facility in cleaning, and less danger of burning out when the boiler is forced. Each tube with its end boxes is separate. The tubes are screwed permanently into the end boxes, the difference of expansion being provided for in a bellows joint. We are informed that any tube can be replaced in ten minutes when the steam is down, and any leakage in the tube joints being external, can be seen and tightened up under steam. Instead of one steam drum, two small receivers are used, the lower one containing steam and water, the upper one steam only. No traps are, therefore, required, and it is claimed that perfectly dry steam is ensured. An interesting feature of this boiler is the surrounding of the furnace by 4in. tubes. These are clearly shown in the transverse section of the boiler. They are provided in order to absorb the heat which would otherwise be lost by radiation on to and through the brickwork. These tubes are set about seven-eighths of an inch apart, and about 1in. clear of the brickwork. Two rows can be provided if required, but we are informed that one is generally sufficient. This boiler is evidently a marked improvement over an "oven full of water pipes," maintaining, as it does, the leading characteristics of water-tube boilers. The tubular water casing is made entirely of wrought iron and steel, and is connected to the rest of the boiler in the same way as the other boiler tubes. It is not a separate water heater, but part of the boiler, and one in which the most rapid circulation of the water takes place.

Tower Lighting.—Tower lighting still continues to thrive in the land of its birth. Detroit, not content with having over one hundred of these strange structures, is agitating for more. As the American correspondent of a gas contemporary points out, the experiences of these tower-lamp trimmers during the past severe winter in the States must have been very trying. At Grand Rapids (Mich.) there are 40 tower lights. In ordinary weather the trimmer ascends in a kind of cage; but when there is a strong wind the cage rocks too much to make this plan safe. He is forced, therefore, to go up the ladder fixed on to the tower. Remembering that the towers are 150ft. high, it will be generally conceded that the task is one not to be sought after.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "The Electrician" Electrical Trades' Directory and Handbook is now ready. This useful book contains over 1,000 pages, and several new and handy features have been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

Tenders Invited.—The Electric Lighting Committee of the County Borough of Huddersfield invite tenders for the wiring of and supply of electric light fittings for their supply station. Some particulars will be found in our advertisement columns, and Mr. A. B. Mountain, the borough electrical engineer, Gas Works-street, Huddersfield, will supply plans and specifications, and tenders have to be sent in to him by Tuesday, May 9th.

——— The Corporation of Cardiff require tenders for the erection of engine-house, boiler-house and coal stores, for the electric lighting station at Canton. All further information can be obtained of Mr. W. Harpur, Town Hall, Cardiff, and tenders must be sent in to Mr. J. L. Wheatley, Town Clerk, by May 6th.

——— The Corporation of Kingston-upon-Thames require tenders for the erection of the buildings for their lighting station, which have to be sent in to Mr. H. A. Winser, Town Clerk's office, by May 3rd.

Tenders Accepted.—The tender of the Electric Construction Corporation (Limited) has been accepted for the main switches and fuses for the electric lighting of the borough of Huddersfield, and that of the W. T. Henley's Telegraph Works Company (Limited), for the supply of cables.

Brockie-Pell Lamps.—Messrs. Johnson and Phillips have contracted for the supply of over 200 Brockie-Pell arc lamps for the electric lighting of the buildings and grounds of the Earl's Court Exhibition of Gardening and Forestry, which is to be opened next month.

Removal Notices.—The metropolitan offices of the National Telephone Company (Limited) will be removed from May 1st to 58-9 London-wall, E.C., and all communications and inquiries in connection with the Company's metropolitan business should be addressed to Mr. A. Calder, the metropolitan manager, at the new address. The general offices for other business remain at Oxford-court, Cannon-street.

——— Messrs. J. D. F. Andrews and Co. notify that they have removed the offices of the Company from 41, Parliament-street, S.W., to the works at Marsham-street, Westminster, S.W.

——— The registered offices of the St. James and Pall Mall Electric Light Company (Limited) will be transfered to their new central station at Carnaby-street, Golden-square, W., on and after May 1st.

——— Mr. G. Stegmann, electrical engineer, has removed from 66, St. John's-road, S.W., to 69, St. John's-hill, Clapham Junction, S.W.

Dissolution of Partnership.—The partnership between Vincent Sydney Allpress and Thomas Oswald Belshaw, carrying on business at 55, Victoria-street, S.W., electrical and mechanical engineers, has been dissolved.

Gilbert and Co.—Messrs. Gilbert and Co., of Hanway-street, and Kensington High-street, inform us that they are supplying electric-light plant for the Maharajah of Bhaunagar.

Messrs. R. and W. Winfield (Limited).—This firm has appointed Mr. Seymour Coneen, late manager to Messrs. F. W. Reynolds and Co., of Southwark, to the charge of their London business.

Personal.—Mr. C. Faraday Proctor, who has for some years past been associated with the Continental Edison Company, has now transferred his services to the Edison and Swan United Company's works at Ponder's End, where he will be specially concerned in the development of the fittings and instrument departments.

Hartmann and Braun's Electrical Governor.—Engineers in charge of central stations require a sensitive and trustworthy electrical governor. Such an instrument should control the station by acting on the exciting current of the dynamo, or, if batteries are used, on the switch which controls the number of cells in use. The essential part of such a piece of apparatus is an accurate standard voltmeter, which is specially sensitive between the limits of variation of pressure allowed. Messrs. Hartmann and Braun have adapted their new electrical governor to work under the conditions set out. It consists of a sensitive standard voltmeter which controls two relays, in their turn controlling the current of a small motor. The motor works a screw switch which alters the number of cells in use, or in a large station controls the dynamos by varying the existing current. The voltmeter has, therefore, only to deal with a very small current itself. At the ends of the switching screw are contacts placed which act on the motor circuits to prevent over running. Messrs. O. Berend and Co. are the agents in this country for Hartmann and Braun's instruments.

Automatic Electric Railway Signal Company.—An interesting working model of this Company's system of signals has been on view this week at 39, Victoria-street, Westminster. The working is entirely automatic, and may be briefly described as follows:—The train in passing depresses a spring rail, and makes contact with a relay. The relay makes and holds down a contact which pulls off a semaphore. A weight of two tons is required to depress the rail, which cannot easily be tampered with by hand, nor is it affected by platelayers' trolleys. The pull is comparatively small, as the semaphore arms are balanced. It appears that so long as they come to "danger" by gravity the Board of Trade do not specify any definite pull; but risk of sticking, due to snow, wind, or other causes, is guarded against by an ingenious device which prevents a further signal being lowered before the first one comes well home to "danger." Numerous contingencies are automatically provided for, and the invention, which has been at work for some time in the Isle of Wight, seems well worthy of the attention of railway men.

Exhibition at Antwerp.—An International Exhibition is to be inaugurated at Antwerp on May 5th, and is to remain open for six months at least. It is to include industrial, scientific, and artistic productions, and all kinds of commercial products. The buildings are to be located near the Scheldt, in the new quarter of the city, and will occupy an area of about 75 acres, connected with the railway. The general plan is for a covered area of about 100,000 square yards, including halls for machinery electricity, &c.

Concert.—The staff and a number of invited guests of the City of London Electric Lighting Company (Limited) were present at a Bohemian concert, held at the International Hall, Café Monico, Piccadilly, W., under the presidency of Mr. David Cook. This was the last of a series of four similar concerts, which have proved so popular that more than 300 persons assembled at the last of the series, including many ladies. This concert was a great success.

Acton.—A proposal which has been received by the Local Board, under which the Board would confer its powers for a limited period upon a firm of contractors who undertook to light the district for the same amount as is already paid, has been deferred for discussion by a special meeting.

Bombay.—The Bombay municipality has received a proposal from the executive engineer for lighting the Crawford markets and the Municipal offices by electricity.

Bournemouth.—The Local Government Board have written to the Town Council, notifying them that in the event of their intending themselves to generate or manufacture electricity for the purposes of lighting and power supplied, it will be necessary for them to obtain a Provisional Order. The Lighting Committee recommended that the Town Clerk be instructed to take the necessary steps to obtain the grant of a licence, and that application should be made to the Local Government Board for their sanction to borrow money for the necessary works, pending the grant of the licence. The Bournemouth and District Electric Lighting Company have been requested to furnish a tender, setting out the terms upon which they are prepared to light the pier and pleasure grounds, the Corporation providing the necessary lamps and fittings. The surveyor estimated the cost of the plant, &c., necessary for this work at £3,200. The Town Clerk anticipated no opposition from the Lighting Company to their application for a licence, as the light was only intended for the use of the Council.

Brighton.—Replying to a letter from a prominent ratepayer, the General Purposes Committee of the Corporation notify that, in the Bill before Parliament relating to the seashore electric railway, powers have been secured by the Corporation protecting their interests and those of the public. The borough surveyor has been instructed to report to the next meeting of the Corporation on the cost of lighting the Town Hall by electricity.

Bristol.—After submitting to the Town Council their report regarding the extended outlay for buildings and purchase of site for the central station, the Electrical Committee asked permission to withdraw a portion of the report until the next meeting of the Council, which was agreed to, the object being to submit a reduced estimate of cost.——The Board of Guardians have decided to light the main entrance of the hall, clerks' offices, &c., of the St. Peter's Hospital by electricity.

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BURNLEY.—It was contemplated that the Burnley central station would have started the supply of electric current about the end of April, but, owing to a stoppage of building operations and a strike, it will be the beginning of June before a start can be made.

CHESTER.—The Electric Lighting Committee of the Town Council have before them two reports in reference to a scheme for lighting the City by electricity, and will shortly meet to discuss the matter.

CHISWICK.—The Local Board have received a letter from Messrs. Bourne and Grant, the contractors to whom the Provisional Order obtained by the Board was transferred, enclosing a memorandum and articles of agreement of the Company which is to be formed under the title of the Bourne and Grant Electric Supply Company (Limited) with a capital of £25,000. A proposal that Mr. Finnis should look into the matter and report to the Board was agreed to.

CITY OF LONDON.—The City of London Electric Lighting Company give notice of a further considerable extension of the area in which electric current will be shortly obtainable, the district including the area represented from Holborn in the W.C. district to Aldersgate-street, E.C.

DORKING.—The Dorking Gas Company have, we understand, under consideration a proposal to light the town by electricity.

FALMOUTH.—The Urban Sanitary Authority have decided to defer engaging an expert to report on the electric lighting scheme until tenders have been invited from public companies willing to light the town.

GLYNCEIRIOG.—This village has recently been provided with reservoirs for a new water supply, and it is under consideration to utilise the water for motive power in connection with a scheme for lighting the village by electricity.

GOUROCK.—The Town Commissioners have had under discussion the advisability of introducing the electric light into the burgh. There is some difficulty in obtaining a suitable site for an additional gas holder, and the introduction of electricity is, therefore, probable.

HAIPHONG.—We learn that the electric lighting of Haiphong is working successfully. There are four dynamos, made by Messrs. Mather and Platt, which at present supply 420 16-c.p. lamps. The 3-wire system of distribution has been adopted with overhead wires, the total length of the circuit being 17 kilometres. Two horizontal compound Marshall engines are employed, capable of working up to 12,000 16-c.p. lamps. The light is giving much satisfaction, and its extension is only a question of terms between the authorities and the Company working the district.

HUDDERSFIELD.—The borough electrical engineer of Huddersfield has been instructed to proceed with the laying down of another 200-unit plant, in extension of the present electric supply plant for the borough.

LAUNCESTON (TASMANIA).—Tenders will shortly be invited for the execution of the necessary works in connection with the scheme for lighting this city.

LECTURES.—Lectures on electrical subjects have been delivered during the week by Mr. W. H. Preece at Hampstead, by Prof. Fitzgerald at Belfast, by Mr. R. Hammond at Croydon, and by Mr. W. H. Watkinson at Sheffield.

MORECAMBE.—A difficulty which has recently arisen between the Local Board and the local Electric Light Company has been satisfactorily settled by the Company agreeing to conform to the orders of the Board in regard to the streets and footpaths being placed in a satisfactory state of repair.

POWDERHALL (EDINBURGH).—Tenders for the installation of electric light at the Refuse Disposal Works have to be sent in this day (Friday).

REDRUTH.—The formation of the Redruth Electric Lighting Company has had the effect of compelling the local gas company to reduce the price of gas by 6d. per 1,000ft.

TECHNICAL EDUCATION.—The Government of India have sanctioned the establishment of a technical school for engineering in connection with Rangoon College for training Burmans, and the Lieutenant-Governor of Bengal has sanctioned the opening of a technical school at Burdwan for the instruction of artizans. In Madras and other parts of India the establishment of technical schools is making considerable progress.

WATFORD.—A proposal that the Local Board should apply at once for a Provisional Order has been approved, and at the next meeting the Clerk will report upon the subject.

WHITEHAVEN.—Considerable progress is being made with the necessary works for carrying out the electric-lighting scheme. The first boiler has been fitted, and the engines and dynamos are expected immediately. August next is expected to see the central station in perfect working order.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

March 28, 1893.

6,556. H. H. LAKE. London. Improvements in electrical instruments for medical purposes. (Boyd's Medico-Electrical Vitalizer Company, United States).*

6,559. M. W. DEWEY. London. Improvements in electric heating apparatus.*

6,565. SIEMENS BROTHERS AND CO. (LIMITED) and E. F. A. OBACH. London An improvement in dry voltaic cells and in conducting connections for the carbons of these and other electric cells.*

6,573. F. BROWN. London. Improvements relating to voltmeters.*

6,579. W. MITCHELL. Improvement in electrically-heated radiator.*

March 29, 1893.

6,605. E. T. PARKER. Wolverhampton. Improvements in diaphra for use in electrolytic processes.

6,613. The Honourable C. A. PARSONS and J. B. WILLIS. Birmingham. Improvements in street and like boxes for containing transformers used in electrical distribution.

6,627. I. A. TIMMIS. London. Improvements in the working of railway signals and points by electricity.

6,637. F. W. GOLBY. London. Improvements in the application of electricity to closed carriages. (A. Casella, jun., France).

6,642. D. MATHER and J. KEMP-WELCH. London. Improvements in securing the socket shank of incandescent lamps.

6,649. G. A. NUSSBAUM. London. Improvements in telephone transmitters.

6,654. E. F. TERREY. London. An improvement in connection with electric bells and their contacts or current interruptors.

6,666. W. GEIPEL. London. Improvements in or relating to the distribution of electricity.

6,671. S. O. COWPER-COLES. London. Improvements relating to electro-metallurgy of zinc.

March 30, 1893.

6,677. W. GRIMES. London. Improvements in railway electrical signalling devices.

6,684. H. L. MÜLLER and W. ADKINS. Birmingham. Improvements in lighting and extinguishing attachments for electric and gas lamps.

6,697. W. DONALDSON. London. Improvements in the heating of gases by electricity.

6,702. K. KOCH. Manchester. Improvements in dynamo brushes.*

6,723. C. T. SNEDEKOR. London. Improvements in coatings or coverings for electric conductors.

6,742. J. D. F. ANDREWS. London. Improvements in electric arc lamps.

6,751. E. PLACET and J. BONNET. London. Improvements in the extraction of chromium by electrolysis.

6,780. V. C. DOUBLEDAY. London. Improvements in secondary batteries. (M. Sussmann, Germany.)

6,785. F. HALLOWS. London. Improvements in or connected with apparatus for feeding carbons in electric arc lamps.

April 1, 1893.

6,800. T. J. FLYNN. Liverpool. Improvements in or appertaining to electric-lighting apparatus or plant for railway trains, tramcars, or other like vehicles.

6,805. E. W. STREETER. London. A new shade for lamps or candles, especially suitable for incandescent electric lamps.*

6,813. F. BRYAN. London. Improvements in electric arc lamps.

6,814. C. R. G. SMITH and J. GORDON. Improvements in the deposition of copper or other metal on ordinary insulated conductors.

6,885. H. H. LAKE. London. Improvements relating to electric railways. (Michael Angelo Cattori, Italy).*

6,886. H. H. LAKE. London. Improvements relating to commutator switches for use in charging electric accumulators. (Carl Liebenow, Germany).

April 4, 1893.

6,907. R. H. BEST. Birmingham. Improvements connected with the apparatus for raising or lowering the centre lights of chandeliers or electroliers.

6,921. F. ROSATI. London. Magneto-electric generator with fixed armature.

6,922. W. MITCHELL. Birmingham. Devices for electrically heating crucibles and other articles.

6,933. THE AUTOMATIC ELECTRIC RAILWAY SIGNAL COMPANY (LIMITED) and E. BLAKEY. Improvements in or relating to the working of signals and locking of points electrically at railway junctions.

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6,935. A. G. Brookes. London. Improvements in meters or apparatus for making measurement of electrical energy. (Herbert Clarence Wirt, United States).

6,952. W. Mitchell. London. Improvements in electrically-heated crucibles and holders therefor.*

6,954. A. J. Jarman. London. Improvements in the construction of primary elements for producing electrical currents by the moisture and heat of the human body or by separate excitation.

6,965. R. Urbanitzky and A. Fellner. London. Improvements in and relating to electric furnaces.

6,975. E. L. Berry and F. Harrison. London. Improvements in or connected with apparatus for periodically completing and interrupting electric circuits.

April 5, 1893.

7,005. R. F. Yorke. London. An improved electric accumulator plate,

7,020. J. A. Kingdon. London. Improvements in the construction of electro-magnets and in their application to electromotors and apparatus for use with alternating currents.

April 6, 1893.

7,069. A. E. Field. Southsea. A new method of fitting telephone instruments.

7,082. F. W. Kelley. London. Improvements in flexible brackets for electric lighting and other purposes.

7,085. O. E. Wheeler. London. Improved apparatus for producing intermittent electric flash-light signals or messages by the Morse or kindred codes.

7,101. F. H. Medhurst and W. J. Hope-Johnstone. London. Improvements in apparatus for use in connection with electrical transformers.

April 7, 1893.

7,190. A. G. New. London. Improvements in the manufacture of the magnetic parts of electrical apparatus.

7,192. J. Eaton-Shore. London. Improvements in guards for electric and other lamps.

7,194. G. Averley. London. Improvements in vehicles running on rails, applicable to electric traction and for other purposes, and adapted to pass around curves.

7,199. S. Hellebrandt. London. Improvements in portable electric lamp apparatus.

7,213. J. S. Raworth and T. O. Callender. London. Improvements in the manufacture of concentric electric conductors.

April 8, 1893.

7,246. H. Nehmer. London. Improvements in material for conveying electrical currents to the human body.

April 10, 1893.

7,297. W. J. Starkey and B. Starkey. Manchester. Improvements in and connected with secondary batteries, applicable also to primary electric batteries.

7,342. A. Bergtheil and R. A. Marples. London. An improved system of conductors for the distribution of electrical energy and in apparatus used therefor.

April 11, 1893.

7,358. J. Wood. Barrow-in-Furness. The gipsy telephone or electric mahatma.

7,387. W. P. Thompson. Liverpool. Improvements in or relating to machines for electrically-welding metals. (C. L. Coffin, United States.)

7,389. W. P. Thompson. Liverpool. Improvements in apparatus for electrically welding or working metals.

7,404. J. Long. London. Improvements in globes, shades, saucers, glasses, incandescent lamps, lanterns, and other appliances used for diffusing and increasing the light arising from electricity, gas, candles, mineral and other oils.

7,407. J. W. Jones. London. Improvements in electric meters.

7,423. W. H. Fahrney. London. Improved means for telegraphing.*

7,424. Addison, Goodyear, Waterhouse, and the Waterhouse Electrical Manufacturing Company (Limited). London. Improvements in electric arc lamps.

7,437. H. H. Leigh. London. An improved microphone (Charles Mildé, Son and Co. France).*

April 12, 1893.

7,470. P. Willis. London. Improvements relating to electric railways, tramways, and the like. (James B. Sheldon, George L. Van Beek and Daniel J. Murnane. United States).

7,471. E. R. Wilder. Manchester. Improvements in and connected with electric annunciators.*

7,488. J. A. Archer. London. Improvements in electric battery apparatus.

ELECTRIC LIGHT REGULATING SYNDICATE (LIMITED).—This Company was registered on April 25th with a capital of £1,000 in £1 shares, to carry into effect an agreement between Edward P. Davis and Adrian C. Collins and this Company; and to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity for the purposes of light, heat, and motive power, and manufacturers of and dealers in all electrical apparatus, plant, and machinery.

COMPANIES' MEETINGS & REPORTS.

The Metropolitan Electric Supply Company, Limited.

The sixth ordinary general meeting of the Metropolitan Electric Supply Company (Limited), was held on the 21st inst., under the presidency of Sir John Pender, G.C.M.G., M.P.,

The SECRETARY (Mr. E. Cunliffe-Owen, C.M.G.), having read the notice convening the meeting,

The CHAIRMAN said: Gentleman, I presume that you will take the report as read. I wish in the first place to direct your attention to a misprint in the accounts as sent out to you, which has been corrected in the copies placed in your hands to-day. In item 2 of the capital account you will see that the addition of the sums expended on buildings up to 1891 and during the past year, which has been made to appear as £127,439, should evidently be £133,429. The total of the capital account is not affected, and the misprint has no bearing on any other of the published accounts. I now come to the examination of the accounts which are in your hands, and which I hope are sufficiently explicit as showing the results of the previous year's working There are, however, some details to which I wish to direct your particular attention, in order that you may more fully realise the improvement in our position. The capital accounts, Nos. 1 and 3, contain little that is new. They show that the £50,000 debentures, about which we spoke last meeting, were duly issued, and now form part of the Company's capital; and I would state that they are almost entirely held by the shareholders, which is, I think, a very satisfactory position. You will observe that the capital expenditure of the year has been principally confined to, first, the completion of the Amberley Road Station at Paddington, with its plant and machinery, and, secondly, the extension of the underground mains, which now amount to upwards of 200 miles, and the provision of the transformers and meters necessary for the supply of our continually increasing customers. I may here remind you that the Amberley Road Station was not contemplated in our original estimates; and it is, indeed, owing to the comparatively recent addition of the Paddington district to our original areas that the debenture issue became necessary. I must not omit to refer to the item for management expenses, they have, as I explained on a former occasion, been divided between capital and revenue, on what the auditors consider to be a fair principle, having regard to the time and attention which have been required in settling and carrying out the various details of construction, the charge to capital being a decreasing one, so that when construction is practically completed, the revenue will have to bear the whole of these charges, which I have no doubt it will be perfectly well able to do. There is another item which I would explain, as it appears for the first time on the accounts. I refer to the heading "expenditure relating to compensation for damage and cost of properties acquired"—£3,311. 18s. This sum is in respect of one of the greatest difficulties we have had to encounter in the carrying out of our works. It has been impossible to lay down large quantities of machinery in thickly populated localities without provoking a certain number of complaints of vibration which may or may not have been justified; and in some cases, rather than incur litigation, we have been forced to acquire properties closely abutting on certain of our stations. As you all know, these complaints are very often greatly exaggerated, and when people in possession of land discover that they can get a little money by finding fault, you may depend upon it that they lose no opportunity of doing so. I have again to refer to this question later on; but I would mention here that we have never found any difficulty in letting such property as we have offered to tenants, and we are receiving a very fair rate of interest on our purchases; so we are under no loss by them. We now turn to the revenue account (No. 4), and the first and most gratifying point to be noticed is that while the income from sale of current has increased 35 per cent., the cost of production has only risen about 4 per cent. The coal bill is, of course, the great item of interest, and the Board are glad to find that their anticipations that the consumption of coal would not increase at all proportionally to income have been so fully verified. They believe that the improvement in this direction will become still greater as the business increases. You will notice in this account the introduction for the first time of a "depreciation fund." As I stated when addressing you last year, the Board are fully alive to the need of providing for the wear and tear of the Company's buildings and plant, more especially of such items as accumulators. It must, however, be borne in mind, that our buildings are quite new, that the machinery is only now really settling down into full working, and that every penny of expenditure incurred in keeping it in the perfect order necessary for successful working, has been charged directly to revenue. Our accumulators are few, and eventually, I believe, they will cease to be an item in our system. The Directors, therefore, consider that they have fairly met the necessity of the case by appropriating the sum of £4,000 to this purpose, leaving the amount to be increased year by year, as may seem most desirable and practicable. It would further be seen that the Board have commenced a most desirable writing off of the item of preliminary expenses, which has been reduced by the sum of £1,000, and will by future reductions be gradually extinguished. After making these appropriations there still remains a balance to credit of net profit of £11,558, and the Directors recommend the distribution of the sum of £9,980 as a dividend at the rate of 4s. per share, leaving a final balance to commence the net revenue account of 1893 of £1,578. I wish to draw particular attention to paragraph 6 of the Report, for in it we refer to the fulfilment of the anticipations I have more than once expressed to you as to the decrease of working expenses in

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proportion to the increase of business. We look to this feature as the proof of the ultimate prosperity of the Company, and the more we can employ our machinery the more economically can we supply our current. Our chief difficulty at present consists of the character of our supply to the residential portion of our districts. Private consumers as a rule do not benefit us to the same extent as commercial consumers. The reason for this requires some little explanation. It will surprise many of you to know the varying requirements of householders, for whereas some consider that 10 lamps would meet their wants, others require many hundreds, and it is not always the largest houses that contain the greatest number of remunerative lamps. The effect of this on our supply is not altogether satisfactory. The small consumer who uses all his lamps regularly is a far better customer for us than the large householder, whose normal consumption bears an extremely small proportion to his maximum requirements. Once, twice, or three times in a year he will turn on all his lamps, and our machinery has to be prepared to meet this emergency, which may come at any time. It is also noticeable that this condition of affairs occurs mostly in the houses of those whose residence in London is of a limited and uncertain duration. We are therefore under the necessity of maintaining a certain portion of our machiney in reserve, which, under other conditions, might be more profitably employed. To show the great difference in the yield per lamp of our various classes of customers, I may state (as I feel that I cannot give you too much information on the subject) that restaurants and other establishments, whose business entails long burning hours, bring us sometimes as much as 30s. per lamp per year, whereas many private consumers only average about 2s. or even less In one or two extreme cases we only get a return of 4d. per lamp installed per annum. These are enormous differences, but I hope they will be rectified by-and-by in a way which will, I think, be perfectly fair between the Company and their customers. To meet these fluctuations and to benefit our good customers we have lately adopted a system of charging by sliding scale, which experience has shown to be well adapted for the purpose; but there is no doubt that the time is not far distant when an effort will have to be made to obtain a minimum return for every lamp which is connected to our mains. It must be understood that we do not keep our plant entirely idle to cope with possible maximum demands, which, of course, would never all arise at one and the same time. We have, therefore, the power of allowing an ample margin for taking on additional lamps, without any perceptible increase of working expenses, the cost (with the exception of a small additional amount of coal) having in any case to be incurred. Experience is teaching us how far we can safely increase our lamp connection beyond the number which our machinery is calculated to supply at one and the same time, and in the light of that experience we are able with confidence, to fill up our area more closely than was originally anticipated would have been possible with our present plant. With regard to the number of lamps connected, the diagram upon the wall will show you how regularly the increase has grown, and I may state that from the applications now in hand we have every hope that this steady demand will be maintained. We have a large number of applications, and they seem to keep steadily coming in. As far as I can see now, the position is this ; we have covered all our expenses, and we are in a position to pay a small dividend—a very small dividend, I am sorry to say—but a dividend that ought to improve every day. The question of street-lighting, to which I referred last year, is still in abeyance, but of course it is possible that we may be called upon by the local authorities to undertake this work. We have no intention, however, of entering into any contract for this purpose except at fairly remunerative terms. I may tell you that we declined to light the City on the terms that were offered, and we have no reason to regret having refused to take up that work. The new street which the London County Council propose to make from Holborn to the Strand would seriously affect our Sardinia-street station, and we have taken precautions to protect our interests in Parliament. I understand, however, that the London County Council do not intend this session to proceed with their Bill as far as this street is concerned. If that project had gone on and the County Council had taken our station, they must have taken it on such terms as would not have been a bad bargain for us ; but we should have had to find another site and provide another installation, and, therefore, for the moment, I am very much better pleased at their leaving us alone. Every day they leave us alone, judging from what I am putting before you to-day (which I am doing with the greatest confidence) we are becoming a more flourishing concern ; and, therefore, if they buy us two or three years hence, they must buy us at a bigger price than they would have to pay to-day. There is one matter to which I should like to refer, which is giving us great cause for anxiety, and that is the complaints which have arisen of vibration at one of our stations. I am unable to say very much on this subject, as an action is pending; but I may tell you that our engineer, acting with the approval of the best experts we have been able to consult, has devised a plan for putting an end to all possible ground of complaint, and we are sanguine that the result of the works now in progress will prove successful. Were I to explain to day what we are doing, it would probably not be as plain to you as I hope to be able to make it when I next address you. Our Paddington station, to which I have already referred, has recently been publicly inaugurated, and it has given great satisfaction by its regular and efficient working. I was present with several of the Directors at the opening of the station. We had with us the whole of the vestry, and I can only say that there were nothing but compliments paid us for the way the work was done, and the very satisfactory manner it is working. We are on very friendly relations with the vestry, and I think that that area, which is a very extensive one, possesses great possibilities for the future. In order to meet the payments due on account of this station and to provide for the mains laid up to the end of the year, it has been necessary to incur liabilities slightly in excess of our present capital. We have also further expenditure to provide for the mains that are yet to be laid, and it therefore becomes necessary for us to issue the remaining £50,000 debentures. We are anxious that the shareholders should again have the first opportunity of subscribing for the new issue, and a circular will therefore shortly be issued to you on the subject offering them to you *pro rata*. I can only say, as I have stated in the past, that I doubt if there is any better security to be found in London than the debentures of the Metropolitan Supply Company. I have put these remarks on paper with the greatest possible care. We desire that you should have the fullest possible information—all the information we possess. We think it creates a better feeling between shareholders and the Board if there is a perfect understanding and perfect confidence between them ; and I must now in a few further remarks give you some little further insight into our experience. I may tell you at once that electricity is comparatively in its infancy. We have experienced that in our telegraph system, but you know what an enormous area our telegraph system now covers, and what a great success it has been. When I and some of my friends sitting around me some years ago saw that electricity was "kicking about" very much in the City on paper, we thought that the time had come when we ought to establish a system of electric light that would be, at all events, honestly constructed and faithfully carried out. We took advantage of the very best information, and we have had no speculation in our system. We took up systems that had proved to be successful in producing the light and in giving a fair return on the investment. Since then we have been learning something, I may say, every day. When we first issued our prospectus we believed that we should get at least 25s., and probably more, per light. I believed that most confidently myself, and when Mr. Edison was over here and paid me a visit, he also believed it, and inspired me with the same conviction. We, however, said that we would take the modest figure of £1, but if we received £1 for every light we have upon our register to-day, I should be declaring to you a dividend of over 10 per cent. at the present time. That is with respect to the past. I believe the average of our lights to-day is not more than 10s. As I have told you, it goes from 4d. per annum up to 30s., but, as I stated, we hope to remedy this extreme fluctuation. We have now surmounted all our difficulties in knowing something of the cost. Having read, as I have done, all the reports and speeches that have been made in regard to electric lighting, I shall, I think, be prepared to show that we can produce the electric light as cheaply as, if not cheaper than, any of the other existing companies. You may on that naturally ask, Then why are you not paying a larger dividend ? The answer is that we have a much larger area to occupy. It will take us longer to fill it up, but when we have done so the case will be something like it was in the early days of gas—we shall be a growing and flourishing concern, and a much more extended concern than we should be if we occupied a very much smaller area, as is the case with some of the other concerns. In reading all these speeches, which I have carefully done, I have noticed that those who made them have pretty much the same idea as we have—that it is a matter of time. The electric light is likely to be the light of the future, and I think there are economies to be made which will go to the dividend side of the account. I have mentioned that we have laid 200 miles of mains. This means that we have drawn 200 miles of cable into conduits running under 85 miles of streets, at an average cost of £1,600 per street mile. We have laid a very large proportion, and provided for a very large increase in our lighting ; and, therefore, while we are not paying a large dividend to-day we are laying the foundations for paying a much larger dividend in the future. As I was coming into the room to-day I had a letter handed to me, in which the writer gave his ideas of the future of electricity. When we originally contemplated the formation of the Company we felt that electricity as a motive power was likely to be largely used. We still believe that that will take place, but we have had all our attention turned so far to introducing the light and completing our installations that we have not yet turned our attention in that way. The other day, however, I went to the opening of our station at Paddington, and found there Mr. Crompton, with all his beautiful appliances for cooking, using electricity for the purpose, and it was one of the prettiest things I have seen for a long time. This must take a very great hold not only in large but in small houses, and with our extended area I think we are likely to utilise our power for this purpose, and to utilise it at a time when it is not so much used for illumination, for all the motive power and a great deal of the cooking will be in the day time, whereas the electric light is used at night. I merely mention this, however, now. Promises and prophesies are not much until they are realised ; but, looking as I have done on many occasions, into the subject and studying the progress of electricity, and seeing the enormous changes that are taking place in our telegraph system, I think I am justified in calling your attention to these subjects as I am doing. We are now carrying four messages over a line at the same time—in other words, quadrupling the value of land lines and doubling the value of submarine lines. That has all been done in the past few years, and I think that similar changes will take place in our system. I think that those who are now shareholders in the Company, if they will hold on and be satisfied with a growing dividend, will find that they have not only one of the safest but also one of the most encouraging and steadily increasing investments existing at the present moment. We have recently received a letter from a customer who writes that he has carefully considered in connection with cooking the cost of electricity as against the cost of gas, and he says that electricity costs him only 25 per cent. more than gas. If electricity can be produced on a very large scale, and at a cost only 25 per cent. more than gas, I think that most people will go in for electricity. This gentleman adds that he has an electric silver grill, upon which he has his rumpsteaks done, and he finds them much nicer and more juicy than those done by the old frying pan. There is one feature about the electric light on which I will give you just an illustration in my own case. I have the electric light ; I do not get it from this Company, but from the Westminster Company—that is to say, I get it from the com-

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pany that can supply me, and very well they do it. It is a beautiful light, and everything about it is very nice, but the difficulty, so far as the use of it is concerned, is to get the servants to believe that they ought to turn it off when it is not wanted. I have sometimes to take a turn round my house to see that this is done. I never leave my own room without turning off the light. The time was when the gas was allowed to burn in the same way, and to spoil the atmosphere in the house; but all that is now removed, and your lungs, your pictures, and your other property are immensely benefited by the use of the electric light. I am afraid I am detaining you, but I am very anxious that you should have as much information as I can give to you. We see now, in looking into our accounts, many ways whereby economies will be effected. We Directors have set the example by reducing our own honorarium by 25 per cent., but we do not want you to understand that cheap Directors are the best Directors, because men who can occupy the position that I am occupying to-day are not going to throw away their time and waste their lives merely for the purpose of being either abused or complimented by gentlemen who think that we ought to work for nothing. We shall work well for you; if we do not, turn us out. If, however, we work well and give you a decent dividend, and establish a strong and sound Company, we are entitled to be fairly considered. As I have said, in this respect we have set an example. We have also been anxious to introduce the very best element of work on to our Board. After careful thought we asked my friend, Sir Eyre Shaw, to join the Board. He has had great experience throughout London in connection with the Fire Brigade, which he brought to a state of perfection which probably no other country has been able to show in connection with such a matter. We offered him a seat at our Board, which he accepted after going round and examining the whole of our stations for himself. He can tell very well whether they are right or wrong in a few minutes with his experience. There is another matter which I must mention. In the midst of brightness there are dark shadows sometimes. We have had names associated with us which are not now occupying a very high position, and which have lately been mentioned, and not favourably, in the courts of law. When we first took up this concern we took over an installation called Whitehall Station. That was owned by a combination in which Mr. Jabez Balfour, Mr. Wright, Mr. Hobbs, and others were concerned in connection with the building of that immense place called Whitehall Court. On paper it looked an uncommonly satisfactory venture, and it must eventually be satisfactory to us when the whole of that place is lighted; but, unfornately, they thought that the place was to be filled up in a day, and many of us probably thought the same, but the result was that the light was not taken up to the extent that was imagined. We took this place over at a valuation which was made by Sir Frederick Bramwell and Sir Whittaker Ellis, and what we got was good value. Two of the gentlemen I have mentioned attended our Board for a short time, but only for a very short time, their attention being all the while taken up in other directions. At the time I am speaking of, Mr. Balfour was a very popular member of Parliament, and was very much employed by the Radical section of the Liberals in going about the country and making speeches. He was before the public very much, and was known as a public man, and I must admit that I did not inquire much beyond this. As a prominent Radical member, when the present Government was formed, I believe that Mr. Balfour applied for Cabinet rank. That was the idea of the man in the public mind at that particular time. Some people have told me that they knew better, but I did not. I saw him as a public man, and knew him as a member of Parliament, and I thought he was what you would call one of those men who was making honourable mark for himself. I have been mistaken, but I may tell you that when these two gentlemen were with us they had no special influence with us, and we have suffered nothing in any shape or form by them, while we are as clear of them to-day as is this sheet of paper. It is rather a painful thing for me to make this statement, but I thought it only right to you to do so. I only speak of these men as I knew them; I do not speak of them as they have since placed themselves before the pubiic. I think I have now pretty well exhausted all the subjects which I have to bring before you excepting one. We received a letter in reference to the accounts from a gentleman the other day—a Mr. Bolton. That gentleman went to the office of the Company, and every gentleman who chooses to go there will get every possible information that he can wish for, with certain exceptions. There are certain details which, if mentioned and given away in writing, would not be politic or just to the shareholders generally. Mr. Bolton called and asked whether the questions which he asked could be answered, to obviate the necessity for him to take up the time of the general meeting. We have no secrets; we will give every shareholder the fullest information which he is properly entitled to. I therefore instructed the secretary to write the following letter to him, and I think you will agree with me that it was a proper letter:—"Referring to your interview with me this morning, when you asked me to see the Chairman respecting your letter of the 17th inst., I am directed by Sir John Pender to say that he would prefer replying to the questions you ask in your letter at the general meeting, where all the shareholders will have an opportunity of hearing him. If you will, therefore, kindly attend the meeting to-morrow and put these questions, a full reply shall be made to them." The letter, I think, you will approve of. I do not say that it was so, but I thought that his remarks to the secretary implied his opinion that there was something wrong in connection with his questions, and that we were afraid to answer them. It seemed to be a kind of threat, and I will not occupy this position, and be threatened by any shareholder in this or any other place, although I will endeavour to satisfy every shareholder. I wished to state this to you, and to assure you that we stand before you to-day entirely free from any question in connection with the preparation of our accounts. Years ago, when I took a prominent part in establishing the telegraph system, I laid down the rule that our accounts were to be kept by a chartered accountant. All our accounts are in the hands of Messrs. Deloitte, Dever, Griffiths, and Co., and Mr. Griffiths is present to-day. They look after these accounts from month to month, and when the proper time comes they bring the accounts before the Directors. The Directors do not place the accounts before them. Probably Mr. Bolton is present, and if he wants to put any questions we shall be very glad to answer them.

Mr. BOLTON regretted that the Chairman had thought it necessary to say that an apparent threat had been made. All that he had asked was whether the secretary would be good enough to tell him how the item in the accounts of £4,787 was made up. The secretary, however, stated that he could not give the information without the authority of the Board.

The CHAIRMAN: Did you not ask to see the cash book?

Mr. BOLTON: Yes, under a misapprehension.

The CHAIRMAN replied that they had no intention of withholding information. He thought there was not much between them after all. He (the Chairman), however, preferred that the questions should be answered by Mr. Griffiths, whose firm had to pass the items.

Mr. GRIFFITHS said he had much pleasure in giving the information regarding the question of Mr. Bolton as to how the £4,787 was made up. Directors' fees, including that of the Managing Director, was £2,274; head office salaries, £953; printing and stationery, £246; postage and telegrams, £52; travelling expenses, £90; head office expenses, £52; office rent, rates, and taxes, £598; insurance and general expenses, including the debenture stamps, expenses of the Electrical Association and other things, £521.

The CHAIRMAN: Is there any other question?

Mr. BOLTON: I am perfectly satisfied with the answer of the auditor.

A brief discussion ensued, after which the report and accounts were adopted. The retiring Directors and auditors were re-elected, and a cordial vote of thanks to the Chairman and Directors brought the meeting to a close.

West Coast of America Telegraph Company (Limited).

The following report of the Directors of this Company will be presented to the shareholders at the meeting to be held at Winchester House, E.C., on Tuesday, May 2nd, at one o'clock:—

Pending the construction of the land line between Buenos Ayres and Valparaiso—which is being pushed forward as speedily as possible by the Pacific and European Telegraph Company (Limited)—no improvement in the traffic receipts was to be expected, the business of the Company being meanwhile virtually restricted to local messages. The completion of the new line will, however, re-open a direct service between the Company's stations and Europe, *vid* Lisbon, and thus enable the Company once more to handle European traffic at all its stations.

The gross income for the year 1892, as shown in the accounts annexed to the report, was £22,218. 16s. 9d., against £35,624. 16s. 5d in 1891, and in order to continue meeting the debenture coupons with regularity, it was necessary this year to take £10,287. 8s. 2d. from the reserve. The receipts include the sum of £4,782. 13s. 6d. from the Chilian Government in settlement of the Company's claim for damage to the cables during the revolution in 1891. The total expenses were £21,919. 14s. 8d., against £24,406. 19s. 7d. in 1891, showing that a real economy has been effected under this heading.

A concession has been obtained from the Chilian Government for an extension of the Company's cable to Talcahuano, with a land line to the city of Concepcion. The rising importance of this city, which is the centre of trade for the south of Chile, holds out a prospect of a considerable increase of traffic, both locally and by means of the new line to the east coast and Europe. The new cable was shipped for Talcahuano in February.

Mr. J. Denison Pender and Mr. Frederick Walters are the Directors retiring by rotation; both are eligible, and offer themselves for re-election. The auditor, Mr. John Francis Clarke, also retires, and is eligible for re-election.

Submarine Cables Trust.

The following report of the Trustees will be presented at the twenty-second ordinary annual meeting of the certificate holders, to be held at the offices of the Trust, 50, Old Broad-street, E.C., on Thursday, May 4th, at 12:45 p.m.

The revenue for the financial year to April 15, 1893, including the balance of £159. 13s. 3d. brought forward, amounted to £23,261. 13s. 11d. During the past year the following coupons have been met:—

Due.	Paid.
April 15, 1892	£1. 17s. 6d. balance August 2, 1892.
October 15, 1892	£1. 10s. on account October 15, 1892. £1. 10s. balance February 7, 1893.
April 15, 1893	£1. 10s. payable April 15, 1893.

The expenses of the Trust amounted to £1,627. 13s. 2d., and the payments on account of the coupons to £21,553. 17s. 6d., together £23,181. 10s. 8d., leaving a balance of £80. 5s. 3d. to be carried forward.

The table showing the original and present investments of the Trust, which accompanies the Trustees' report, remains unchanged from last year.

It is with regret the Trustees have to record the death of their secretary, Mr. William Payton. They have appointed as his successor Mr. A. Brodrick. The meeting will have to elect two auditors for the current year, and Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election.

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Brazilian Submarine Telegraph Company (Limited).

The following is the report of the Directors for the half-year ended December 31, 1892, to be submitted to the thirty-ninth ordinary general to be held at Winchester House, Old Broad-street, E.C., on May 3rd, at 12 noon :—

The revenue for the half-year ended December 31, 1892, amounted to £113,891. 15s. 8d., and the working expenses to £24,536. 6s. 6d. After providing £12,880 for debenture interest and sinking funds, and £1,547. 19s. 6d. for income tax, there remains a balance of £74,927. 9s. 8d.; to this is added £3,073. 8s. 5d. brought forward from June 30th last, making a total of £78,000. 18s. 1d. First and second interim dividends amounting to £39,000 have been paid and £35,000 transferred to the reserve fund, leaving the sum of £4,000. 18s. 1d. to be carried to the next account. The receipts for the half-year include the sum of £1,500 dividend to June 30, 1892, on the Company's shares in the African Direct Telegraph Company (Limited).

In accordance with the provisions for repayment of the first issue of debentures, dated July 31, 1884, 177 bonds, representing £17,700, were drawn on the 17th inst., for payment at par on July 31st next. This, with the previous drawings, will make a total repayment of £131,300, leaving £18,700 of the first issue of debentures outstanding.

In view of existing competition, the Directors have found it advisable to make a further reduction in the rates to and from South America.

During the last six months, several repairs have been successfully carried out; but, in consequence of the duplication of the Company's cables, the traffic was not interrupted. Arrangements have been made whereby the duplex system referred to in the report for the general meeting of May 4, 1892, can now be applied to either of the Company's cables. The land line from Buenos Ayres to Valparaiso to connect the west coast of America cable with the east coast cables, referred to by the Chairman at the general meeting held October 19th last, is being erected with all possible speed, and the Directors anticipate the line will be opened for traffic in about three months.

The principle of establishing staff pension and superannuation funds has been carefully considered by your Directors, who have had the details worked out by experienced actuaries, and a scheme will be submitted to the meeting for dealing with the matter, together with a formal resolution empowering the Directors to carry out the necessary arrangements.

The various sections of the Company's line are in good working order.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

BAILY AND GRUNDY, LONDON (LIMITED).—This Company was registered on April 24, 1893, with a capital of £10,000 in £10 shares, to take over the business now carried on by Robert M. Baily, at Amberley Works, London, W., and to carry on the business of electricians, mechanical and electrical engineers and contractors, suppliers of electricity, workers and dealers in electricity, and manufacturers of and dealers in all and any apparatus and things connected with the generation, accumulation, supply, distribution, and employment of electricity. The subscribers are :—

	Shares.
Robert M. Baily, Amberley Works, Paddington, W., engineer	1
Alfred Grundy, 32, Brassey-square, S.W., electrician	1
Edward Nathan, 168, Alexandra-road, London	1
George A. Knight, 4, Donaldson-road, Kilburn, N.W., engineer	1
Chas. S. Winbush, 72, Oakhurst-grove, East Dulwich	1
Fredk. A. A. Simons, Nilgiri House, Camberwell, engineer	1
Sydney B. Tatham, 16, Davies-street, Berkeley-square, W., electrical engineer	1

MERVEILLEUSE ELECTRIC ARC LAMP SYNDICATE (LIMITED).—This Company was registered on April 24, 1893, with a capital of £15,000, in £1 shares, to adopt an agreement made between Emilio Zuccani and Alfred Conder for the purchase of the patent rights of the "Merveilleuse Electric arc lamp" for the United Kingdom and Ireland, and to carry on in Great Britain and Ireland the business of electricians, electrical and mechanical engineers, contractors, and manufacturers of and dealers in electric arc lamps and other electric appliances.

PNEUMATIC WHEEL COMPANY (LIMITED).—Capital, £85,000 in £1 shares. Included among the objects of this Company is that of carrying on the business of mechanical and electrical engineers, india-rubber manufacturers and merchants, &c., and also of adopting an agreement to be made between George Philip (on behalf of this Company) and the Electrical Power Storage Company (Limited).

R. BOLTON AND CO. (LIMITED).—This Company was registered on April 22, 1893, with a capital of £12,000 in £5 shares, to enter into and carry into effect an agreement to be made between Reginald Bolton, A.M.I.C.E., and Herbert Coward (on behalf of the Company), for the acquisition of the business of engineer and engineering merchant, carried on by the said Reginald Bolton, at 110, Leadenhall-street, London, E.C.

ELECTRIC AND GENERAL CONTRACT CORPORATION (LIMITED).—The statutory return made up to March 31st has been filed. The nominal capital is £50,000, divided into 9,000 preference and 1,000 deferred shares of £5 each. The Company recently acquired the business of a contractor for electrical undertakings carried on by Mr. W. S. Graff Baker, at 35, Parliament-street, Westminster, S.W., including his rights in connection with electric tramways at Leeds, Coventry, and elsewhere. At the time of making up 805 preference and 1,000 deferred shares were taken up, and 799 deferred shares issued as fully paid. Upon the remaining 805 preference and 201 deferred shares, the full amounts have been called and £5,030 paid.

EDISON-BELL PHONOGRAPH CORPORATION (LIMITED).—The statutory return made up to April 6th has been filed. The nominal capital is £60,000 in £5 shares. At the time of making up all the shares had been taken up.

EDISON-GOWER-BELL TELEPHONE COMPANY OF EUROPE (LTD.).—The annual return was made up to and filed on April 14th, when 385,009 shares out of a total nominal capital of £500,000 in £1 shares were taken up; 370,000 of these were issued as fully paid, while the full amount has been called and paid on the remaining 15,009 shares.

ELIESON ACCUMULATOR (BRITISH PATENT) SYNDICATE (LIMITED).—The annual return made up to March 2nd has been filed. Out of a nominal capital of £12,000, in £1 shares, 2,007 shares have been taken up, and a call of 10s. per share made. The calls paid amount to £103. 10s., while those unpaid amount to no less than £900.

ELECTRICAL ADVERTISING SYNDICATE (LIMITED).—The annual return, made up to December 29th last, has been filed. 907 shares of £10 each, out of a capital of £10,000, have been taken up, the full amount called, and all calls (£9,070) paid.

ELECTRICAL PURIFICATION ASSOCIATION (LIMITED).—The annual return, made up to December 31st last, has been filed. 18,326 shares out of a nominal capital of £25,000 in £1 shares have been taken up, of which 5,000 have been issued as fully paid. Upon the remaining 13,326 shares the full amounts have been called, resulting in the payment of £13,226, and leaving £100 in arrears.

FAREHAM ELECTRIC LIGHT COMPANY (LIMITED).—The annual return, made up to March 30th, has been filed. The nominal capital is £5,000, in £1 shares, of which 4,158 have been taken up. Upon these the full amount has been called.

ELECTRICITY SUPPLY COMPANY FOR SPAIN (LIMITED).—The annual return, made up to January 12th, has been filed. The nominal capital of £100,000, divided into 19,900 ordinary and 100 founders' shares of £5 each, has been taken up, of which the founders' shares were issued as fully paid to Robert Hammond for registration and promotion expenses. Upon the 19,900 ordinary shares the full amount has been called and paid.

HASTINGS AND ST. LEONARD'S-ON-SEA ELECTRIC LIGHT COMPANY (LIMITED).—The annual return, made up to April 21st, has been filed. Out of a nominal capital of £50,000, in £10 shares, 1,667 shares have been taken up, the full amount per share called and paid.

WOODHOUSE AND RAWSON UNITED (LIMITED).—A petition was presented on April 25th by Mr. C. E. Challis for the compulsory winding up of this Company, and is down for hearing at the Royal Courts of Justice, London, on May 17th.

CITY NOTES, &c.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—Notice is given that the second drawing for payment of the Four per Cent. Mortgage Debentures of this Company, 106 in number, will take place on Monday, May 8th, at noon, at the offices of the Company, Winchester House, Old Broad-street, E.C.

CALLS DUE.—*May 5:* PRINTING, TELEGRAPH AND CONSTRUCTION COMPANY OF THE AGENCE HAVAS (LIMITED), £1 on 19,900 £5 shares. *May 15:* CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED), final £2 on 20,000 Accumulative Six per Cent. £10 preference shares; and ELECTRIC CONSTRUCTION CORPORATION (LIMITED), final £3 on 10,000 Six per Cent. Second Mortgage Debenture Bonds of £10.

CENTRAL AND SOUTH AMERICAN TELEGRAPH COMPANY.—The Board has declared a quarterly dividend of 1¾ per cent., after which there is a surplus of $51,772. This Company recently entered into a contract with the Government of Guatemala for a cable communication with that Republic, which it is expected will be completed in July. Guatemala will give a subsidy of $150,000 in gold to the new cable.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended April 23rd were £851, as against £807 for the corresponding period of last year, being an increase of £44. The total receipts for the half-year amount to £14,568 against £13,302 in the corresponding period of 1892, being an increase of £1,266.

MEXICAN TELEGRAPH COMPANY.—The Directors have declared a quarterly dividend of 2½ per cent., and report a surplus of $338,655 after the payment of dividend.

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ST. JAMES'S AND PALL-MALL ELECTRIC LIGHT COMPANY (LIMITED).—It is notified that the electric current sold for the quarter ended March 25th last amounted to £10,119, as against £10,024 for the quarter ended March, 1892, a period of six days more.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended April 21, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,937.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Apr. 19.	Price Wednesday, Apr. 26.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Apr. 26. Highest	Lowest.
			TELEGRAPHS			£ s. d.			
£1,247,720	Stock	12/6	Anglo-American	52 53	52½ 53½	5 2 10	Jan , Apr., July, Oct.	52⅜	52¼
£2,876,140	Stock	25/0	Do. Preferred	93 94	93 94	5 18 3	" "	93	92¼
£2,876,140	Stock	5/0	Do. Deferred	12½ 13	12¾ 13¼	..	" "	2⅞	12⅜
£250,000	100	4%	African Direct, Telegraph 4% Debentures	101 104	101 104	3 16 11	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11¼ 12¼	11¾ 12¼	5 6 1	Mar., June, Oct., Dec.	12¼	12⅛
£68,200	£100	5%	Do. 5 per Cent. Bonds	100 103	100 103	4 17 1	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	105 109	106 110	4 10 11	June and December	..	..
$7,716,000	$100	$1¾	Commercial Cable Capital Stock	165 170	140 150	4 13 4	April and October..	..	..
16,000	10	8/0	Cuba Submarine	11½ 12½	11½ 12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10%	18½ 19½	18½ 19½	5 2 7	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½ 3½	2½ 3½	4 11 5	April and October...	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	" "	..	..
60,710	20	3/6	Direct United States	11½ 12	11⅜ 12	5 13 8	Jan., Apr., July, Oct.	11⅜	11⅜
400,000	10	2/6	Eastern	15 15½	15⅜ 15⅝	4 4 6	" "	16¼	15⅞
70,000	10	6%	Do. 6 per Cent. Preference	16½ 16¾	16¼ 16¾	3 11 8	" "	16⅜	16¼
£1,294,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114 117	114 117	3 8 5	May and November	115¼	..
£105,900	100	5%	Do. 5 per Cent. Debentures 1899	107 110	107 110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15½ 15¾	15⅝ 15⅞	4 8 2	Jan., Apr., July, Oct.	15⅞	15⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112 115	113 116	3 9 0	February & August	115½	115
£78,800	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103 106	104 107	4 13 6	January and July ..	—	
£135,000	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102 105	103 106	4 14 4	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101 104	101 104	3 16 11	February & August	101¾	..
180,227	10	2/3	Globe Telegraph and Trust	9¾ 10	9¾ 10	4 12 6	Jan., Apr., July, Oct.	10	9⅞
180,042	10	6%	Do. 6 per Cent. Preference	15⅝ 15⅝	15⅝ 15⅝	3 16 10	" "	15⅝	15½
150,000	10	5/0	Great Northern	19¼ 19¾	19¼ 19¾	4 6 1	Jan., April, and July	19⅞	19⅝
£220,000	100	5%	Do. 5 per Cent. Debentures, 1883	105 108	105 108	4 12 7	March & September	106	..
17,000	25	12/6	Iado-European	43 46	43 46	5 8 8	May and November	45¼	44⅜
38,348	10	4/0	London Platino-Brazilian	4 6	4 6	6 13 4	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	106 109	106 109	5 10 1	March & September	..	..
10,802	8	4/0	Reuter's	7 8	7 8	..	April and October...	..	..
3,381	£100 Cert.	30/0	Submarine Cables Trust 6%	120 125	120 125	4 16 0	" "	121	..
15,609	10	5/0	West African Telegraph	5½ 6½	5½ 6½	7 13 10	January and July ..	..	..
£271,400	100	5%	Do. 5 per Cent. Debentures	100 103	100 103	4 17 1	March & September	102	..
30,000	10	2/0	West Coast of America	2 3	2 3	..	January and July ..	..	..
£150,000	100	8%	Do. Debentures 8% 1902	105 109	100 104	7 13 10	June and December	..	..
88,321	10	6d.	West India and Panama	1⅝ 1⅞	1½ 1⅝	..	" "	1 1/16	1⅝
34,563	10	6%	Do. 6 per Cent. 1st Preference	11½ 12	11⅝ 12¼	4 18 0	May and November	12	11⅞
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9½ 10½	9½ 10½	5 14 3	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	108 111	108 111	4 10 1	June and December	110½	109¼
64,242	15	3/0	Western and Brazilian	7⅜ 8⅛	7¾ 8¼	5 9 1	May and November	8 1/16	7⅞
33,129	7½	3/0	Do 5 per Cent. Cumulative Preferred	5⅝ 6¼	6 6½	5 15 7	" "	6¼	5 13/16
33,129	7½	4/6	Do. 5 per Cent. Deferred	1⅜ 2¼	1¾ 2¼	..	" "	1 13/16	—
£189,700	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	106 109	106 109	5 10 1	February & August	..	..
£237,200	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	106 109	106 109	5 10 1	" "	..	..
$1,336,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	120 125	5 12 0	May and November	..	..
£173,100	£100	6%	Do 6 per Cent. Sterling Bonds	101 104	101 104	5 15 5	March & September	..	..
			TELEPHONES.						
40,000	£5	10/0	Chili Telephone (fully paid) .....xd and rights	3 4	3 4	..	..	—	—
22,860	14/0	1½d.	Consolidated Telephone Const. & Maintenance	¼ ⅜	1 1/16 1 1/16	..	May and November	¼	..
220,000	£1	4⅜d.	Oriental (11s. paid)	⅜ ⅜	⅜ ⅜	7 18 2	Yearly	..	..
454,747	5	2/6	National	5¼ 5½	5⅛ 5⅜	5 11 7	June and December	5 1/16	5¼
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15 15½	15 15½	3 17 6	" "	15½	15 1/16
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14½ 15	14½ 15	4 0 0	" "	14⅝	14⅜
90,950	5	6⅜d.	Do. 5% Non-Cumulative 3rd Pref. (£3 paid)	5½ 5⅝	5½ 5⅝	..	..	5⅝	5⅜
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully pd.)	113 116	113 116	3 17 7	January and July	115	114⅛
48,000	£10	..	New Telephone, Limited (£4 paid)	.. ..	.. ..	..	..	..	..
58,000	5	1/0	United River Plate	2 3	2 3	..	January and July ..	..	..
	Stock	5%	Do. 5 per Cent. Debenture Stock	90 100	90 100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.						
30,152	£10	..	City of London Electric Lighting (fully paid)	12¼ 12¾	12¼ 12¾	..	—	12⅝	12½
20,000	£10	..	Do. 6 per Cent. Preference (£4 paid)	10½ 11	10½ 11	..	—	11	10⅝
19,900	£5	..	Electricity Supply Co. of Spain	.. ..	.. ..	..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	.. ..	.. ..	..	—	—	—
£47,900	£100	5%	Do. 5 per Cent. Debentures, 1900	.. ..	.. ..	..	—	—	—
8,332	£5	..	House to House Electric	.. ..	.. ..	..	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully pd.)	.. ..	.. ..	..	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	.. ..	.. ..	..	January and July ..	..	—
30,000	£5	3/4 92	Liverpool Electric Supply (£3 10s. paid)	4¼ 4⅜	4¼ 4⅜	..	..	..	—
10,000	£5	5/0 '92	Do. (fully paid)	6 6¼	6 6¼	..	..	..	—
111,000	5	..	London Electric Supply	1 1⅛	1 1⅛	..	—	..	..
43,900	£10	2/0	Metropolitan Electric Supply (fully paid)	7⅛ 7⅜	6⅞ 7	..	—	7⅛	6¾
£50,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	102 105	102 105	4 15 3	June and December	..	..
36,318	10	..	Notting Hill Electric Lighting (fully paid)	5⅛ 6⅜	5 6	..	—	5 5/16	5
18,680	£5	9½%	St. James' and Pall Mall	7⅝ 8⅛	7⅜ 8⅛	..	—	8⅛	7⅞
7,900	£5	7%	Do. 7% Preference	8 8½	7⅜ 8¼	4 4 10	—	8¼	8⅛
42,853	5	2/0	Westminster Electric Supply (fully paid)	5½ 6	5½ 6	2 18 4	—	5⅝	5 5/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
77,978	3	1/6	Brush Electrical Engineering	3⅛ 3⅜	3¼ 3½	..	—	3 7/16	3 5/16
69,996	2	6%	Do. 6 per Cent. Preference	2¼ 2⅜	2¼ 2⅜	4 6 0	—	2⅜	2 5/16
£125,000	Stock	4⅓%	Do. 4½ per Cent. Debentures	106 108	109 111	4 3 4	..	110	107
20,000	5	3/6	Crompton and Co., 7 per Cent. Pref. Shares	5¼ 5⅜	5¼ 5⅜	6 1 9	January and July	5 1/16	5¼
12,139	5	..	Edison and Swan United	.. ..	.. ..	..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	.. ..	.. ..	..	—	..	..
45,000	10	12/0	Electric Construction	2 3/16 3 5/16	2 3/16 3 5/16	..	—	..	..
70,000	2	10/0	Elmore's Patent Copper Depositing	.. ..	.. ..	..	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	1 2	1 2	..	—	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	22 23	22 23	5 8 8	February & August	22¾	22½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102 104	102 104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Limited Ordinary	2½ 3½	2½ 3½	..	..	..	..
11,334	£10	8/0	Do. Preference	6 7	6 7	..	December and June	..	..
£20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	5/0 6/0	5/0 6/0	..	..	..	..
78,949	5	4/2½	Swan United (£3. 10s. paid)	3 3½	3 3¼	10 0 0	May and November	3½	3 3/16
37,350	12	24/0	Telegraph Construction and Maintenance	31 34	29 32	5 12 6	March and July	32½	29
150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	January and July	..	..
..	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	.. ..	.. ..	..	—	—	—
..	£5	..	Do. Preference (fully paid)	.. ..	.. ..	—	—	—	—
			RAILWAYS AND TRAMWAYS.						
63,000	£10	..	City and South London Railway	.. ..	.. ..	..	—	..	..
600,000	Stock	5%	Do. Stock	37 39	37 39	2 17 8	May and November	37½	..

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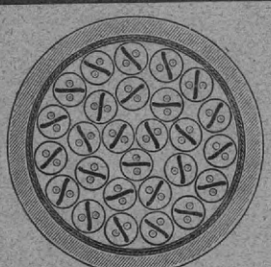

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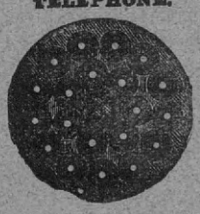

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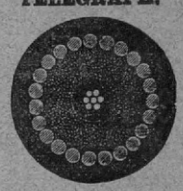

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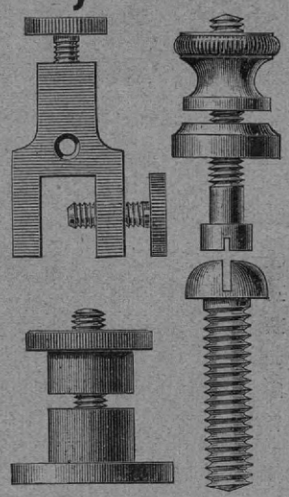

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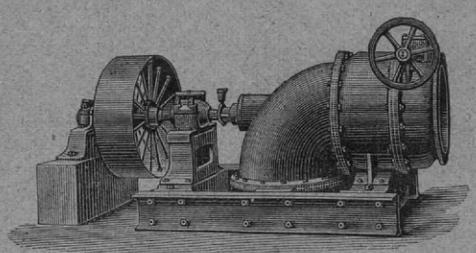

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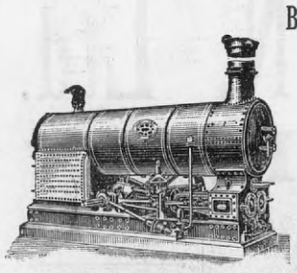

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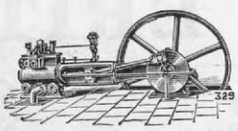

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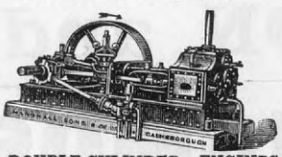
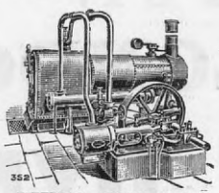


DOUBLE-CYLINDER ENGINES, High Pressure or Compound.



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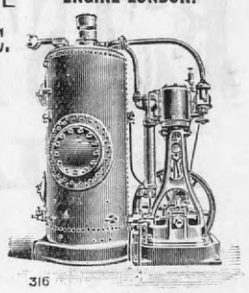

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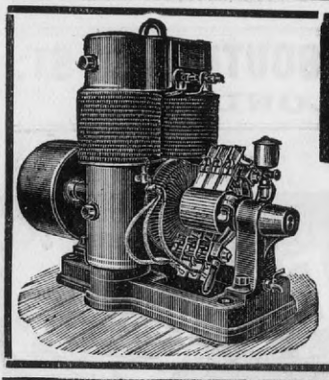

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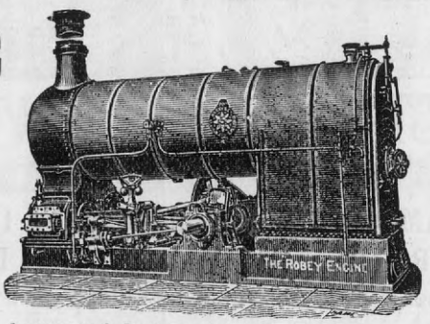

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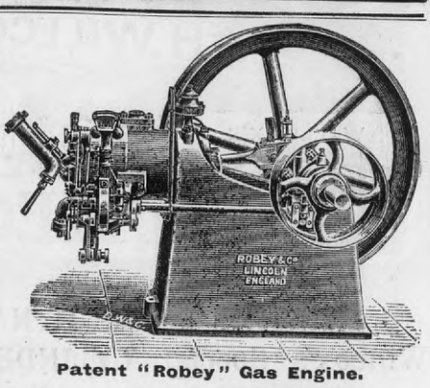

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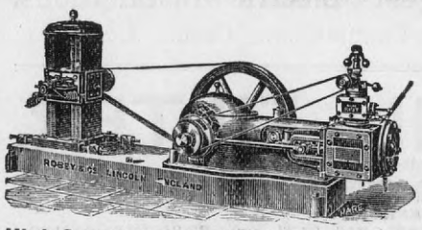

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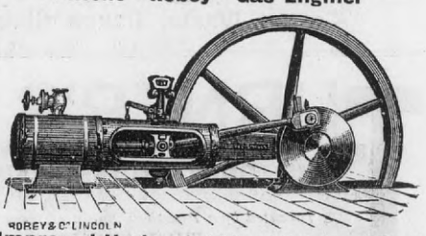

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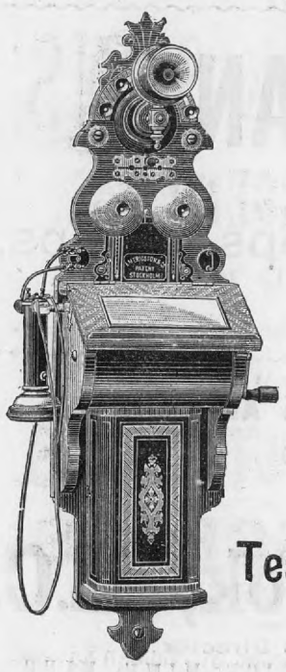

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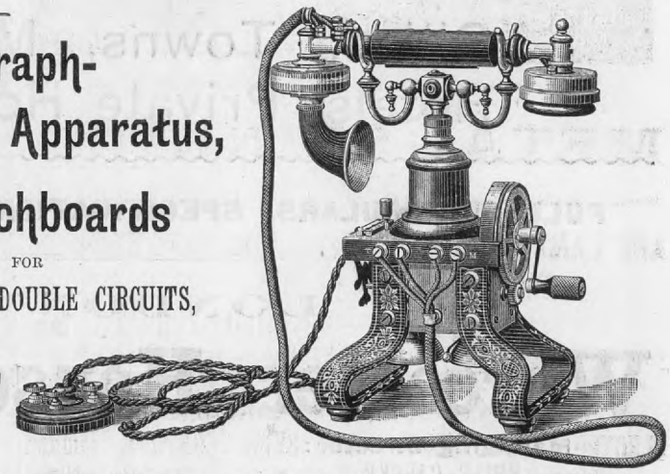

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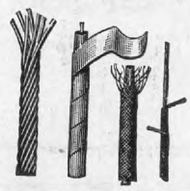

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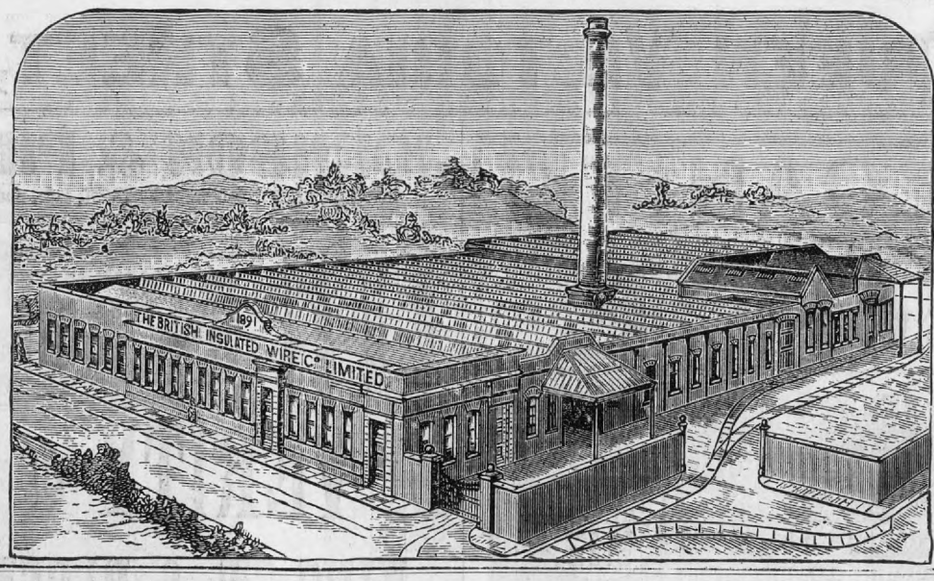

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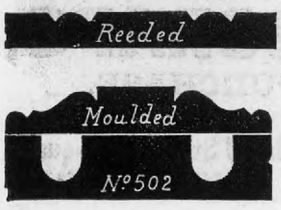

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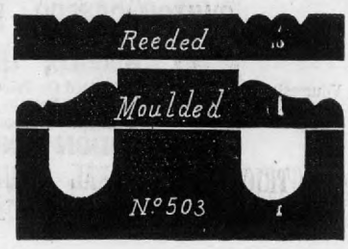

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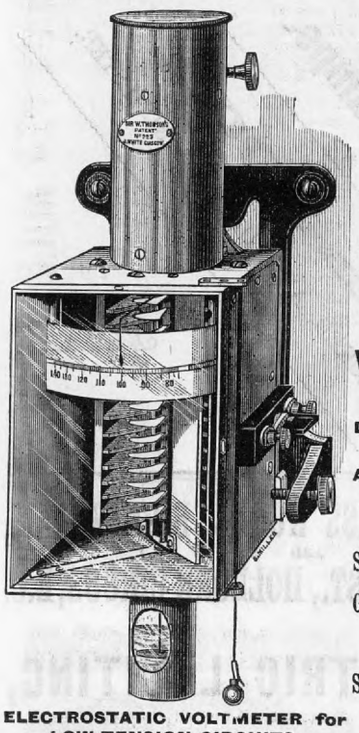

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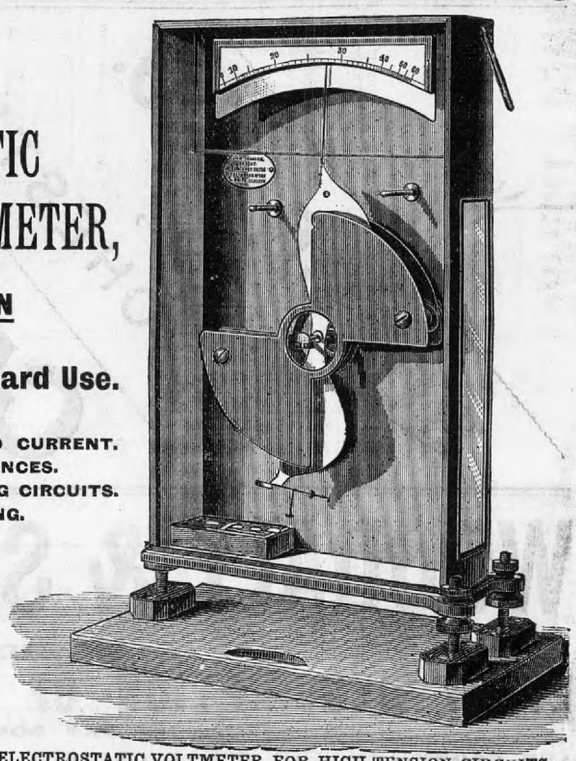

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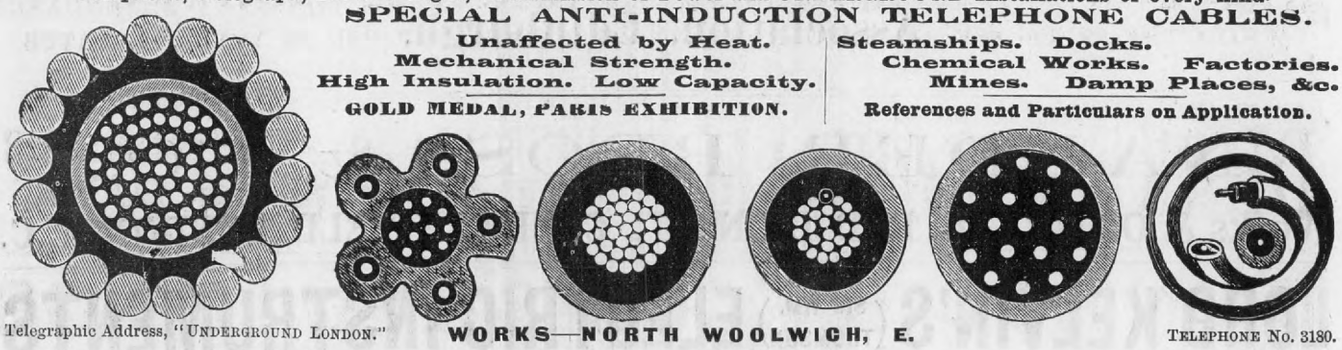

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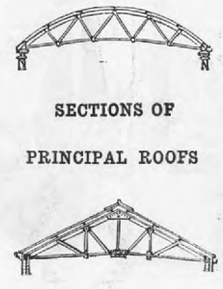

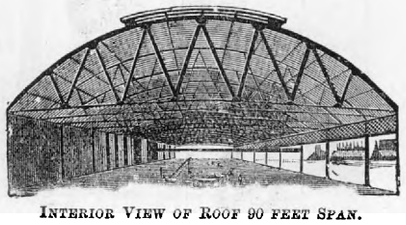

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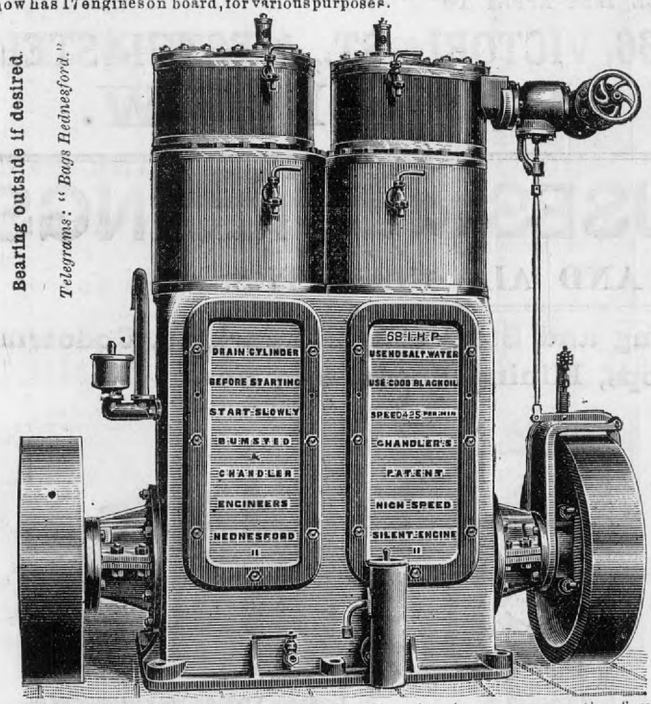

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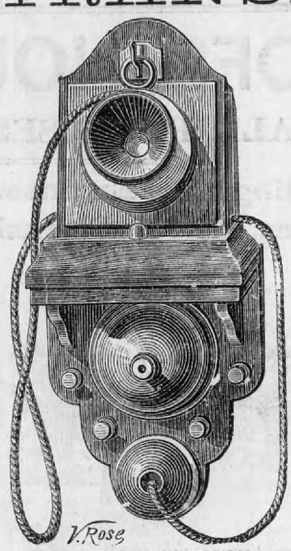

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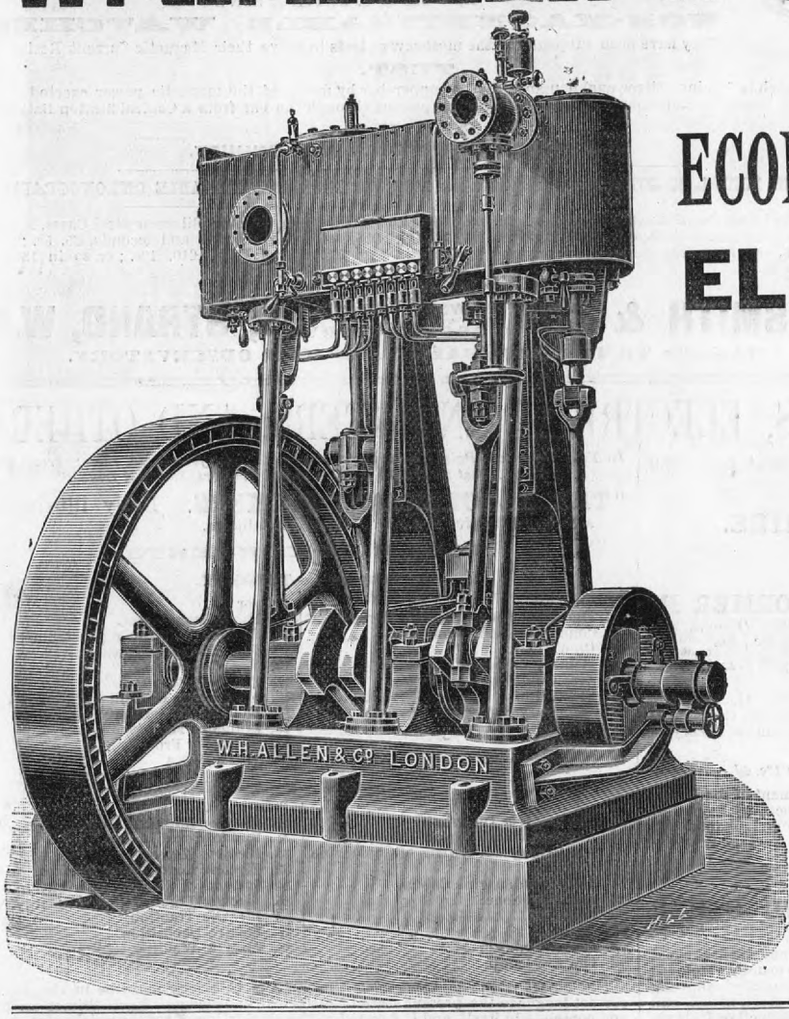

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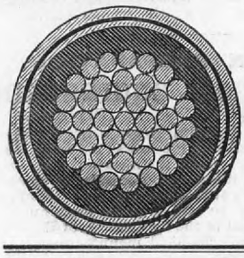

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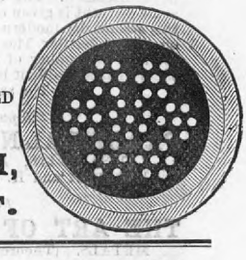

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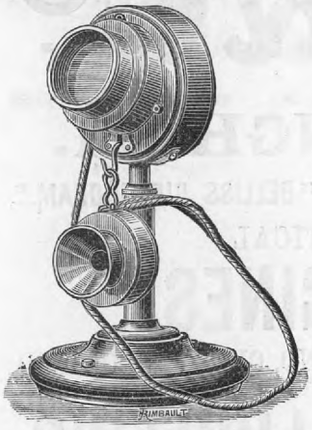

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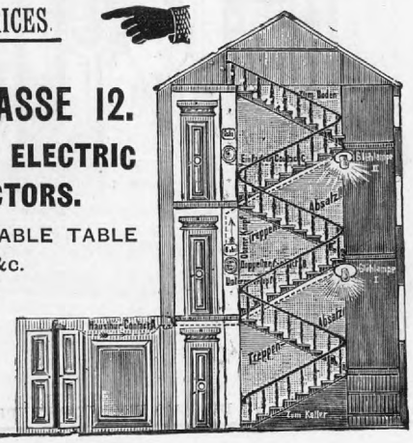

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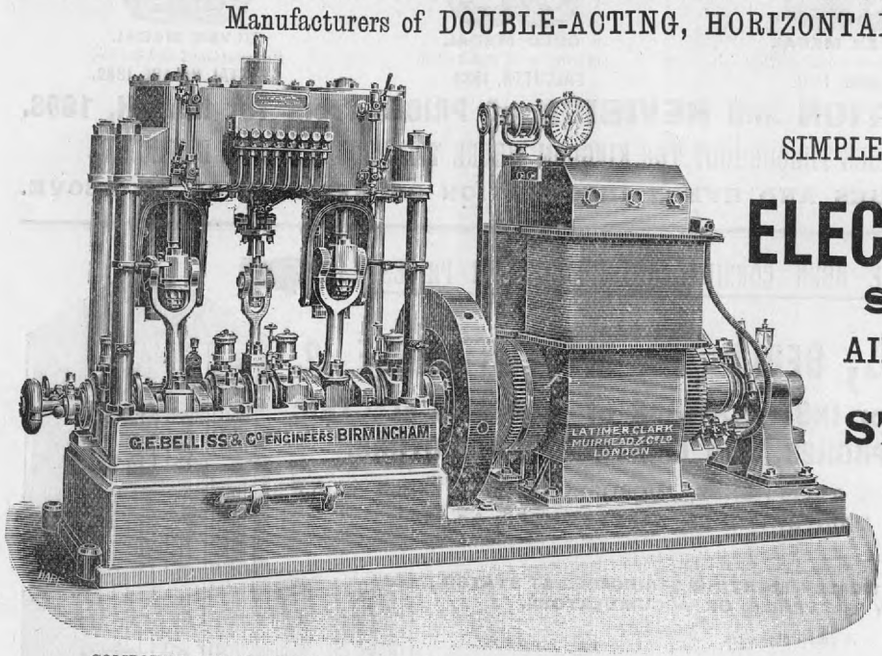

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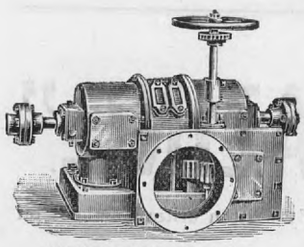

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Capital Paid up	£366,702 0 0
Fire and other Reserve Funds, including Balance of Profit and Loss	2,981,078 0 0
Life and Annuity Funds	4,546,577 0 0
Total Invested Funds, 31st December, 1891	£7,894,357 0 0

INCOME FOR THE YEAR £2,230,635

The following Comparative Statement shows the progress of the Company :—

1881	... Life Funds	£2,737,858	... Total Funds	£4,673,299
1886	... „	3,257,609	... „	5,672,041
1891	... „	**4,546,577**	... „	**7,894,357**

INCREASE OF FUNDS IN TEN YEARS, £3,221,058.

EXTRACT FROM AUDITORS' REPORT.

"We have examined all the Securities held here . . . . and have found them correct and in order, and we further certify that the present aggregate Market Value thereof is in excess of the amounts in the Balance Sheets."

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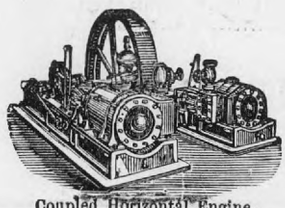

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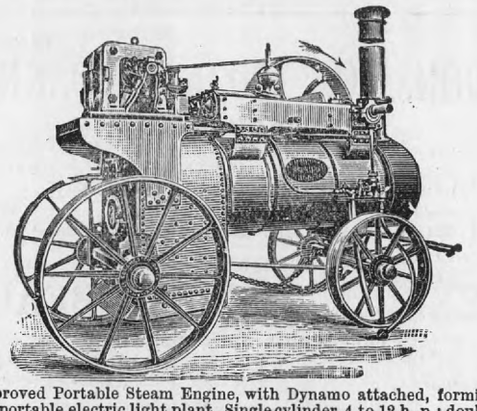

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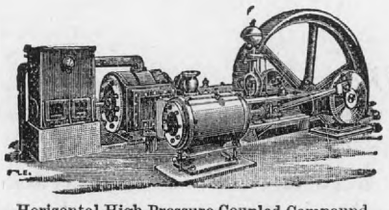

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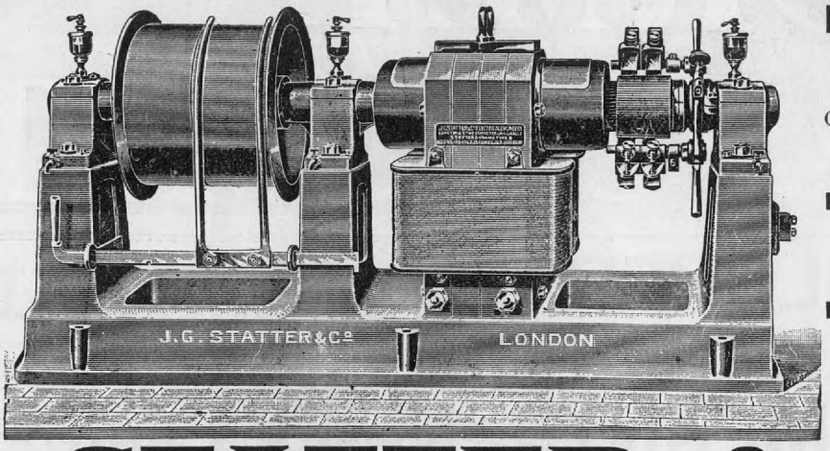

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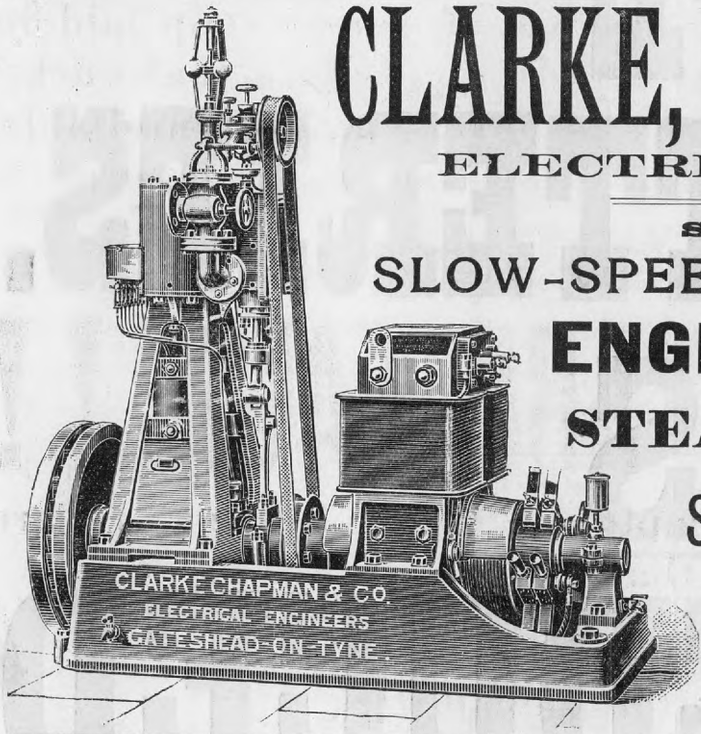

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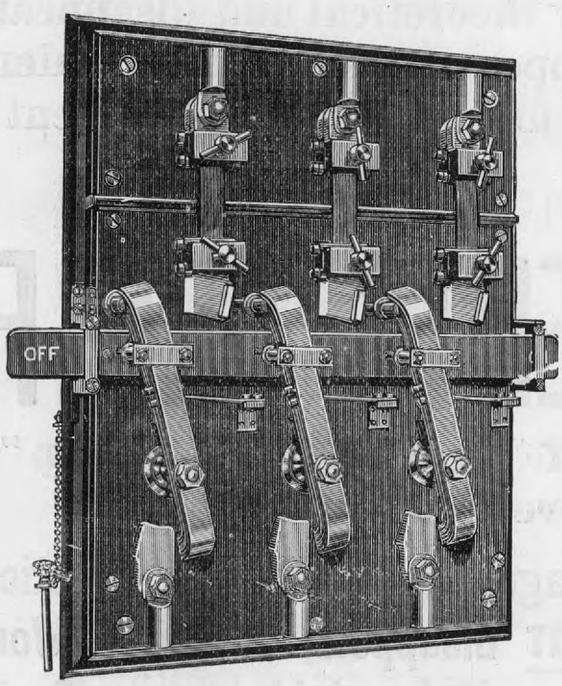

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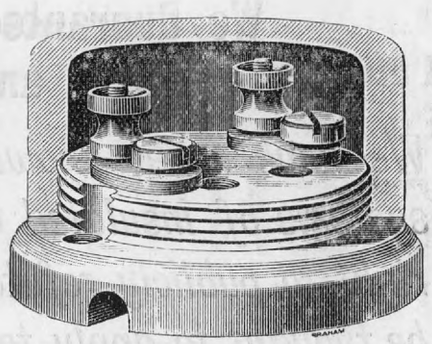

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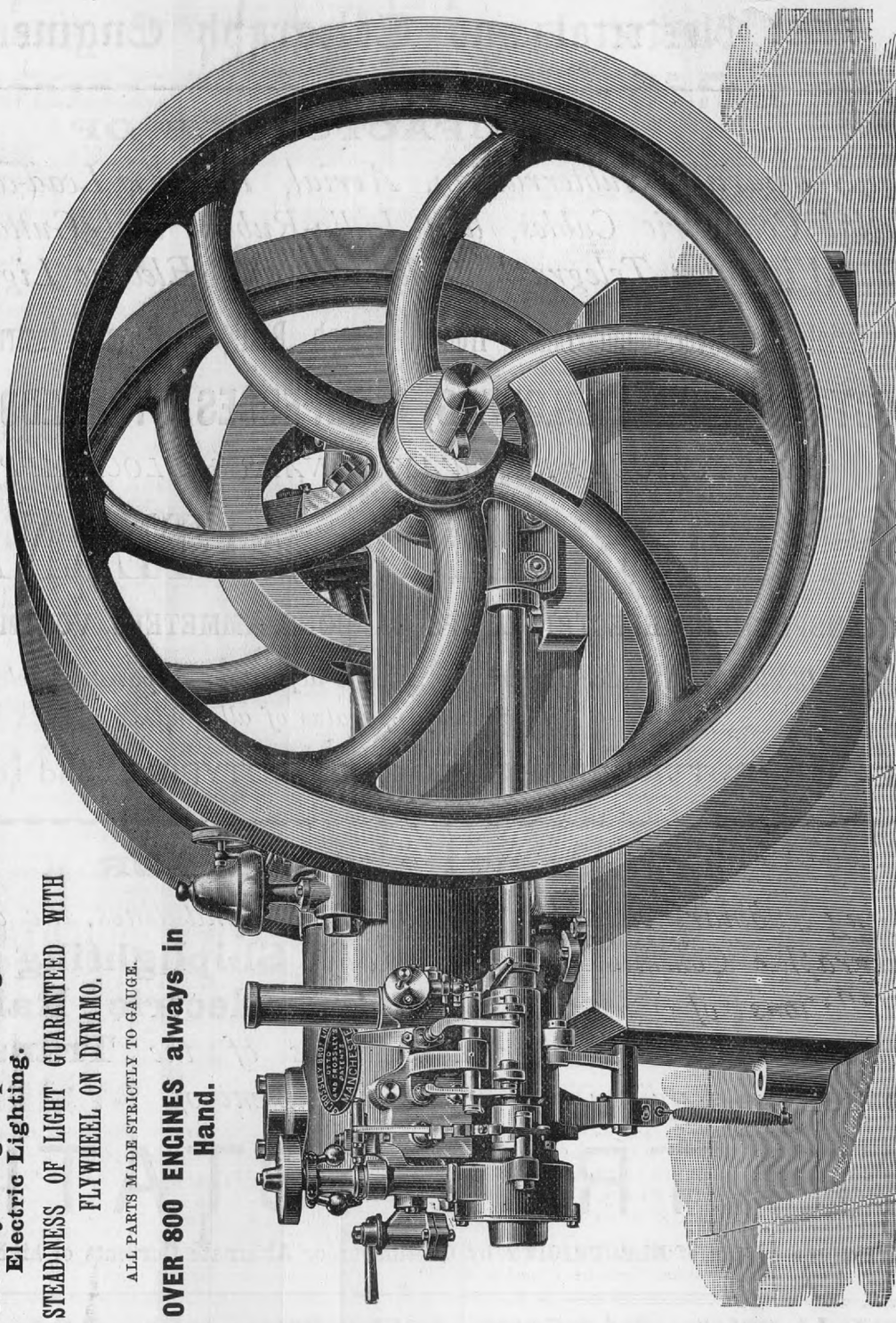

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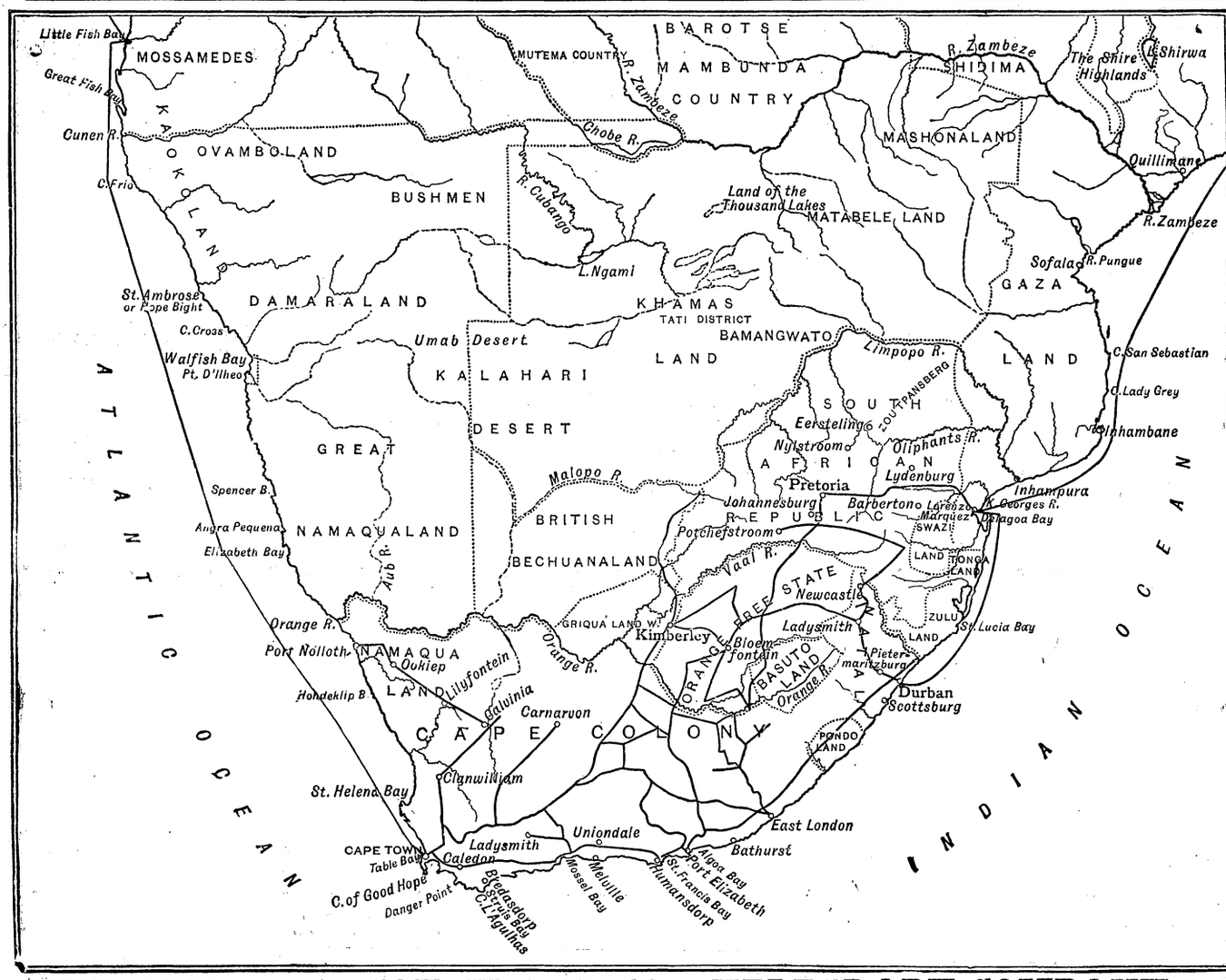

THE EASTERN & SOUTH AFRICAN TELEGRAPH COMPANY, Ltd.
THE AFRICAN DIRECT TELEGRAPH COMPANY, LIMITED, AND
THE WEST AFRICAN TELEGRAPH COMPANY, LIMITED.

The above Companies, by means of Cables along the East and West Coasts of Africa, as shown in the Map on the opposite page, connect the following Colonies and Dependencies with the European System of Telegraphs:—

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CAPE COLONY.	NATAL.
ORANGE FREE STATE.	TRANSVAAL.

EAST COAST.

ZANZIBAR. MOZAMBIQUE (Portuguese). DELAGOA BAY (Portuguese).

WEST COAST.

BRITISH.	*PORTUGUESE.*	*FRENCH.*
BATHURST (Gambia).	BISSAO.	CONACRY.
SIERRA LEONE.	BOLAMA.	GRAND BASSAM.
ACCRA.	PRINCIPE.	KOTONOU (Porto Novo).
LAGOS.	SAO THOME.	GABOON.
BRASS.	LOANDA.	
BONNY.	BENGUELA.	
ELMINA.	MOSSAMEDES.	
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Books of Forms, Tariff and all Information can be obtained at the Companies' Head Offices, Winchester House, 50, Old Broad Street, E C.

By order,

H. E. PLANK, *Secretary*, AFRICAN DIRECT TELEGRAPH COMPANY.

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J. CAMBROOK, *Secretary*. WEST AFRICAN TELEGRAPH COMPANY.

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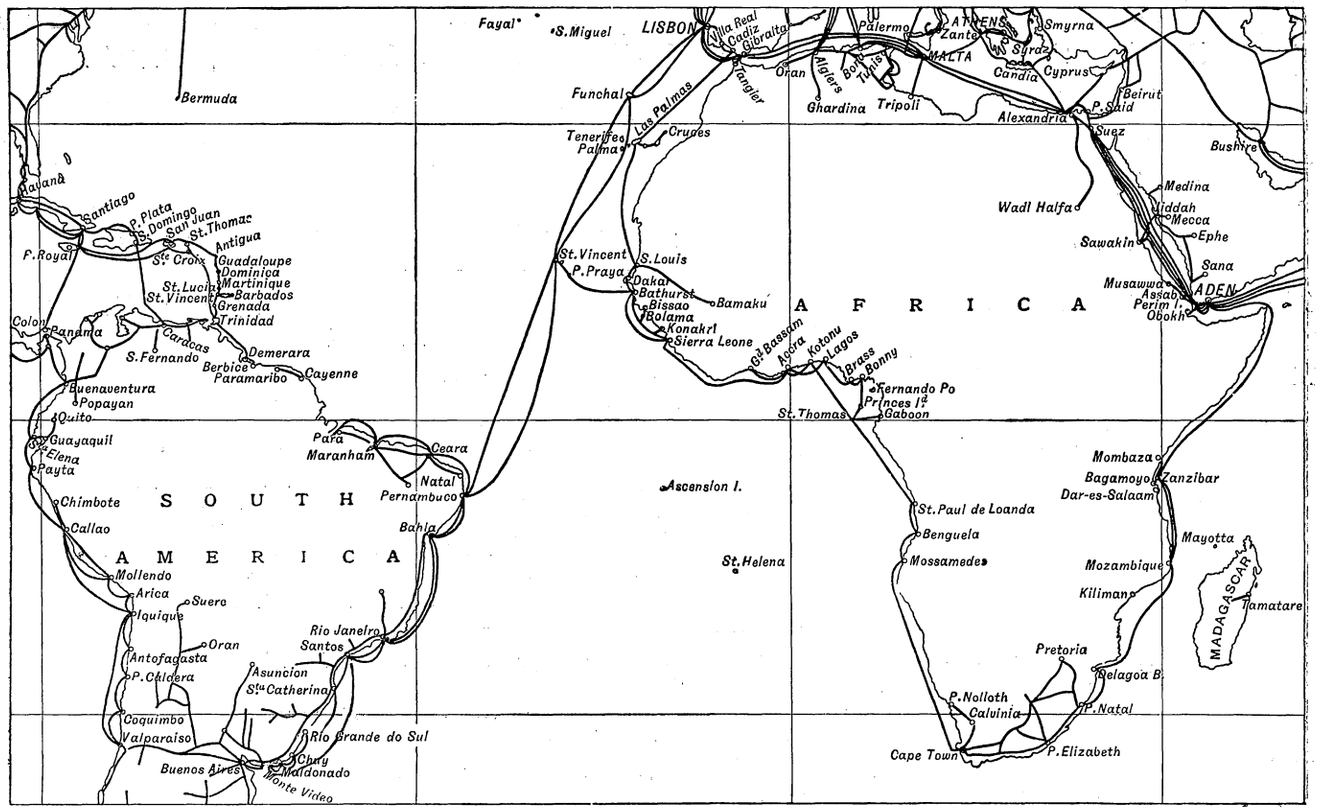

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LTD.

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THE above Companies connect the Continent of Europe with that of South America by means of the DIRECT DUPLICATE Cables from Lisbon via Madeira and St. Vincent to Pernambuco, Bahia, Rio de Janeiro, Santos, Monte Video and Buenos Ayres, also by cable from Pernambuco to Ceara, Maranham, and Para.

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	s.	d.
Madeira	1	2
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,, ,, St. Iago	3	5
Brazil—Pernambuco	5	4
,, All other Stations	5	9
Uruguay—All Stations	5	9
Argentine Republic—All Stations	5	9
Paraguay—All Stations	5	9
Bolivia—All Stations	7	8
Chili—All Stations	8	10
Peru—All Stations	8	2
Ecuador—All Stations	11	3
Colombia—All Stations	12	0

Tariff-Cards, Books of Forms, and all information can be obtained at the Head Offices of the Companies. Messages should be marked "Via Eastern."

BY ORDER,

RICHARD COLLETT, *Secretary*,

BRAZILIAN SUBMARINE TELEGRAPH CO.,

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THOS. T. ECKERT, President and General Manager.

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21, ROYAL EXCHANGE, LONDON, E.C.
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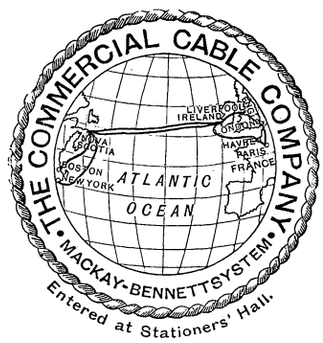
EFFINGHAM HOUSE, ARUNDEL ST., STRAND, LONDON, W.C.
2, NORTHUMBERLAND AVENUE, LONDON, W.C.
A5, EXCHANGE BUILDINGS, LIVERPOOL.
BACKHALL CHAMBERS, BALDWIN ST., BRISTOL.
29, GORDON STREET, GLASGOW.
10, FORSTER SQUARE, BRADFORD.
1, PANMURE STREET, DUNDEE.
106, GEORGE STREET, EDINBURGH.
EXCHANGE BUILDINGS, LEITH.
7, ROYAL EXCHANGE, BANK ST., MANCHESTER.
1, SIDE, NEWCASTLE-ON-TYNE.



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DUPLEX—AUTOMATIC—SPEED.

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CONNECTIONS.

POSTAL TELEGRAPH CO.—The greatest competitive system of Telegraphs ever maintained in the United States, covering all commercial points in the country.

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"Via COMMERCIAL."

To insure your Cablegrams being forwarded by the ONLY INDEPENDENT Atlantic Cable Company, please mark them "Via Commercial," which indication is not charged for; or use this Company's own forms, bearing its GLOBE Trade Mark.

This Company's routes avoid all long land lines on both sides of the Atlantic.

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LIVERPOOL	A1, THE EXCHANGE.
MANCHESTER	7, ROYAL EXCHANGE.
GLASGOW	29, GORDON STREET.
BRISTOL	BACK HALL CHAMBERS, BALDWIN STREET.
NEWCASTLE-ON-TYNE	1, SIDE.
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T. H. WELLS, *Secretary.*

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34, THROGMORTON STREET, E.C.

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General Offices: WINCHESTER HOUSE, 50, Old Broad Street, London E.C.

T. FINNIS, *Secretary.*

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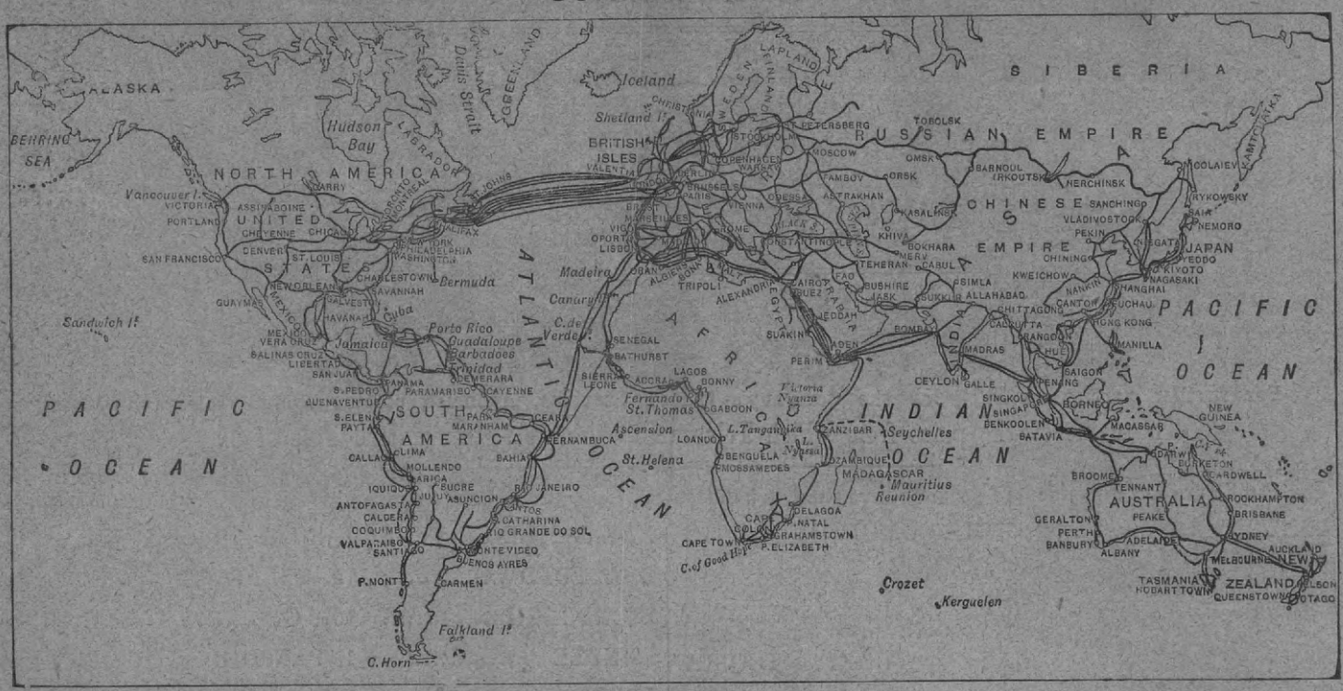
THE EASTERN TELEGRAPH COMPANY'S SYSTEM AND ITS GENERAL CONNECTIONS.



THE EASTERN TELEGRAPH COMPANY, LIMITED.

IN CONNECTION WITH THE

EASTERN EXTENSION (AUSTRALASIA AND CHINA); BRAZILIAN SUBMARINE, EASTERN AND SOUTH AFRICAN, WEST AFRICAN AND AFRICAN DIRECT TELEGRAPH COMPANIES.

By DIRECT TRIPLICATE CABLES, to Spain, Portugal, Gibraltar, Malta, Egypt, Aden, and India.

By DIRECT DUPLICATE CABLE ROUTES to Madeira, St. Vincent, Brazil; and to Suakin, Perim, Penang, Malacca, Singapore, Java, Australia, New Zealand, Tasmania, Bankok, Cambodia, Saigon, Tonquin, Hainan, China.

By ALTERNATE CABLES to Zanzibar, Mombasa, Mozambique (duplicate), Delagoa Bay, and Natal for Cape of Good Hope. Bathurst, Sierra Leone, Accra, Lagos, Bonny, Bolama, Bissao, St. Thome, Principe, Loanda, Benguela, Mossamedes, Conakry, Grand Bassam, and Gaboon, and to Peru, Chili, and South America.

By SINGLE CABLE to Manila.

Telegrams should be sent from the Company's Stations—

LONDON—11, OLD BROAD STREET, E.C.; 8, LEADENHALL STREET; 3, GREAT TOWER STREET; 42, PARLIAMENT STREET, WESTMINSTER, OR 37, HOLBORN VIADUCT, E.C.; AND

MANCHESTER—20, Brown Street. LIVERPOOL—K13, Exchange Buildings.

GLASGOW—5, ROYAL BANK PLACE.

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Maps and Books of Forms and Tariffs forwarded post free on application at the Company's Chief Offices as above, or at

12, RUE CAUMARTIN, PARIS; and HOTEL DES POSTES ET TELEGRAPHES, MARSEILLES

Winchester House, 50, Old Broad Street, E.C. By Order, GEORGE DRAPER, *Secretary.*

Printed and published for the Proprietors by GEORGE TUCKER, at the Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of London, FRIDAY, APRIL 28, 1893.

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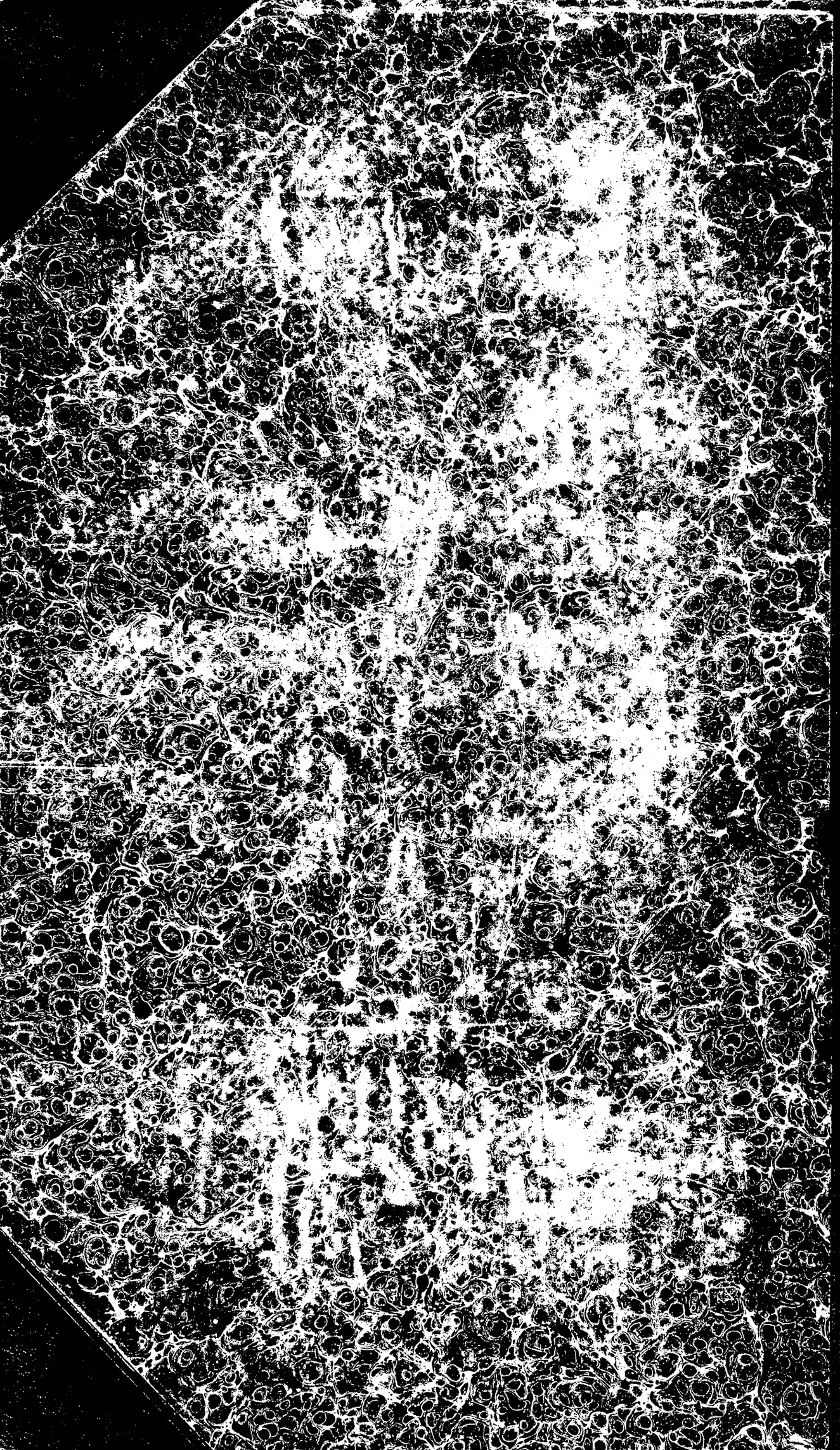
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